Healthcheck Phase 2

Australian Fisheries Healthcheck

Alistair J. Hobday, Jason R. Hartog, Emily Ogier, Linda Thomas, Aysha Fleming, Sara Hornborg

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Researcher Contact Details

Name: Alistair Hobday
Address: Castray Esplande
Hobart
Phone: 62325310
Fax:
Email: alistair.hobday@csiro.au

FRDC Contact Details

Address: 25 Geils Court
Deakin ACT 2600
Phone: 02 6285 0400
Fax: 02 6285 0499
Email: frdc@frdc.com.au
Web: www.frdc.com.au

In submitting this report, the researcher has agreed to FRDC publishing this material in its edited form.

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Executive Summary

Sustainability is a broad and complex concept, and consideration of the diverse suite of factors involved in social, economic, ecological and governance arrangements is needed to create truly sustainable food production industries. Australian fisheries encompasses a much broader range of issues than just status of the target species. This recognition is important for the seafood industry and for stakeholders and customers nationally and internationally.

The Healthcheck comprises a framework, guidance document, and data compilation providing summary data to transparently, independently and comprehensively support reporting on a broad range of sustainability issues relevant to Australian fisheries. These data can be used by a wide range of stakeholders to understand sustainability issues and reuse in other formats.

Provision of information on Australian fisheries that spans biological, economic, governance and social components is supported by the stakeholders involved in this research, consistent with international trends. Consistent comparative treatment of Australia's national and state fisheries can allow comparisons with international fisheries.

Background

The first Healthcheck project (FRDC 2014-008) developed an approach to provide information on the performance of Australian commercial fisheries in four categories (biological, economic, governance and social) using a total of 32 indicators. The first phase also developed the mechanics to support a data repository and a draft web-portal providing the indicator data for Australian fisheries. The approach was tested on three fishery case studies which revealed some difficulty with obtaining data on all indicators, and a need for more work on the coverage of categories and indicators.

In the current project, the Healthcheck was expanded, updated, and tested on a wide range of case studies. The specific project objectives were:

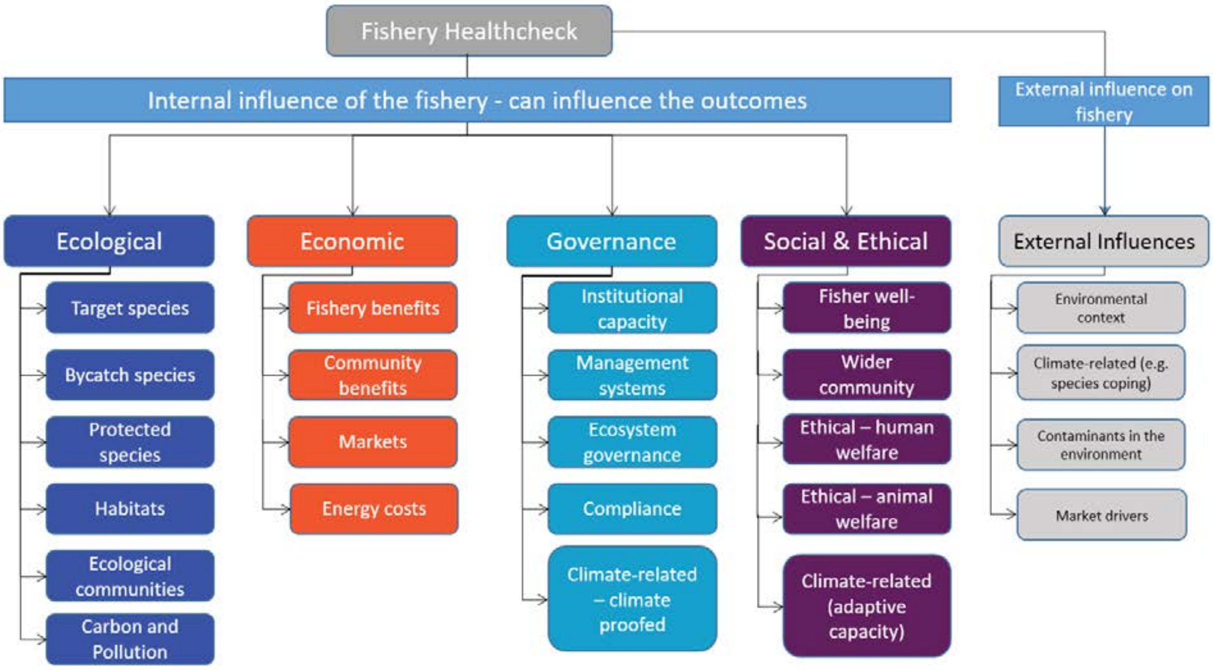
- Objective 1. In consultation with fisheries stakeholders refine a broad range of criteria and indicators for reporting the status of Australian fisheries.
- Objective 2. (revised) Complete case studies for Australian fisheries drawn from all jurisdictions and upload to web-based repository.
- Objective 3. Refine the pathway for linking these fishery-level reports with the stock status reports (SAFS) and handing over methods to appropriate jurisdictions for updating the reports into the future.
- Objective 4. With the expert group provide input into sustainability discussions relating to this project and broader national initiatives.

Methods

The Phase 2 project team undertook an examination of newly-published assessments, papers and popular media, as well as reanalysis of the process of identifying categories and sub-categories. We reconsidered sub-categories not yet commonly included in assessments and were previously seen as ‘over the horizon’ in Phase 1. These forms of review were undertaken to address, firstly; the comprehensiveness of the categories and sub-categories in response to current and emerging challenges; and secondly, whether sub-categories of fisheries performance outside of the scope of public fisheries management and administration should be included. We retained the structure of categories and subcategories, but expanded these to accommodate new issues.

Main Results

A structure representing the areas important to understanding sustainability of fisheries was further developed in Phase 2 of the Healthcheck project. The structure covered four categories, relatively common to sustainability assessments, biological, economic, governance and social and ethical. The Framework also recognises that a range of external issues (category 5) can also affect fisheries sustainability (positively and negatively). Each of the five categories contains between 4 and 6 sub-categories, each represented by 2 indicators. Revision of the initial Framework from Phase 1 of the Healthcheck project showed the structure was flexible to inclusion of additional subcategories including those issues on the horizon.



A set of Guidelines for gathering information for each indicator was developed, and tested on 20 case study fisheries from each jurisdiction in Australia. This revealed that information was not equally available across indicators, or fisheries. Data were available for 81% of all indicators across the 20 fisheries. By category, data were available for 76% of Ecological indicators, 63% of Economic indicators, 98% of Governance indicators, 46% of Social and Ethical indicators, and 91% of External indicators. This pattern of missing information can help prioritise additional data preparation or collection efforts by fisheries and strategic research by agencies and other research providers.

Implications for stakeholders

Community awareness and recognition of fisheries was perceived to be low based on the perceptions of the interviewed stakeholders. The Healthcheck can contribute to a broader understanding of sustainability, and illustrate the range of issues that are being addressed by fisheries and fisheries management agencies.

The Healthcheck as an information resource will provide transparency and trusted data across the spectrum of sustainability issues, for a wide range of users, including the fishing industry, fisheries managers, media, seafood certification schemes, the "informed" public, NGOs, other agencies with non-regulatory interests (e.g. Departments of Environment).

Recommendations

The remaining issues to address if the Healthcheck system were to be operational are related to Objective 3, the alignment and linking to existing data management and access.

Once updating and information delivery is finalised, then the number of fisheries considered can be increased. A similar prioritization as used by the SAFS approach (by value or volume) can be used to stage the work.

For this vision to be fully achieved, participatory processes that involve interested stakeholders in development of fishery assessment frameworks, prioritization of useful indicators and testing the systems for accessing and delivering the information, are needed.

This project has delivered a framework and an improved understanding of the need for broad sustainability reporting, however, without progressing to this next stage of development, the investment to date will not be fully realized.

Keywords

assessment, sustainability, Australian seafood, indicators, Eco-certification,

Introduction

Background

A holistic picture of the sustainability of Australian fisheries is needed to inform both the general public and public and private organisations about the sustainability of Australian fisheries. The Phase 1 Healthcheck (FRDC 2014/008) described an approach to summarise available information to document the sustainability of Australian fisheries - efficiently, consistently, comprehensively and transparently. The Phase 1 Healthcheck categories included social, economic and governance factors not consistently included in fishery assessments to date, alongside common biological considerations, such as stock status.

If implemented, a fisheries Healthcheck portal will support transparent and efficient access to commercial fishery information such as bycatch levels or economic performance which will then serve in tandem with the Status of Australian Fish Stocks reports (SAFS) as the 'go to' source of overview information about individual fisheries. An online evaluation tool could provide clear information on the strengths and challenges for Australian fisheries across a range of indicators. To make this online tool operational, additional fisheries information would need to be added, and wide consultation with potential users undertaken.

This Phase 2 project explored support for the concept of providing data on a wide suite of fisheries indicators. This data provision can show that Australian fisheries consider a much broader range of issues than just status of the target species. This recognition is important for the seafood industry and for customers nationally and internationally. Consistent comparative treatment of Australia's national and state fisheries is important, and will also allow comparisons with international fisheries. Without a proactive presentation of the health of Australian fisheries, third party reports (e.g. seafood guides) will be the only "comprehensive" source of information for Australian seafood. These third party reports, while often comprehensive, fail to consider the range of indicators that we consider a complete assessment of sustainability.

The main output from the project is development of templates for the reporting of fisheries status across the five elements of sustainability (the four identified in phase 1 of the project, and the external influences category identified in this phase). This output represents a holistic checklist for agencies to consider if they are actively managing or assessing all relevant dimensions of fisheries performance, and for industry as to whether they are actively addressing the dimensions of industry self-management that they are increasingly held to account for.

A scientific overview of the context for this work is provided in the Introduction of Hobday et al. 2018 (**Appendix 6).**

Need

Sustainable fishing is typically used to imply sound use of a sustainable resource. Australian fisheries are recognized as world leading with regard to research and management (Hobday et al. 2018), yet that message is still not being heard by many Australians, potentially eroding support for this industry. Recent events have shown that information about fishery performance with regard to target species is no longer sufficient for many Australians.

Increasing attention in media and society-at-large is now given to a range of other fishery issues, including bycatch, economic performance, stock status and social/societal issues. For example, the arrival and subsequent debate around the use of factory trawlers in southern Australia exposed the confusion and different perspectives present in the Australian community (Haward et al. 2013; Tracey et al. 2013). Thus, for Australian fisheries, it is no longer just about catching fish - it is about a sustainable industry and management of a range of other issues. We lack a framework for transparently, independently and comprehensively reporting on these issues.

Phase 2 continued the development of a reporting framework for the status of Australian fisheries across a range of issues, as a companion to the ABARES-led stock status report (SAFS). This assessment template and the associated case studies has provided a holistic picture of the sustainability (biological, social, economic and governance) of key Australian fish fisheries to inform the broader seafood sustainability debate. This project will provide fisheries managers and other stakeholders with a clear view of successes, strengths, and challenges. This template could form the basis for performance reporting on fisheries or for use in other efforts such as State of Environment Reports. This work is needed to see Australian fisheries recognized more widely amongst the general public for the strong sustainability focus, and the strengths compared to other nations. This assessment approach draws on a wide range of existing research and management outputs, can be made widely accessible, and based on an inclusive development and consultative process, is likely to be trusted by the fishing sector and the Australian public.

Users of the Healthcheck

The Healthcheck does not provide an overall assessment of sustainability for a fishery, but aggregates comprehensive and quality data from existing sources, including fisheries agencies, the stock status (SAFS) and other sources (**Figure 1**). The Healthcheck (when operational) will provide information on indicators which can be used by a wide array of users (media, fisheries managers and departments, seafood retailers and suppliers, and seafood guides) to assess sustainability. Each of these users will consider the information in different ways.

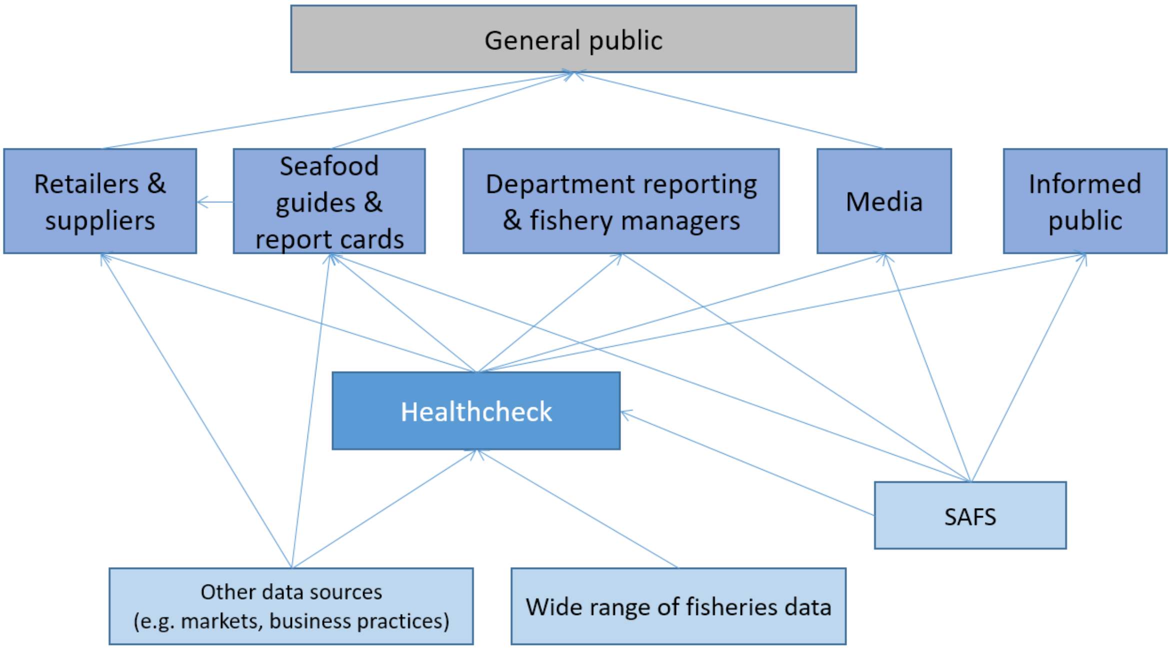


Figure 1: Summary of data flow from original sources, to the Healthcheck, and then to a range of other users.

The starting point for Phase 2 Healthcheck

The Phase 1 Healthcheck project (FRDC 2014/008) proposed a broad Australian sustainability framework, with four categories and 16 sub-categories (**Figure 2**). To briefly recap, in the Phase 1 approach we reviewed the frequency with which particular information categories and indicators were used in existing seafood assessments applied both in Australia and globally. We then compared these with the issues raised during the stakeholder engagement as important for inclusion in a broad sustainability assessment framework for Australian commercial fisheries. This informed the initial selection of categories and sub-categories.

We used four categories (representing overarching objectives) and 16 subcategories (representing specific performance areas) based on an extensive review of 54 seafood assessment and reporting schemes. The development of these sub-categories and categories drew on existing frameworks elsewhere and aligned with Australia's National Ecologically Sustainable Development (ESD) framework for wild-capture fisheries (Fletcher et al. 2002), which has informed the design of management goals and objectives for Australian fisheries.

As described in the Phase 1 project report, discussions with representatives from a number of different management agencies, including federal and state fishery management organisations, the Fisheries Research and Development Corporation, fisheries management consultants and academic management experts. These refined the initial structure, and subsequent feedback over the 18 months following the conclusion of Phase 1 was included in Phase 2 project as described below.

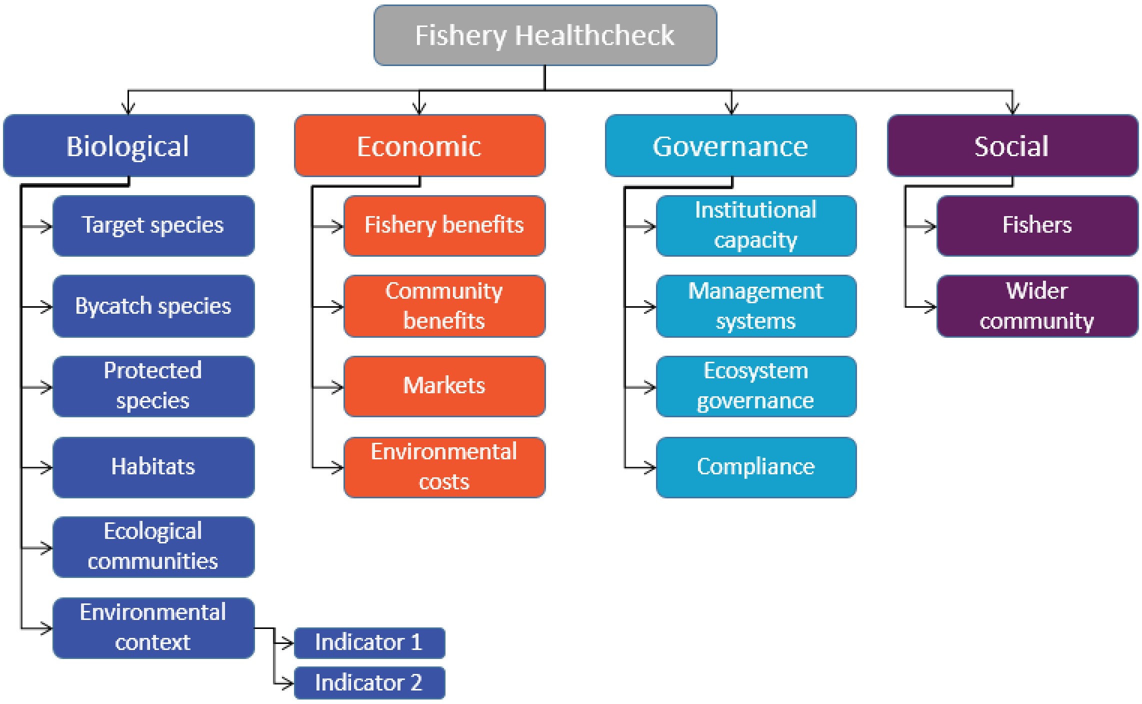


Figure 2: Initial framework from Phase 1 of the Healthcheck illustrating the sustainability framework based on four categories and 16 sub-categories. This structures has been enhanced in Phase 2.

Objectives

The Phase 2 project had 4 objectives, as below. Only Objective 2 was modified during the project.

Objective 1. In consultation with fisheries stakeholders refine a broad range of criteria and indicators for reporting the status of Australian fisheries

Objective 2. (original) Complete case studies for Australian fisheries drawn from all jurisdictions and upload to web- based application

- Objective 2 was changed to place less emphasis on the web-based case study delivery. It was also clear that by the time of publishing the case studies, the indicators presented, or at least some of them, would already be out-of-date. In discussion with the National Priority 1 steering committee and FRDC the decision was to make a simple repository of the case studies and make them available as pdf documents, rather than spending time developing an interactive website. Instead, the project team focused on how to demonstrate methods for machine to machine communication of indicators and provide this as a template for other agencies, as presented in the Results and Discussion.

Objective 2. (revised) Complete case studies for Australian fisheries drawn from all jurisdictions and upload to web-based repository *The difference is the repository will not be interactive but simply store the PDF documents.*

Objective 3. Refine the pathway for linking these fishery-level reports with the stock status reports (SAFS) and handing over methods to appropriate jurisdictions for updating the reports into the future

Objective 4. With the expert group provide input into sustainability discussions relating to this project and broader national initiatives

Method

Objective 1

In consultation with fisheries stakeholders refine a broad range of criteria and indicators for reporting the status of Australian fisheries

Following Phase 1 workshops and interviews, the initial Healthcheck structure **(e.g. Figure 2)** was discussed and presented to a wider range of stakeholders at peak body meetings, national conferences, and industry events over an 18 month period, before being revised and updated on the basis of feedback as part of Phase 2.

The Phase 2 project team, which included new members with additional expertise (**Appendix 1**), undertook an examination of newly-published assessments, papers and popular media, as well as reanalysis of the process of identifying categories and sub-categories. We reconsidered sub-categories not yet commonly included in assessments and were previously seen as ‘over the horizon’ in phase 1. These forms of review were undertaken to address, firstly; the comprehensiveness of the categories and sub-categories in response to current and emerging challenges; and secondly, whether sub-categories of fisheries performance outside of the scope of public fisheries management and administration should be included. This process of revision also tested the flexibility of the Healthcheck framework to accommodate new issues (Hobday et al. 2018). We retained the structure of categories and subcategories, but expanded these to accommodate new issues.

Engagement with the FRDC National Priority 1 steering committee was important in scoping issues that might be included in a revision of the Phase 1 framework. Indicators were selected for each sub-category. We also undertook a range of interviews to assess the revised framework.

Selection of indicators

We reviewed a large number of indicators as described in Phase 1, updated these in Phase 2, and refined the final set based on criteria for the **indicator** and/or **data** behind the indicator. Between 2 and 4 draft indicators were then considered in each of the sub-categories. The indicators could be quantitative, semi-quantitative, or qualitative. We considered the potential inclusion of each indicator using criteria described in **Table 1**. These criteria are related to the indicator itself, or the data that would be used to represent the indicator, as explained in the table. This step helped the project team to refine the final choice for each sub-category. Only the final indicator set is reported in the results, as this was an iterative process of refinement.

Table 1: Criteria for assessing indicators to be used in the Healthcheck. In considering the indicators, each was scored as 1 (yes), 0 (no) by the project team to inform inclusion and refinement.

Indicator will be useful if it is…	…which is interpreted as:
1. Objective	**Indicator** is directly related to the sub-component (transparent).
2. Established	**Indicator** is generally accepted as appropriate by general stakeholders (e.g. stock status, vs ecosystem structure)
3. Interpretable	**Indicator** can be clearly interpreted with respect to trends or values, and not be able to be interpreted in multiple ways (e.g. up is good, down is bad)
4. Important/Relevant	**Indicator** is important and relevant (connected) to the management and policy goals under existing processes, or on the horizon (noting that the Healthcheck will be ahead in some cases). The indicator should have significance not just readily/easily obtainable.
5. Available	**Data** for the indicator are readily available from existing reports, datasets, or online databases. OR **Data** for the indicator should be possible to measure using existing methods, technologies or data sources.
6. Inexpensive	**Data** for the indicator are inexpensive with respect to time & money to obtain if they are available (#5a) or to collect if not available (#5b).
7. Direct	**Data** are a direct measure of the desired indicator (e.g. population size), rather than a proxy (e.g. frequency in catch).
8. Consistency of responses to above	Criteria for these **indicators** would be scored similarly for most fisheries we are considering and **data** for the indicators are similarly available across fisheries.

Soliciting feedback with interviews

To solicit additional feedback, we conducted 21 interviews with stakeholders who may use a Healthcheck in the future. The interviewees asked about key issues of interest and current information sources, potential risks and any other suggestions for how a potential Healthcheck might be developed and presented, who the Healthcheck would be best tailored to and how it might be best used. This approach was similar to that used in Phase 1, and reported in Hobday et al. (2018).

The phone interviews were conducted with representatives from government departments, the media, and indigenous organisations. We also completed several interviews with representatives from marine conservation organisations and fishery managers not included in Phase 1. All participants were interviewed by phone for approximately 30 minutes. The interview questions are provided in **Appendix 2,** and this project element received ethics approval from the CSIRO human ethics committee. A list of participants and full transcripts are securely held by the project team, but these details are not included in the results presented here.

Implementing the Healthcheck framework

Once the categories and sub-categories were developed, and indicators selected, we developed guidance for collating information for each indicator. This Guideline document follows a hierarchical approach, as shown in the results.

It was also important to recognise the very iterative process followed by the project team in populating the case studies, which informed the development of scoring rubrics, metric definitions, and data handling for each indicator, and refinement of indicators. This year-long process resulted in the final Healthcheck Guideline document (**Appendix 3)**, and is one of the major project outputs (along with case studies).

Comparison with Australian fishery objectives

The Healthcheck assessment framework was compared with the management objectives and indicators used in the fisheries management frameworks of the 20 case study fisheries. Management objectives were defined as the goals for a specific managed fishery that are consistent with policy (adapted from the FAO 2002; 2003). They are typically stated in management documents for a specific fishery. The purpose of this analysis was to determine the level of equivalence and coverage of the Healthcheck assessment framework with Australian fisheries management goals and performance assessment frameworks, and to highlight areas of divergence for further consideration. To do this we compared the themes of:

- Healthcheck sub-categories and those of stated management objectives of each fishery
- Healthcheck sub-category indicators and the performance indicators for stated fisheries management objectives

Objectives and performance indicators for the 20 case study fisheries were collated from fisheries management acts, management plans and harvest strategies and tabulated. Objective hierarchies (Pascoe et al. 2013) were generated in which performance indicators were listed with the most defined and operational level of management objective within the same theme. The unit of analysis was the objective unit, which comprised: high level objective; subsidiary operational level objective, performance indicator.

Thematic content analysis was undertaken by means of a first pass analysis of objective units to identify key theme terms used. Secondary analysis was undertaken to relate those key theme terms to any Healthcheck sub-categories sharing the same or similar key theme terms. A similar process was undertaken for performance indicators used for fisheries management, and the indicators selected for Healthcheck sub-categories.

We then analyzed the frequency of Healthcheck sub-category themes identified in management objectives, and of Healthcheck indicators in fisheries performance indicators in MS excel.

Objective 2

Complete case studies for Australian fisheries drawn from all jurisdictions and upload to web-based repository (revised).

We sought case studies in order to ensure that we tested the Healthcheck approach for a range of gear types, low and high value fisheries, presumed likely data availability (sufficient or limited), single or multi-species fisheries, certification status (Yes/No) and market (predominately domestic, or domestic and international). The process of selection was based on the need to span these dimensions. Fisheries from all Australian jurisdictions were included in the final set of 20 case studies (**Table 2**).

Table 2: Summary characteristics for fishery case studies.

Case study	Fishery	Jurisdiction	Gear	Value (L/H) (>10m /YR)	Data (sufficient/limited)	Species (single/multiple)	Eco-certified (Y/N)	Market (domestic/international)
1	ETBF	Comm	Longline	H	S	M	N	D/I
2	SESSF - Otter trawl	Comm	Trawl	H	S	M	N	D/I
3	Northern Prawn	Comm	Trawl	H	S	M	Y	D/I
4	Heard Island and McDonald Island Fishery	Comm	Midwater trawl	H	S	M	Y	D/I
5	Spanner Crab - Ocean Trap and Line	NSW	Trap	L	L	M	N	D
6	Ocean Haul	NSW	Purse seine	L	L	M	N	D
7	Mud Crab	NT	Trap	L	L	S	N	D
8	Offshore snapper	NT	Line, Net	H	L	M	N	D
9	Coral reef finfish	QLD	Line	H	S	M	N	D
10	Blue swimmer crab	QLD	Trap	L	L	S	N	D
11	Spencer Gulf Prawn	SA	Trawl	H	S	S	Y	D/I
12	Lakes and Coorong - Pipi	SA	Hand	L	S	S	Y	D
13	Lakes and Coorong - Net	SA	Net	L	S	M	N	D
14	Turbo	SA	Dive	L	L	S	N	D
15	Scalefish	TAS	Net	L	L	M	N	D
16	Abalone	TAS	Dive	H	S	S	N	D/I
17	Rock Lobster	VIC	Trap	H	S	S	N	D/I
18	Scallop	VIC	Dredge	H	S	S	N	NA
19	Abalone	WA	Dive	H	S	S	Y	D/I
20	Southern & West Coast demersal gillnet & longline	WA	Net	L	L	M	N	D

We examined the availability and quality of data for each of 50 indicators for each fishery, using the recipe for each indicator as described in the Guidelines (**Appendix 3)**, and present summaries for the data availability by indicator and by fishery. This process of data collation involved refinement of indicators and data choice. In some cases, data were available, but could not be processed efficiently in the time available for the project team. We have noted availability in such cases. Data that were available for an indicator were rated on the basis of the information quality (**Table 3)**.

Table 3: Data quality for each indicator was scored as Bronze, Silver or Gold. Examples of the quality for a quantitative and qualitative indicator are shown in this table. Refer to Appendix 3 for detailed data quality information about specific indicators.

	Gold	Silver	Bronze
Interpretation	Direct information	Proxy or robust alternative	Weakest or most general evidence available
Example of information quality for a **quantitative** metric	Specific information is available for the fishery, species or habitat (and is obtained from the last 5 years)	Information is available for like fisheries, species or habitats in Australia (or as for Gold, but more than 5 years old)	Information is available for like fisheries, species or habitats elsewhere in the world
Example of information quality for a **qualitative** metric	A specific policy covering the fishery exists and is backed up by evidence of action in the fishery.	A specific policy covering the fishery exists	A national document exists

Indicators for which data could not be provided were noted in each fishery case study with the additional data quality terms:

1. Not found by the project team
2. Not organised/analysed
3. Not released
4. Not collected

These fishery case study documents were sent to the appropriate fishery manager for review – we sought input on the data acquired, and potential sources for data for indicators that we could not locate.

These results are presented as fishery documents, which are loaded to a web-based repository, and included as **Appendix 4** to this report.

Objective 3

Refine the pathway for linking these fishery-level reports with the stock status reports (SAFS) and handing over methods to appropriate jurisdictions for updating the reports into the future

This objective was achieved via a range of meetings and discussions with National Priority 1 steering committee, and FRDC IT and data managers. FRDC are the current host of the SAFS process, and have experience linking information produced by scientists and managers to existing web-servers and data processes through to delivery of on-line reports and portals. We also held discussions with Queensland Fisheries scientist Anthony Roelofs who is leading a data delivery and maintenance project.

Objective 4

With the expert group provide input into sustainability discussions relating to this project and broader national initiatives

This component of the project involved members of the project team attending meetings with the National Priority 1 Steering committee, and interactions with our steering committee. As part of these discussions, we considered how the Healthcheck aligned with other sustainability initiatives.

Comparison with other initiatives

We compare the Healthcheck to several other initiatives, seeking to provide insight into how information gathered using the Healthcheck structure would complement information needs for these other initiatives.

Results and Discussion

Objective 1: The Healthcheck Framework

In consultation with fisheries stakeholders refine a broad range of criteria and indicators for reporting the status of Australian fisheries

Development of broader sustainability frameworks is of world-wide interest, however, there are many existing global assessment schemes (Roheim, 2009; Hilborn et al. 2015; Hobday et al. 2016). According to study participants in Phase 1 (Hobday et al. 2018), a reporting framework that supports these many existing assessments, rather than adds more competition, represents the best option. Thus, rather than developing another competitor scheme for Australia, the Healthcheck seeks to gather, verify and provide existing data across the sub-categories identified for use in any already existing assessment.

As described in the methods, the project team reviewed emerging issues in seafood sustainability, consulted with a wide range of stakeholders, and updated the Phase 1 framework. The development of these sub-categories and categories drew on existing frameworks elsewhere, and aligned with Australia's National Ecologically Sustainable Development (ESD) framework for wild-capture fisheries (Fletcher et al. 2002), which has informed the design of management goals and objectives for Australian fisheries and may be used in the future to support certification schemes.

The revised framework spanned four categories over which a fishery and the management system has some control, and a fifth category (External Influences) that influences fishery sustainability, but in which external influences dominate, and a fishery may have little control (**Figure 3**). This final category is to provide information to stakeholders about issues which can threaten fisheries sustainability, yet are outside the domain of direct influence. For example, contaminants from other sources of pollution (e.g. mercury) may limit the ability of the seafood sector to provide safe food. Without action to manage this impact, industry sustainability may be impacted. A total of 24 sub-categories were included across the five categories. The number of sub-categories varies across the categories, represented by between 4 and 6. This is not an issue for concern, as the Healthcheck is a provider of information on fisheries, and the indicators are not scored or aggregated in anyway.

The new sub-categories added in Phase 2 were in the Biological (carbon and pollution), Economic (energy costs), governance (climate-related responses), social and ethical (human welfare, animals welfare, and climate-related adaptive capacity) categories. All five sub-categories in the external influences category were new. This structure was evaluated by external peer reviewers (Hobday et al. 2018), the project steering committee, and stakeholders as described in the several of the following sections.

New sub-categories (and hence indicators) can be added in future, as new issues are identified.

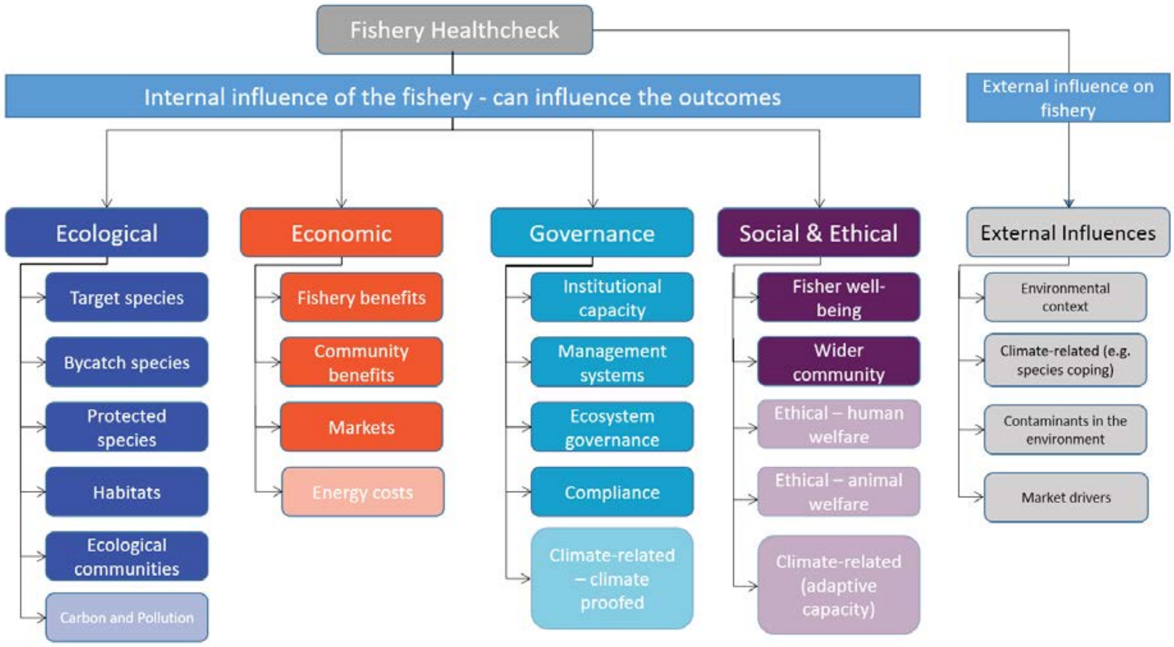


Figure 3: Revised framework, showing five categories, including one covering external influences, and 24 sub-categories, with new areas indicated by a transparent background.

Selection of indicators

The process of selecting suitable indicators was an iterative process which was refined during the development of the case studies and from feedback with steering committee and others as part of Objective 4, and we show only the final retained indicators (**Table 4)**. Each indicator in turn was represented by a metric (data), which was quantitative, semi-quantitative, or qualitative.

Some existing sustainability assessments (Hobday et al. 2018) provide scores for particular issues (indicators), or an overall rating of the fishery or target species. However, the focus of the Healthcheck is provision of accurate and detailed information rather than an overall score or rating of a fishery as ‘good’ or ‘bad’. As discussed in detail in the Healthcheck Phase 1 report, an overall score is also illogical given the breadth of sustainability issues. Some sustainability issues or goals, such as economic value, may also conflict with others, such as ‘maximise employment’, and so reporting of scores for a fishery would hide important trade-offs that stakeholders may need to understand in more depth before judging if the fishery met their sustainability standards. The inclusion of information on the rationale for each indicator in the Guidelines document (**Appendix 3**) also seeks to improve the knowledge base regarding sustainability issues.

Table 4: Summary of the indicator assessment against 8 suitability criteria. The metric number is used in data management. The criteria are defined in Table 1.

						Criteria								
Category	Sub-category	Indicator	Metric Number	Metric	Qualitative (T), semi-quantitative (S), or quantitative (N)	Objective	Established	Interpretable	Important/Relevant	Available	Inexpensive	Direct	Consistency	Criteria scored (n)
Ecological	Target species	Stock status	1.1.1	SAFS/ERAEF categories	S	1	1	1	1	1	1	1	1	8
		Harvest level	1.1.2	Catch weight	N	1	1	0	1	1	1	0	1	6
	Bycatch species	Bycatch composition	1.2.1	mean trophic level	N	1	1	0	0	1	1	0	1	5
		Bycatch amount	1.2.2	total weight	N	1	1	1	1	1	0	1	0	6
	Protected species	Capture amount	1.3.1	total captures	N	1	1	1	1	0	0	0	0	4
		Reporting	1.3.2	Fraction of monitoring by independent observers	N	1	1	1	1	1	1	0	1	7
	Habitats	Habitat impact	1.4.1	Impact score	S	1	1	1	1	1	0	0	1	6
		Habitat status	1.4.2	Habitat status	S	1	0	1	1	0	0	0	0	3
	Ecological Communities	Ecosystem status	1.5.1	Ecosystem status	S	1	0	1	1	1	0	1	1	6
		Ecosystem structure	1.5.2	Species diversity	N	1	1	0	1	0	0	0	1	4
	Carbon and Pollution	Macro-plastics	1.6.1	Plastic code of conduct	T	1	0	1	1	1	1	0	1	6
		Carbon footprint	1.6.2	CO_2-equivalents (kg	N	1	1	1	1	1	1	0	1	7

						Criteria								
Category	Sub-category	Indicator	Metric Number	Metric	Qualitative (T), semi-quantitative (S), or quantitative (N)	Objective	Established	Interpretable	Important/Relevant	Available	Inexpensive	Direct	Consistency	Criteria scored (n)
				CO_2e per kg of fish landed										
Economic	Fishery benefits	Net economic returns	2.1.1	Economic rent	N	1	1	1	1	0	0	1	1	6
		Gross Value of Production (GVP)	2.1.2	GVP	N	0	1	1	0	1	1	1	1	6
		Profitability*	2.1.3	Financial performance	N	1	1	1	1	0	0	1	1	6
		Latency*	2.1.4	Underutilised effort	N	1	0	1	1	1	1	0	1	6
	Community benefits	GDP Value to communities	2.2.1	Contribution to Australia's GDP	N	1	1	1	1	1	1	0	1	7
		Wealth spread	2.2.2	Distribution of fishing firm size	N	1	0	1	1	1	1	1	1	7
	Markets	Fish Distribution	2.3.1	Fish receivers	N	1	1	0	0	1	1	1	1	6
		Volatility in market price	2.3.2	Price volatility	N	1	1	1	0	1	0	1	0	5
	Energy costs	Energy Use	2.4.1	Fuel use (l) per kg of fish landed	N	1	1	1	1	1	1	1	0	7

						Criteria								
Category	Sub-category	Indicator	Metric Number	Metric	Qualitative (T), semi-quantitative (S), or quantitative (N)	Objective	Established	Interpretable	Important/Relevant	Available	Inexpensive	Direct	Consistency	Criteria scored (n)
		Fossil fuel subsidies	2.4.2	Fuel subsidies directed to the fishery (A$/kg fish landed)	N	1	1	1	1	1	1	1	1	8
Governance	Ecosystem governance	Bycatch mitigation	3.1.1	Description of the bycatch mitigation measures	T	1	1	0	1	1	1	0	1	6
		Protected species mitigation	3.1.2	Description of the protected species mitigation measures	T	1	1	0	1	1	1	0	1	6
	Management system	Harvest strategy	3.2.1	Scope of Harvest Strategy	S	1	1	1	1	1	1	1	1	8
		Management plans	3.2.2	Scope of management plan	S	1	1	1	1	1	1	1	1	8
	Institutional capacity	Accountability of decision making bodies	3.3.1	Level of accountability	S	0	0	1	1	1	1	0	0	4
		Uncertainty management	3.3.2	Extent of incorporation of uncertainty	S	1	0	1	1	1	1	0	1	6

						Criteria								
Category	Sub-category	Indicator	Metric Number	Metric	Qualitative (T), semi-quantitative (S), or quantitative (N)	Objective	Established	Interpretable	Important/Relevant	Available	Inexpensive	Direct	Consistency	Criteria scored (n)
	Compliance	Compliance regime	3.4.1	Level of compliance	T	1	1	1	1	1	1	1	1	8
		Surveillance	3.4.2	Surveillance effort	N	1	1	1	1	1	0	1	0	6
	Adaptive capacity - climate related	Governance arrangements	3.5.1	Climate change recognition	T	1	0	0	0	1	1	0	1	4
		Coping strategies	3.5.2	Climate responses	T	0	0	1	1	1	1	1	1	6
Social & Ethical	Fishers wellbeing	Fisher satisfaction	4.1.1	Satisfaction scores	N	1	0	1	0	0	0	1	0	3
		Age structure	4.1.2	Proportion of fishers in standard age cohorts	N	0	1	0	0	1	1	1	1	5
	Wider community	Community satisfaction with fishery	4.2.1	Community feedback	T	1	0	1	0	0	0	1	1	4
		Levels of local employment	4.2.2	Percentage of local employment	N	1	1	1	0	1	1	1	1	7
	Ethical - human welfare	Protections in place	4.3.1	Legislation exists	T	1	1	1	1	1	1	0	1	7
		Level of compliance	4.3.2	Level of compliance	N	1	1	1	1	1	1	0	0	6

						Criteria								
Category	Sub-category	Indicator	Metric Number	Metric	Qualitative (T), semi-quantitative (S), or quantitative (N)	Objective	Established	Interpretable	Important/Relevant	Available	Inexpensive	Direct	Consistency	Criteria scored (n)
	Ethical - animal welfare	Animal Welfare protections	4.4.1	Animal welfare protections in place	T	1	0	1	1	1	1	0	1	6
		Level of compliance	4.4.2	Level of compliance	N	1	0	1	1	0	0	0	0	3
	Climate-related (adaptive capacity)	Access to information	4.5.1	Availability of information	T	1	0	0	0	1	1	0	1	4
		Access to networks	4.5.2	Level of membership of industry association	N	1	1	0	0	1	1	0	1	5
External - impacts on the fishery	Environmental context	Environmental productivity	5.1.1	Mean chlorophyll	N	1	1	1	0	1	1	0	1	6
		Ecosystem character	5.1.2	Description of the ecosystems	T	0	0	0	0	1	1	0	1	3
	Climate related	Susceptibility of target species	5.2.1	Impacts on target species	T	1	0	1	1	1	1	0	0	5
		Susceptibility of key habitats to climate change	5.2.2	Habitat impacts of climate change	T	1	0	1	1	0	0	0	1	4
	Contaminants in the environment	Detection system for seafood contaminants	5.3.1	Risk for concentration of contaminants	S	1	1	1	1	0	0	1	1	6

						Criteria								
Category	Sub-category	Indicator	Metric Number	Metric	Qualitative (T), semi-quantitative (S), or quantitative (N)	Objective	Established	Interpretable	Important/Relevant	Available	Inexpensive	Direct	Consistency	Criteria scored (n)
		Management arrangements to ensure food safety related to contaminants	5.3.2	Evidence for arrangements	T	1	1	0	0	1	1	0	1	5
	Market Drivers	Macroeconomic factors	5.4.1	Exchange rates	N	1	1	1	0	1	1	1	1	7
		Consumer trends	5.4.2	Per capita annual consumption of seafood	N	1	1	1	0	1	1	1	1	7
	24					**45**	**33**	**38**	**34**	**40**	**35**	**23**	**39**	

The 24 sub-categories shown in **Figure 3** were each represented by 2 indicators, with the exception of “fishery benefits”, which was represented by 4 indicators, for a total of 50 indicators (**Table 4)**. A total of 27 indicators were quantitative (represented by numeric data, such as a time series), 10 were semi-quantitative (e.g. represented as “low”, “medium”, or “high” on the basis of a scoring rubric), and 13 were qualitative (represented by text descriptions).

The 50 indicator-metric combinations were considered against each of the criteria (defined in **Table 1**), with 45 considered as “objective” (criteria 1) measures of the sub-category (**Table 2)**. “Ecosystem character” was considered as less objective, as was “age structure” as a measure of fisher well-being, “climate responses” as a measure of coping strategies for climate change, “level of accountability” as a measure of institutional capacity, and “GVP” as a measure of economic benefits of a fishery. These rationale for inclusion of these sub-categories in a sustainability assessment is less mature (e.g. Stephenson et al. 2017), and so as more work is done in these areas, improved indicators may be identified. A total of 33 of the indicator-metric combinations were considered “established” (criteria 2), 38 as clearly “interpretable” (criteria 3, i.e. as “good” or “bad”), 34 as important (criteria 4), 40 as available (criteria 5), 35 as inexpensive (criteria 6), 23 as direct measures of the sub-category (criteria 7), and 39 as “consistent” across fisheries (criteria 8).

The fact that these numbers are all less than 50 (the total number of indicators) suggests that there is ongoing need for development of indictors. It is widely accepted that development of indicators for fishery assessments is a work-in-progress (e.g. Rice and Rochet, 2005; Hobday et al. 2016; Stephenson et al. 2017).

Healthcheck Guideline document

The Guidance document is a major output of the project (**Appendix 3**). This document describes each component, sub-component, indicator and metric in the Framework. It includes a “recipe” for obtaining the data for each metric, and a scoring rubric, if required (semi-quantitative indicators). As an illustration, the Target species sub-category within the Ecological category contains two indicators, each represented by a metric (**Figure 4)**. The indicator is measured with a “metric”, which could be substituted or replaced in future, if improved metrics for the indicator could be developed. Likewise, indicators for a sub-category could be modified if required as more information is identified. The framework is flexible to future improvements at the indicator and metric level.

- Ecological category

Target species sub-category
  - **Indicator 1: Stock status**
    - Metric: SAFS status (Semi-Quantitative)
  - **Indicator 2: Harvest level**
    - Metric: Catch weight (Quantitative)

- Social and ethical category

Animal welfare sub-category
  - **Indicator 1: Animal welfare protections**
    - Metric: Animal welfare protections in place for fish (Qualitative)
  - **Indicator 2: Level of compliance**
    - **Metric:** Levels of compliance or violations of animal welfare (Qualitative)

Figure 4: Two examples of the hierarchical structure to the Healthcheck framework, illustrating the category, sub-category, indicator and metric.

Different data or information qualities allow the metric to be reported at a Gold (best), silver (medium) or bronze (weak) level (**Table 3)**. In some cases, a different recipe may be used to calculate each indicator value, depending on the available data. These levels also offer insight into future work needed for a fishery, such as data collection. The use of a low level does not allow a better rating than using a higher level data source, consistent with the precautionary principle.

Interviews with potential users of the Healthcheck

As a result of the 21 phone interviews, the following major points emerged. Additional information and examples of interviewee quotes are included in Project Update 4 (**Appendix 6**). This feedback was used to refine the Guidelines document, and the interpretation provided in this final report. Detailed analyses of these interview results are ongoing as part of producing a peer-reviewed paper.

1. **Sustainability is recognised to be much broader than biological or environmental factors but data is lacking for broader considerations.**

A number of interviewees noted that sustainability had become a meaningless term because it had now become so complex and uncertain and information to assess sustainability in broader terms was often not available. Further, information for factors such as fisher well-being, community satisfaction, eco-system status and climate change impacts were not necessarily seen as feasible to obtain (or easy to interpret), limiting how useful information can ever be to inform decisions.

2. **A 'Healthcheck' approach that reported on different indicators of fisheries had support or qualified support from all interviewees.**

All the interviewees supported the concept of the Healthcheck although some noted that they may not use it themselves and many noted that they might use it once they had more of a chance to see what it did and how it worked.

3. **Clarity of objectives and of audience were identified as critical.**

Who the Healthcheck is aimed at and why they should use it were nominated as the most important aspects to communicate clearly in the Healthcheck and there was general disagreement that the Healthcheck could successfully be used by different audiences for different purposes.

4. **Risks identified included the misuse or misinterpretation of information or the Healthcheck never being used.**

It was noted that there are always risks, and that more information is usually better, but it is not possible to control how information is used once it is in the public domain and there should be a clear strategy to manage that. Another key risk was that the Healthcheck might never be used if the project team did not sufficiently work with end-users through its development.

Comparison to Australian fishery objectives

The analysis established that of the 291 objective units examined, all but five of them could be coded against equivalent Healthcheck sub-categories. The five management objective themes not included in the Healthcheck were:

- Human safety from shark attack (n=2)
- Recognize and incorporate Indigenous traditional and cultural values and interests (n=2)
- Monitor and manage external threats to ecological sustainable development of the fishery (n=1)

All of the 20 case study fisheries included management objective themes concerned with the following Healthcheck categories:

1.1 Target species

1.3 Protected species

2.1 Fishery benefits

3.1 Ecosystem governance

3.2 Management system

In contrast, no management objectives were identified which were thematically equivalent to the following Healthcheck sub-categories:

1.6 Carbon and pollution

2.3 Markets

2.4 Energy costs

4.3 Ethical - human welfare protections

4.4 Ethical - animal welfare protections

5.2 Climate effects

5.4 Market drivers

The number of management objectives coded against different Healthcheck sub-categories is provided in **Figure 5** and **Table 5**.

Table 5: Comparison of the frequency and percentage of themes of management objectives stated for the 20 case study fisheries that are equivalent to Healthcheck sub-categories

Healthcheck sub-category	Equivalent management objective theme (n=291)	Equivalent management objective theme (%)
1.1 Target species	62	21%
1.2 Bycatch species	26	9%
1.3 Protected species	20	7%
1.4 Habitats	4	1%
1.5 Ecological communities	7	2%
1.6 Carbon and pollution	0	0%
2.1 Fishery benefits	20	7%
2.2 Community benefits	7	2%
2.3 Markets	0	0%
2.4 Energy costs	0	0%
3.1 Ecosystem governance	32	11%
3.2 Management system	15	5%
3.3 Institutional capacity	28	10%

3.4 Compliance	13	4%
3.5 Adaptive capacity	4	1%
4.1 Fisher wellbeing	18	6%
4.2 Wider community	22	8%
4.3 Ethical - human welfare protections	0	0%
4.4 Ethical - animal welfare protections	0	0%
4.5 Adaptive capacity of the fishery	4	1%
5.1 Environmental context	3	1%
5.2 Climate effects	0	0%
5.3 Pollution in the environment	1	0%
5.4 Market drivers	0	0%
No equivalent sub-category	5	2%

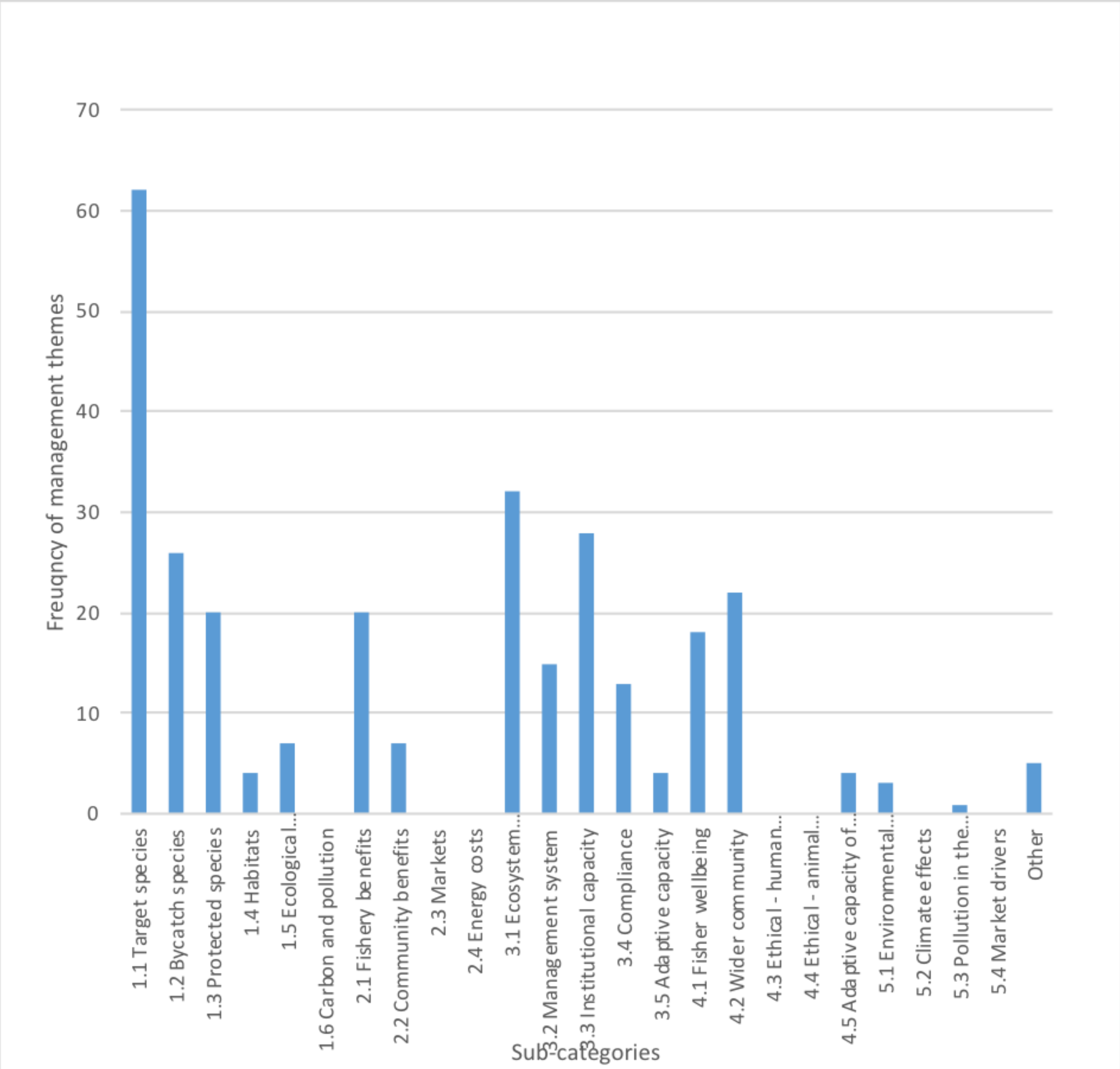


Figure 5: Comparison of the number of management objective units identified from the 20 Healthcheck case study fisheries which are equivalent to any of the 24 Healthcheck sub-categories (total themes = 291).

In terms of the equivalence of performance indicators provided for fisheries management objectives, and the Healthcheck sub-category indicators, only 50% of the stated fisheries management objectives provided performance indicators which were equivalent to Healthcheck indicators. Of the remaining 50%, 30% of these objectives provided an alternative performance indicator which was not equivalent to the listed Healthcheck indicators (**Table 6**). Alternative or non-equivalent indicators were most likely to be found for management objectives concerned with "target species", "environmental governance" and institutional capacity".

Table 6: Management performance indicators with no direct equivalent to Healthcheck indicators.

Healthcheck sub-category	Alternative performance indicator with no direct Healthcheck indicator equivalent (n=88)	Frequency
1.1 Target species	Biomass	9
	Age composition	1
	Standardised CPUE	7
	CPUE trends	6
	Fishing effort	4
	Fishing mortality	3
	Stock stress	1
	Reproductive indicators	1
1.2 Bycatch species	Discard rate	2
1.3 Protected species	Interaction rate	4
1.4 Habitats		0
1.5 Ecological communities		0
1.6 Carbon and pollution		0
2.1 Fishery benefits	Minimise costs to industry	2
2.2 Community benefits		0
2.3 Markets		0
2.4 Energy costs		0
3.1 Ecosystem governance	Closed areas maintained	1
	Ecological risk assessment and monitoring undertaken	5
	Bycatch species identified	1
	Industry codes of practice developed and followed	2
	Habitat impact mitigation measures	1
	Reporting of ecosystem impacts	3
3.2 Management system	Fishery assessment undertaken	4
	Manage to within allocations	1
	Develop research plan	1
3.3 Institutional capacity	Cost recovery	5
	Resource sharing enabled	3
	Efficient and cost-effective management	4
	Participatory management	1
	Policy coordination	4
3.4 Compliance	Compliance risk assessment undertaken	3
	Understanding of regulations	5
3.5 Adaptive capacity		0
4.1 Fisher wellbeing		0
4.2 Wider community	Level of community engagement by agency	1
4.3 Ethical - human welfare protections		0
4.4 Ethical - animal welfare protections		0
4.5 Adaptive capacity of the fishery		0
5.1 Environmental context	Manage impacts of pest species	3
5.2 Climate effects		0

5.3 Pollution in the environment	0
5.4 Market drivers	0

Management objectives concerned with themes of "Wider community benefits", "Ecosystem governance" and "Institutional capacity to manage" were the least likely to have performance indicators defined at all (**Table 7**). Overall, 20% of the management objectives identified included no performance indicator.

Table 7: Gaps in provision of performance indicators for the management objectives for 20 case study fisheries.

Healthcheck sub-category	Number of management objectives for which no performance indicator was provided (n=52)
1.1 Target species	2
1.2 Bycatch species	2
1.3 Protected species	1
1.4 Habitats	2
1.5 Ecological communities	2
1.6 Carbon and pollution	
2.1 Fishery benefits	7
2.2 Community benefits	
2.3 Markets	
2.4 Energy costs	
3.1 Ecosystem governance	8
3.2 Management system	6
3.3 Institutional capacity	8
3.4 Compliance	1
3.5 Adaptive capacity	
4.1 Fisher wellbeing	1
4.2 Wider community	10
4.3 Ethical - human welfare protections	
4.4 Ethical - animal welfare protections	
4.5 Adaptive capacity of the fishery	2
5.1 Environmental context	
5.2 Climate effects	
5.3 Pollution in the environment	
5.4 Market drivers	

These results highlight a potential contribution of the Healthcheck assessment framework as a source of nationally consistent performance indicators to address gaps in fisheries management performance assessment frameworks.

Objective 2: Case studies

Complete case studies for Australian fisheries drawn from all jurisdictions and upload to web-based repository (revised)

A total of 20 fishery case studies were completed, representing all Australian marine fishery jurisdictions (**Figure 6)**. This required seeking information on 50 indicators across 20 fisheries, for a total of 1000 items. These results are presented as individual fishery documents, which are loaded to a web-based repository managed by FRDC (www.fisherieshealthcheck.com.au), and included as **Appendix 4** to this report.

Figure 6: Approximate location of each fishery included as a case study. Specific locations are provided in each case study document. Abbreviations for fisheries include Northern Prawn Fishery (NPF), Eastern Tuna and Billfish Fishery (ETBF), Heard Island and Macquarie Island (HIMI) fishery, and the South East Shark and Scalefish Fishery (SESSF).

The quality of data available to report for each indicator-metric was indicated as Gold (best) to Bronze (weakest) (**Table 3**). This reporting allows judgement about the degree to which the information presented can be considered reliable. This is illustrated in each of the case studies. In the case where only Bronze data were available, there may be an effort to produce or process higher quality data. The rationale for this scoring of data quality was specific to each indicator-metric, and is described for indicator each in the Guidance document (**Appendix 3).**

The time required to collate the information across these case studies was considerable, and so attention to efficient data collation and management is needed, as discussed under Objective 3.

Data availability by fishery

Data for some of the 50 indicators were available for all 20 fisheries (**Figure 7**), however, between 7 (ETBF) and 21 (Victorian scallop fishery) indicators could not be populated across the fishery set. The Victorian scallop fishery is currently closed, and so this result is not surprising, as there is less effort to collate and make data available given that status. Only four fisheries had missing information for more than 15 indicators. In the majority of cases across all case studies, the missing information could not be found (188, or 19% of all indicators, representing a success rate of 81%). This information may not exist, or may not be inaccessible to the project team. Less commonly, information was available, but could not be organised/analysed by the project team in 24 (2.4%) of cases, was not “publicly” released in 32 (3.2%) cases, and not applicable in 17 (1.7%) of cases.

Missing information might inform research priorities on a fishery-by-fishery level, particularly when a fishery is one of only several missing that information. However, by considering the frequency of missing information at an indicator level (next section), more efficient collection of information across a wide range of fisheries might occur.

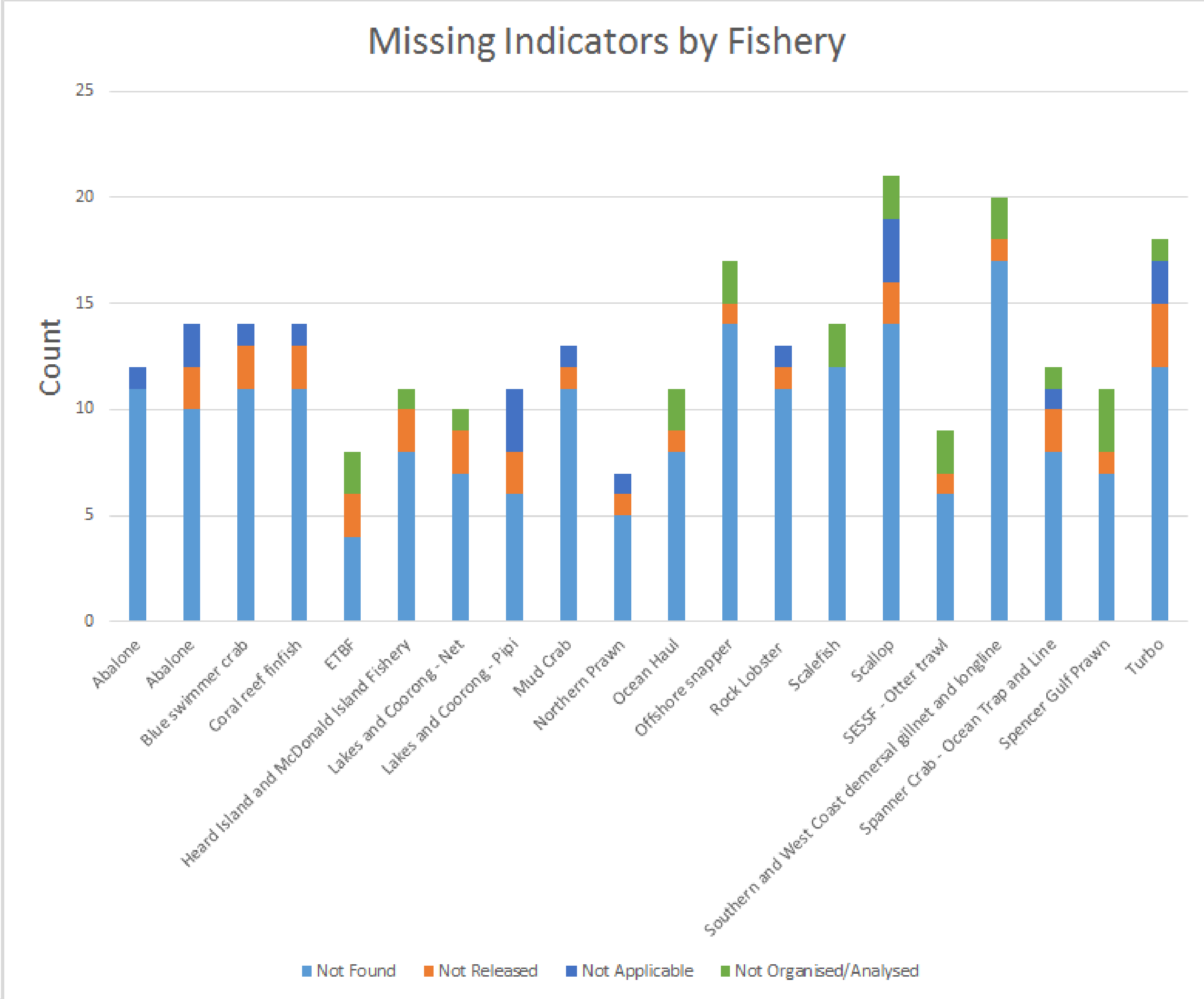


Figure 7: Summary of data availability across 20 case study fisheries considered in Phase 2. Full details provided in Appendix 4.

Data availability for indicators

Data for 49 of the 50 indicators were available for at least one fishery. Data could not be reported for indicators for several reasons (**Figure 8).** Not all indicators were relevant to all fisheries. For example, a fishery that only captures one species does not have bycatch on which to report. Some data could not be located for a particular fishery (i.e. not found), either because it is not collected, was not organised or analysed in way that could be included without additional effort, or was not available due to confidentiality reasons. Across the categories:

- Most indicators could be populated for the **Ecological** category, and were populated for all fisheries for five indicators. At an indicator level, we had 76% coverage as we could not present data for 57 out of a possible 240 indicators (20 fisheries, 12 indicators in this subcategory). The most commonly missing information was for measures of species diversity in the fishery. This information could be calculated from species abundance lists (**Appendix 3)**, and so is achievable provided such data are collected, but was not completed for any fishery case study as this additional level of analysis was out of scope for the Healthcheck project due to limited resources.

- **Economic** category indicator data could not be found for relatively few indicators. Indicators were populated for all 20 fisheries for three indicators. At an indicator level, we could not present data for 75 out of a possible 200 indicators (20 fisheries, 10 indicators in this subcategory). This represents 63% coverage across all indicators in this category. Information on “wealth spread” (Indicator 2.2.2) was not released or organised for 14 of the case studies.

- Data for **Governance** indicators were generally found for all fisheries, indicating relative transparency and availability of this information. Indicators were populated for all 20 fisheries for seven indicators. At an indicator level, we could not present data for 5 out of a possible 200 indicators (20 fisheries, 10 indicators in this subcategory). This represents 98% coverage across all indicators in this category.

- The **Social & Ethical** category is the least mature in terms of development of indicators (e.g. Stephenson et al. 2017), and data were not found for most indicators for most fisheries. Indicators were populated for all 20 fisheries for only 2 of 10 indicators. At an indicator level, we could not present data for 108 out of a possible 200 indicators (20 fisheries, 10 indicators in this subcategory). This represents only 46% coverage across all indicators in this category. This indicates a gap that might be addressed with additional research or data collation projects. The likely expense of collecting such data varies, as noted in **Table 4.** Stakeholders seeking social and ethical information on fisheries will be limited by lack of available data.

- Information to populate indicators for the **External Influences** category was also widely available, with the exception of “Management arrangements to ensure food safety related to contaminants” (Indicator 5.3.2) evidence for which could not be found for 11 fishery case studies. Indicators were populated for all 20 fisheries for 6 of 8 indicators. At an indicator level, we could not present data for 14 out of a possible 160 indicators (20 fisheries, 8 indicators in this subcategory). This represents 91% coverage across all indicators in this category.

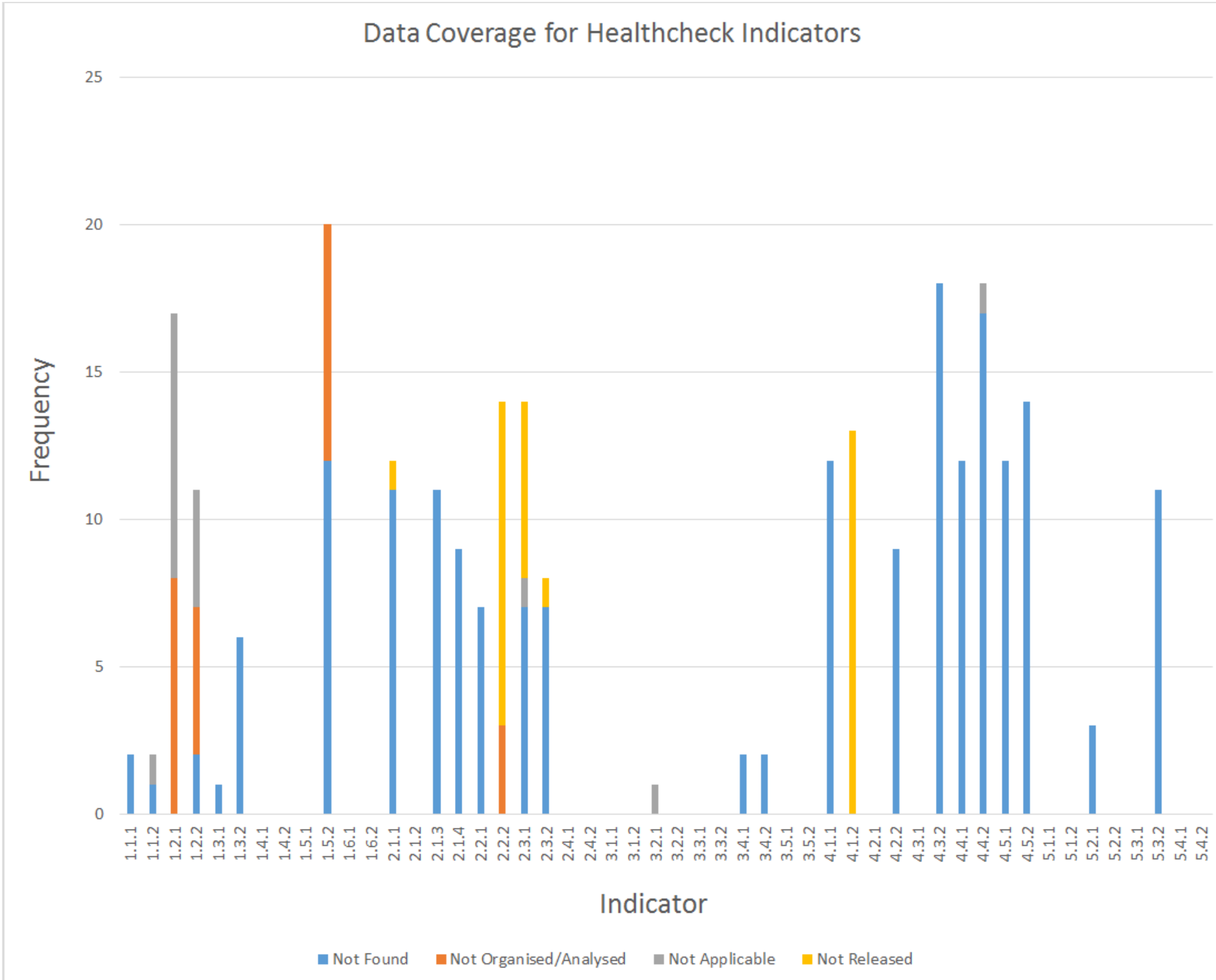


Figure 8: Summary of missing data across the indicators for 20 case studies Indicator names corresponding to these numbers are provided in Table 4. Indicators in the Biological category begin with "1", Economic with "2", Governance with "3", Social & ethical with "4", and External Influences with "5".

Excluding sub-categories with missing indicator data from the framework

If the fishery results for the case studies were to be made available to the end users in their current form, there would be missing data for a range of indicators. For some fisheries, the missing data might never be available, based on costs of collection or processing, or for privacy reasons. This could be noted, and the results from all 24 sub-categories used.

An alternative is to consider including only the sub-categories that could be comprehensive at this stage, assuming that the 20 case studies are broadly representative of the data coverage for all Australian fisheries. For example, if the Healthcheck framework were to be used with only sub-categories with comprehensive data for at least one indicator, then the structure would be as shown in **Figure 9**, and would include 15 of 24 sub-categories, with between two and four retained in each category. Collection of data could occur for the excluded categories, which could be added back in when sufficient data across fisheries were available. Alternatively, new indicators could be devised to replace those for which data were difficult to obtain. A pragmatic approach is to require reporting on a minimum set of indicators, while data for the remainder was being collated.

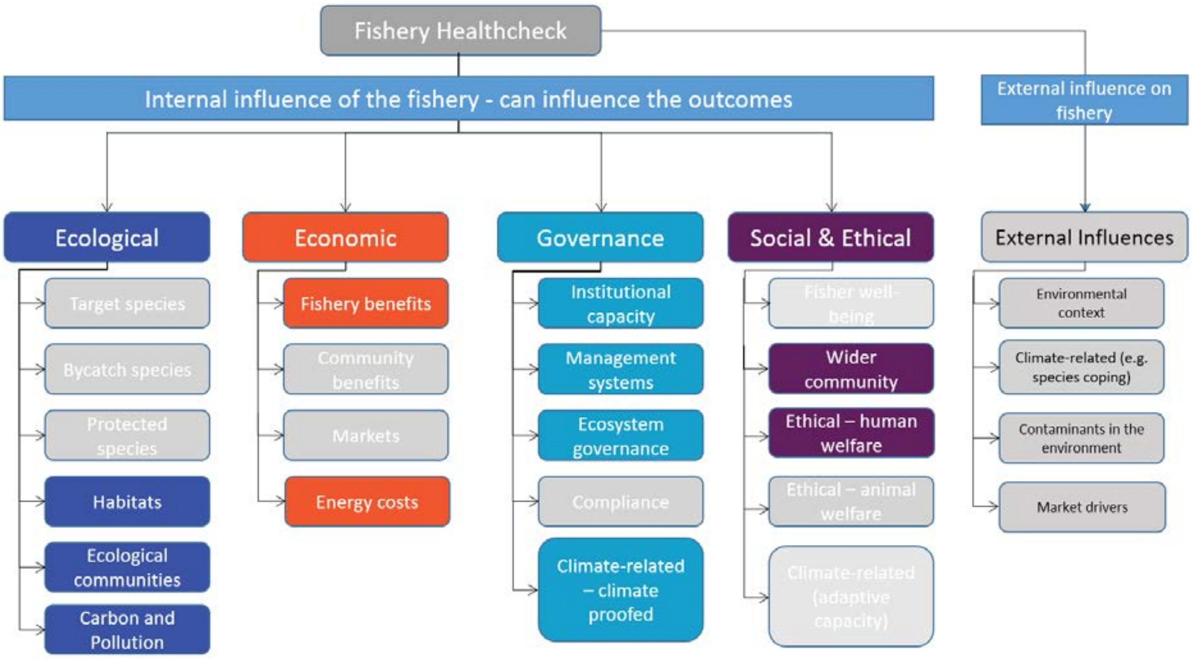


Figure 9: Example of the Healthcheck structure and sub-categories if only sub-categories with at least one indicator available for all 20 case studies were retained. Sub-categories that do not meet this level of coverage are shaded.

Extending Healthcheck coverage to additional fisheries

This project has collated information for 20 fisheries, with gaps in coverage as described in the previous sections. If the Healthcheck approach were to be extended to additional fisheries, efficiency could be ensured by collating information at an indicator level. This is explained further in the Recommendations section.

Objective 3 – Pathway for delivery

Refine the pathway for linking these fishery-level reports with the stock status reports (SAFS) and handing over methods to appropriate jurisdictions for updating the reports into the future.

The process of obtaining metrics for the indicators proposed in this project highlighted the need for data reporting standards. In many cases the metric was numeric and presented as a figure or table in a Portable Document Format (PDF) on an industry or agency website. The project team would take a screen shot or highlight selected table and paste into a word document for reporting in the Healthcheck. This is an acceptable, albeit clumsy, method for a once off proof-of-concept case study. Currently, **Appendix 4** is a detailed explanatory document that can be provided to fisheries managers or other consultants to perform a Healthcheck for a fishery. Should indicators or indeed the Healthcheck as presented here be something that is pursued as a repository for all Australian fisheries, a **data reporting standard** will need to be developed, to enable the efficient production of the indicators in a Healthcheck.

As the data is reported in a PDF and published, the actual data exists to generate the tables or figures, and a machine-readable format of the data should be made available along with the report. A range of delivery options are possible, including fishery reports (e.g. **Appendix 4**), indicator reports, or any other combination (**Figure 10).** SAFS has already started this process for data interoperability between state agencies and the FRDC, and many lessons learned there could be applied to other metric datasets.

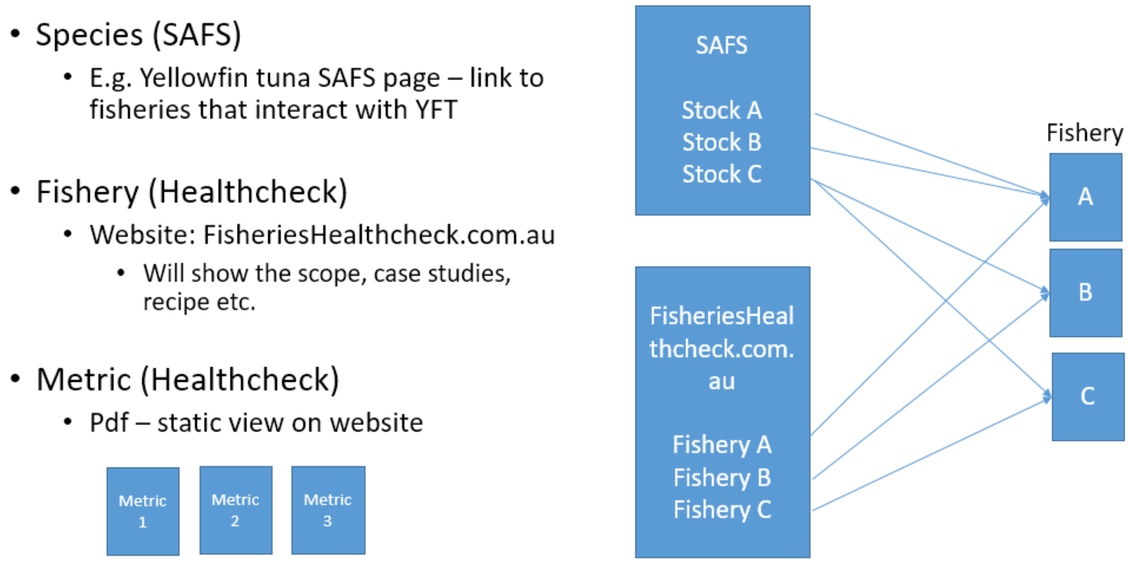


Figure 10: Summary of the packaging options for the Healthcheck data. The point of entry for obtaining information could be via SAFS portal, the Healthcheck portal, or static documents.

The pathway for delivery will require the data standard to be developed with input from the Commonwealth and state agencies that hold the data. Agreements will need to be put in place on how the data is to be used, as has occurred with the SAFS process. If supported, this will need to be an ongoing initiative from NP1 with the FRDC as the champion of any such initiative, rather than the CSIRO or other research agency. A data interoperability initiative will offer benefits to a wide range of other projects and reporting requirements in the national context.

There are a number of indicator metrics that would be easily delivered by central coordination, as they are being regularly updated, such as logbook-derived data (e.g. Harvest level - catch weight;

Bycatch amount – total weight). Other indicators could be batch processed across a wide range of fisheries, once basic data were available (e.g. Bycatch composition – mean trophic level; Carbon footprint – mean CO_2e).

Updating information

As demonstrated in this report and discussed above, Healthcheck data for each fishery can be generated by following the recipe and guidelines (**Appendix 4**). This represents a brute force fishery-by-fishery approach, and was followed in producing the first 20 case studies.

For quantitative indicators, as described above, two efficient options are

1. Automatic uploads – centrally coordinated for selected indicators. Logbook-based data that is already processed by agencies (e.g. catch weight), or information that is already electronically housed (e.g. SAFS status). A machine-machine way to query data from existing and multiple databases (e.g. logbook data, data.gov.au). As an additional example, economic data from EconSearch could be accessed in this way.

2. Batch processed indicator-by-indicator across all fisheries (e.g. carbon footprint, mean trophic level; environmental productivity). This is because the same dataset and processing scripts underpin the metric calculations for all fisheries.

A number of the indicators are qualitative in nature, and are statements about the status of an indicator at a certain point in time. Two options may be useful in collecting this information from the agencies responsible:

3. Provision of a survey tool to collect this information from the appropriate agencies (e.g. SurveyMonkey or similar).

4. Attach them to the SAFS process so that when staff are updating stock status information, a series of questionnaires are part of the process.

For the semi-quantitative indicators, automation is also difficult, as the information is provided using a rubric that needs to be applied to each case.

5. These might also be best processed indicator-by-indicator across all fisheries (e.g. habitat status)

Objective 4 – Sustainability discussions

Objective 4. With the expert group provide input into sustainability discussions relating to this project and broader national initiatives

The project team members have been involved in discussions including National Priority 1 stakeholders. We attended a range of meetings – see Extension and Adoption – and contributed to discussions about a range of over-the-horizon sustainability issues, including slavery and animal welfare. Over the course of the project, these issues became more immediate, and we helped review the scope for projects to consider human slavery and animal welfare. They also informed the development of sub-categories, indicators and metrics in the revised Healthcheck framework.

As a result of these discussions, we also considered the relationship between the Healthcheck framework and other sustainability initiatives.

Healthcheck relationship to other sustainability initiatives

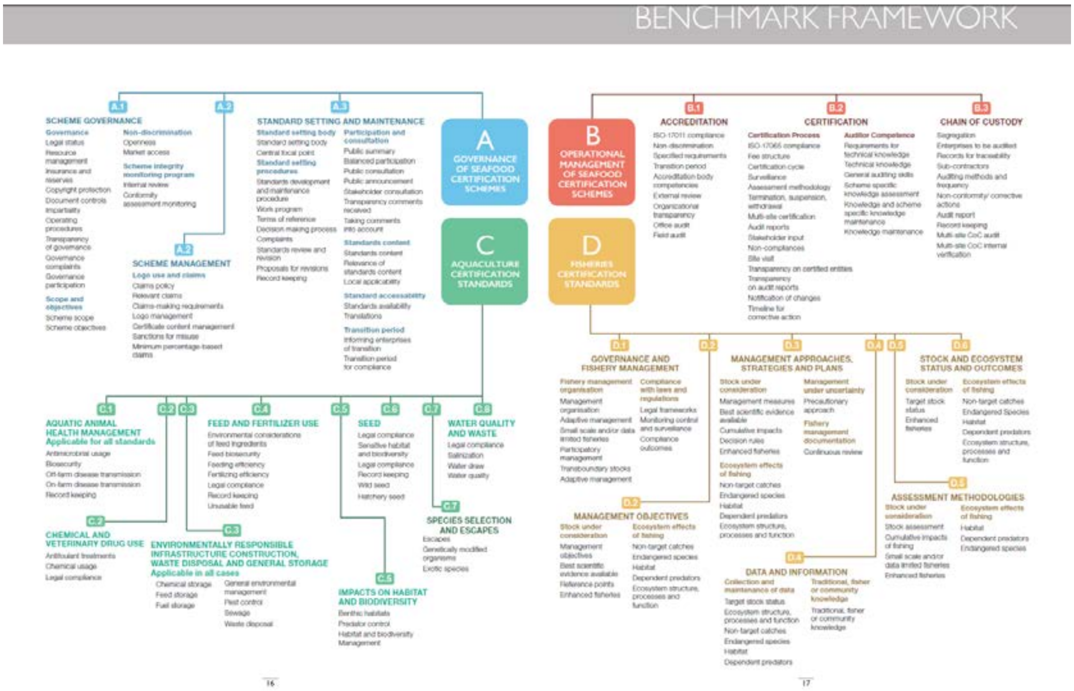
As part of the evaluation process, we compared the Healthcheck to a selection of other existing and high-level sustainability initiatives and approaches, including the GSSI (**Box 1**), Sustainable Development Goals (**Box 2**), Ecosystem-based Fisheries Management **(Box 3)** and the Fisheries Agency Guidelines project (**Box 4)**

Each of these examples shows that the indicators in the Healthcheck structure provides large coverage for a major portion of each of these other initiatives, but additional information would still be required.

Box 1. GSSI and the Healthcheck

Global Seafood Sustainability Initiative (GSSI) is a benchmarking tool to evaluate the quality of seafood certification schemes. Despite this higher level focus, there are aspects that can be compared to the Healthcheck approach. With regard to the Australian Fisheries Healthcheck – GSSI sections A, B and D were considered relevant. Section D was able to be mapped to governance or biological indicators in the case of 123 of 129 GSSI elements. Elements related to data quality and small scale fishery classifications could not be mapped. With regard to Sections A and B, the elements (n=115) were related to the use and performance of a wide range of accreditation schemes, and thus not considered as primary fishery health indicators.

Overall, the Healthcheck categories and indicators will provide the detail needed for a fishery that is undergoing assessment in any certification scheme by allowing a range of the GSSI section D elements to be populated.



Box 2. Connection between the Healthcheck and the UN Sustainable Development Goals (SDGs)

The United Nations [*Sustainable Development Goals*](https://www.un.org/sustainabledevelopment) *are a call for action by all countries – poor, rich and middle-income – to promote prosperity while protecting the planet. They recognize that ending poverty must go hand-in-hand with strategies that build economic growth and address a range of social needs including education, health, social protection, and job opportunities, while tackling climate change and environmental protection* https://www.un.org/sustainabledevelopment

The 17 SDG goals are supported by 169 targets, cover a broad range of economic, social, and ecological topics. For example, SDG 14 seeks advances in conservation and sustainable use of the oceans.

Fisheries receive only limited coverage in the SDGs, however there are still overlaps between the two systems. Mapping Healthcheck indicators to the SDGs was considered at the level of the SDGs and then specifically to SDG targets. As the SDGs cover a broad range of different topics, every Healthcheck-indicator can be mapped to an SDG. Overall, there were strong SDG links for 66% of Healthcheck indicators and weak links for 34% (**Figure B2.1**). Some of the connections, however, are rather weak and linking the Healthcheck-indicators to specific targets within each SDG was more challenging (**Figure B2.2**).

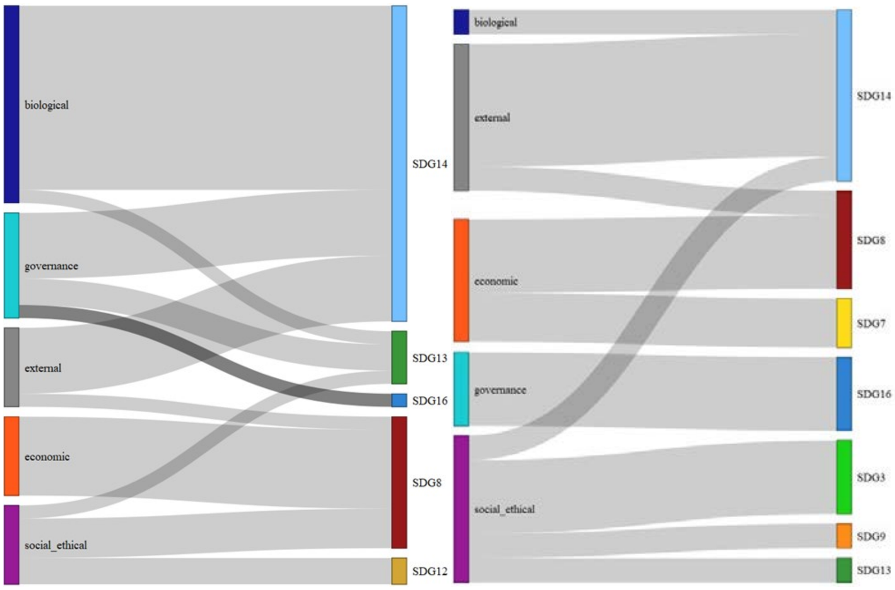


Figure B2.1. Mapping of the strong (**left panel**) and weak (**right panel**) connection among indicators in the five Healthcheck categories with different SDGs. GOAL 3: Good Health and Well-being, GOAL 7: Affordable and Clean Energy, GOAL 8: Decent Work and Economic Growth, GOAL 9: Industry, Innovation and Infrastructure, GOAL 12: Responsible Consumption and Production, GOAL 13: Climate Action, GOAL 14: Life Below Water, GOAL 16: Peace and Justice Strong Institutions

Box 2 (continued)

The Healthcheck Biological category had the strongest connection to the SDGs and except one; all indicators could be linked to single targets. Economic indicators were almost equally split among strong and weak connections, however, compared to the other categories, no direct link to any target could be found. The Healthcheck categories “External influences” and “Social & ethical” were evenly distributed among strong and weak links and specific allocation to a target. The category Governance also mapped well, in a similar pattern to the Biological categories.

Overall, the Healthcheck structure and information can support Australian reporting regarding fisheries against the SDGs, especially for Goal 14 (Oceans) (**Appendix 6, Table 1)**. Of the 17 SDGs, the Healthcheck indicators were connected to eight, with nine SDGs not being covered **(Appendix 6, Table 2)**.

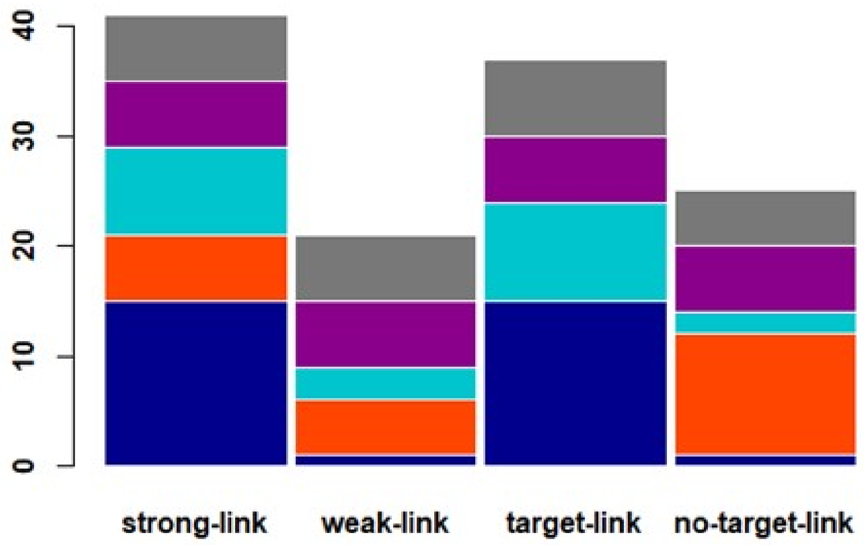


Figure B2.2. The indicators of the five Healthcheck-categories (blue – Biological, orange - Economic, light blue - Governance, magenta - Social & ethical, grey - External) were strongly (column 1) or weakly (column 2) linked with an SDG, and clearly linked (column 3) or not (column 4) to targets associated with each SDG. The y-axis is the number of Healthcheck indicators. For example, column 1 shows that 15 of the Biological indicators (blue colour) had a strong link with an SDG, and column 2 shows that 1 biological indicator had a weak link with an SDG. Column 3 shows how many indicators had a strong link to a SDG target, and column 4 shows how many indicators did not link to a specific target.

Box 3. The Healthcheck and Ecosystem-based Fisheries Management (EBFM)

The Healthcheck addresses most principles considered in Ecosystem-Based Fisheries Management, but is not a universal checklist, particularly as EBFM definitions vary.

Ecosystem-Based Fisheries Management (EBFM) is an approach and set of guiding principles used in fisheries around the world. However, there is no universal definition of EBFM, and interpretations differ (Long et al. 2017; Troctha et al. 2018). In general terms, the FAO defines ecosystem-based management as:

> *'An approach that takes major ecosystem components and services −both structural and functional− into account in managing fisheries. It values habitat, embraces a multispecies perspective, and is committed to understanding ecosystem processes. Its goal is to rebuild and sustain populations, species, biological communities and marine ecosystems at high levels of productivity and biological diversity so as not to jeopardize a wide range of goods and services from marine ecosystems while providing food, revenues and recreation for humans.' (*http://www.fao.org/faoterm/en/?defaultCollId=21)

Thus, the Healthcheck may address one definition of EBFM better than another. Here we compare it to two widely used EBFM descriptions provided by Pikitch et al. (2004) and Ward et al. (2002).

EBFM Description 1 - Pikitch et al. (2004)
Four objectives of EBFM proposed by Pikitch et al. (2004) are:

i) Avoid degradation of ecosystems, as measured by indicators of environmental quality and system status;
ii) Minimize the risk of irreversible change to natural assemblages of species and ecosystem processes;
iii) Obtain and maintain long-term socioeconomic benefits without compromising the ecosystem
iv) Generate knowledge of ecosystem processes sufficient to understand the likely consequences of human actions.

How does the Healthcheck address Description 1 EBFM objectives?
The Healthcheck performs well with regard to evaluating EBFM according to the description of Pikitch et al. (2004). The Healthcheck reports information related to ecological pressures with categories and subcategories related to different ecosystem components (e.g. target, bycatch, protected species), pollution and addressing both fisheries-specific pressures and external ones. Composite metrics (such as habitat and ecosystem status) are proxies for environmental quality and status. There are also several Healthcheck indicators related to wellbeing and benefits, from fishery-specific to the wider community.

EBFM Description 2 - Ward et al. (2002)
A broader view of EBFM is taken by Ward et al. (2002), where EBFM is described as one that acknowledges:

i) Maintaining the natural structure and function of ecosystems, including the biodiversity and productivity of natural systems and identified important species, is the focus for management;
ii) Human use and values of ecosystems are central to establishing objectives for use and management of natural resources;
iii) Successful management is adaptive and based on scientific knowledge, continual learning and embedded monitoring processes;
iv) Ecosystems are dynamic; their attributes and boundaries are constantly changing and consequently, interactions with human uses also are dynamic. This EBFM definition refers more than Pikitch et al. (2004) to the management process.

How does the Healthcheck address these EBFM objectives?
The Healthcheck includes categories and indicators related to governance including references to the Management system (harvest strategy, management plans, reference points), Compliance (compliance regime, surveillance), Institutional capacity (accountability of decision making bodies, uncertainty management), Ecosystem governance (Bycatch mitigation, Protected species mitigation) and Adaptive capacity- climate related (governance arrangements, coping strategies). However, for the Healthcheck to provide information relevant to this EBFM definition, additional indicators related to management principles such as stakeholder involvement and research capacity would be needed. These aspects are covered in the Best Practice Guidelines for Fisheries Management Agencies (FRDC 2015/203), as they are not as directly relevant to the health of a fishery.

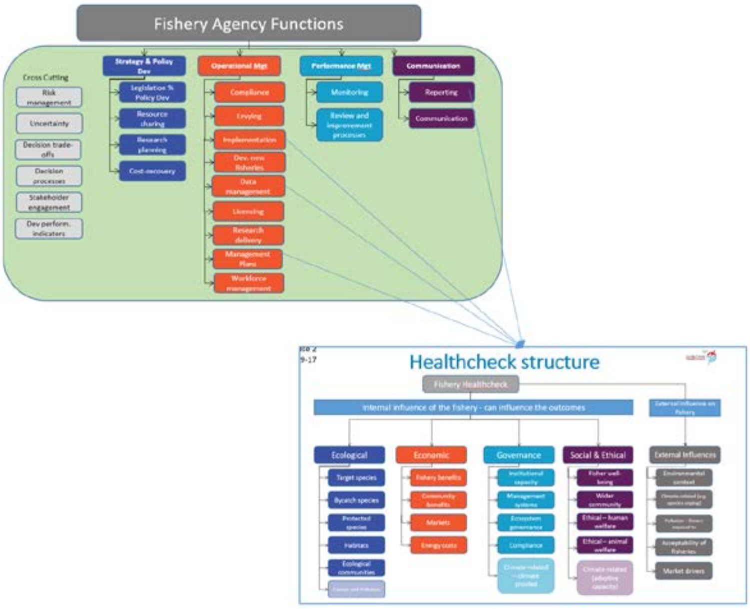
Summary
For the Healthcheck to be a complete checklist of EBFM implementation across the span of EBFM definitions, additional management process indicators are needed. The most common key principles for ecosystem-based management is consideration of ecosystem connections, appropriate spatial and temporal scales, adaptive management, use of scientific knowledge, stakeholder involvement and integrated management (Long et al. 2015). However, there is no universal consensus on what characterizes as an ideal governance mode to foster sustainable development (Lange et al. 2013) and the Healthcheck is an assessment of the fishery performance. In contrast, EBFM relates to higher order fisheries objectives (Scandol et al. 2005), In this regard, Healthcheck assessments may be an important contribution since quantitative evaluations of implementation of EBFM have generally been at a country-level and only recently attempted for different fisheries (e.g. Troctha et al. 2018). Overall, if fishery managers seek to report on how they are performing against EBFM objectives, the Healthcheck indicators will be useful.

Conclusion: The Healthcheck can help evaluate most EBFM attributes, but does not provide comprehensive coverage for evaluating all EBFM approaches.

Box 4. The Healthcheck and Fishery Agency Guidelines

The Healthcheck is not an audit tool for the set of Best Practice Fishery Guidelines. The two systems are complementary.

- The Best Practice Fishery Agency Guidelines (FRDC 2015/203) provide high level guiding principles for a Fishery Agency that help to demonstrate agency processes.
- The Healthcheck gathers information regarding specific fishery performance
- Some of the Guidelines are only relevant at an agency level, and some are applicable to fisheries, and can thus be evaluated for a single fishery
- Some of the Guidelines are reflected in the Healthcheck, shown below.



Conclusion

All the objectives of the project were achieved.

A structure representing the areas important to understanding sustainability of fisheries was further developed in Phase 2 of the Healthcheck project. The structure covered four categories, relatively common to sustainability assessments, biological, economic, governance and social and ethical. The Framework also recognises that a range of external issues (category 5) can also affect fisheries sustainability (positively and negatively). Each of the five categories contains between 4 and 6 sub-categories, each represented by 2 indicators. Revision of the initial Framework from Phase 1 of the Healthcheck project showed the structure was flexible to inclusion of additional subcategories including those issues on the horizon.

A set of Guidelines for gathering information for each indicator was developed, and tested on 20 case study fisheries from each jurisdiction in Australia. This revealed that information was not equally available across indicators, or fisheries. Data were available for 81% of all indicators across the 20 fisheries. By category, data were available for 76% of Ecological indicators, 63% of Economic indicators, 98% of Governance indicators, 46% of Social and Ethical indicators, and 91% of External indicators. This pattern of missing information can help prioritise additional data preparation or collection efforts by fisheries and strategic research by agencies and other research providers.

Data reported for each fishery could be used as to gain an in-depth understanding of the fishery (Stephenson et al. 2017), however, the audience and users of Healthcheck information are broader than just fishery managers. Interviews with some of these stakeholders revealed that lack of access to data – not in public domain to be accessed by “informed public” – is a widespread concern. Healthcheck categories included some components that were addressed by fisheries management and others that were broader, and useful in complementary sustainability initiatives.

A range of challenges were identified by stakeholders consulted in the project, including:

- Different audiences have different needs and it is a challenge for the Healthcheck to service the general public, fishery managers, eNGOs and the media effectively.
- Whether the Healthcheck is accepted and used by industry, given the range and differences across different sectors and the difficulty working together.

The Healthcheck will have to capture and report on information in a time of significant and uncertain change. Fishers and fishery communities in some regions are under pressure and struggling and there may need to be significant changes to the industry overall which may be challenging to implement, for example in terms of occupational health and safety, increasing conflicts over resources (e.g. new blue economy industries), climate change impacts, social demographic changes (e.g. ageing fishers) and increasing social demands and digital technology leading to a need for more communication, digital record keeping, transparency and public engagement.

Ongoing development of an operational Healthcheck system requires efficient data access and processing, such as implemented for the SAFS assessment process. Overall, an operational Healthcheck will deliver benefits aligned with the 1st priority of the FRDC’s RD&E Plan 2015–20: *Ensuring that Australian fishing and aquaculture products are sustainable and acknowledged to be so.*

However, a system providing wide-ranging sustainability information across the sustainability categories should be more than just a repository of information - it should be a benchmarking tool to highlight gaps in information, where fisheries are doing well, where resources need to be targeted to improve practices, data, or management, and where there are untold success stories to communicate.

Sustainability is a broad and complex concept, and consideration of the diverse suite of factors involved in social, economic, ecological and governance arrangements is needed to create truly sustainable food production industries (Stephenson et al. 2017). A new framework for Australian fisheries that incorporates biological, economic, governance and social components is clearly supported by the stakeholders involved in this research, consistent with international trends (e.g. Link et al. 2018; Stephenson et al. 2018). For this vision to be fully achieved, participatory processes that involve interested stakeholders in development of fishery assessment frameworks, prioritization of useful indicators and testing systems for accessing and delivering the information, are needed.

Implications

Australian fisheries are recognized as world leading with regard to research and management, yet many Australians lack information to judge aspects of fishery performance they value. Recent events have shown that information about fishery performance with regard to target species is no longer sufficient. Increasing attention in the media and society-at-large is now given to a broader range of concerns. Thus, for Australian fisheries, it is no longer just about catching fish - it is about a sustainable industry and management of a broader range of factors. The Healthcheck will contribute to a broader understanding of sustainability, and illustrate the range of issues that are being addressed by fisheries and fisheries management agencies.

Community awareness and recognition of fisheries was perceived to be low based on the perceptions of the interviewed stakeholders. The Healthcheck could potentially help to raise awareness and social license of Australian fisheries – see recommendations for reporting.

The Healthcheck offers the potential to allow cost-effective provision of fishery information across a wide range of sustainability categories. The Healthcheck as an information resource will provide transparency and trusted data across the spectrum of sustainability issues, for a wide range of users, including the fishing industry, fisheries managers, media, seafood certification schemes, the "informed" public, NGOs, other agencies with non-regulatory interests (e.g. Departments of Environment).

Future strategic data collection and research priorities can be identified based on absence of indicator data in a range of sub-categories. Holistic views based on indicators can also lead to improvements in national data harmonisation.

Recommendations

There is a clear interest and need for broader reporting on sustainability issues for Australian fisheries. The Healthcheck has potential to be useful to a wide range of people and be important for Australian fisheries in a range of ways, including to improve transparency and communication and raise public awareness of good practice.

The **Social & Ethical** category is the least mature in terms of development of indicators and data were not found for most indicators for most fisheries (46% available). Stakeholders seeking social and ethical information on fisheries will be limited by this lack of available data. This gap might be addressed with additional research or data collation projects.

Opportunities identified via interviews and feedback from expert committee and other stakeholders

- Data access
  - The potential for online, interactive presentation so that people can access up to date information that is relevant to them.
  - The potential for graphs, maps and infographics to help communicate information simply.
- Reporting
  - A snapshot report could be released annually to engage the public, minister and the media.
  - Fisheries were noted as being inherently political and the Healthcheck was welcomed as a way to increase transparency.
- Engagement
  - Continued discussion with end users who will actually use the Healthcheck and involving them directly in the processes of how the Healthcheck looks and works will be important to guarantee useability and adoption.

Further development

The remaining issues to address if the Healthcheck system were to be operational are related to Objective 3, the alignment, linking and access to existing databases.

The frequency with which information can be updated is in turn related to the access question. If access is streamlined with machine to machine processing, then updates can be ongoing and near-real-time (with some checking for quality control). The updating could be synchronised with the SAFS timetables. There are a number of indicators that could be efficiently obtained as all the information is already published electronically in a harvestable form.

Once updating and information delivery is finalised, then the number of fisheries considered can be increased. A similar prioritization as used by the SAFS approach (by value or volume) can be used to stage the work.

Although this project has delivered a framework and an improved understanding of the need for broad sustainability reporting, without progressing to this next stage of development, the investment to date will not be fully realized. Different skillsets are needed to undertake this further development, and an advisory role in a subsequent development of the Healthcheck would be an appropriate role for a member of the current project team to ensure continuity.

Extension and Adoption

The project has been communicated to a range of stakeholders via conferences, workshops and publications.

Conference presentations

- Seafood Directions (Sydney, September 2017) – Emily Ogier
- Coast to Coast Conference (Hobart, April 2018) – Emily Ogier
- International Political Science Association (Brisbane, July 2018) – Emily Ogier
- Australian Society for Fish Biology (Melbourne, Oct 2018) – Rich Little, on behalf of team.
    - Abstract: Demonstration of fishery sustainability has expanded from a relatively narrow biological focus to one that includes a wide range of issues in response to environmental legislation, social factors, and demands from markets and consumers. The Healthcheck for Australian Fisheries Sustainability (Healthcheck) is a new initiative designed to be comprehensive with regard to ecological, economic, social and governance aspects, presenting available information about a fishery for easy access and use. Here we report on the framework development process, including engagement with fishery managers, environmental non-government organisations, and fishery participants. All participants emphasised the need for a broad sustainability assessment with timely reporting, easy availability, and wider coverage of seafood sustainability information than is currently accessible, and expressed the importance of trustworthy and transparent information. Differences were found when comparing sustainability issues generally reported and issues of main concern to stakeholders. Subsequent refinement of the Healthcheck has extended coverage into issues that are on the horizon for fishery reporting, but may soon be of interest to a wide range of stakeholders.

Workshops and meetings

- WWF harmonisation project – Alistair Hobday participated in workshops and phone meetings between 2016 and 2018, where organisations producing seafood eco-guides discussed issues with data and interpretation.

- NP1 steering committee and stakeholder workshops – Jason Hartog and/or Alistair Hobday participated in meetings held August 2017; Feb 2018 and Nov 2018.

International interest

- The project has also been socialised in Sweden and Canada via our team members Sara Hornborg and Rob Stephenson, with interest in applying the approach in a project now completed in Sweden.

    - Hornborg & Mann (2019) Broad sustainability analysis of Northern shrimp fisheries in the Skagerrak. RISE report 2019:36. ISBN: 978-91-88907-63-9. Gothenburg, Sweden

Review by fishery managers – a focus on case studies

The Healthcheck categories, sub-categories, and indicators and the overall approach has been reviewed prior to submission of the final report. We sought additional feedback on the case studies, and the available data for each indicator. We specifically requested feedback as to whether the project team, relying on available data, had obtained the most relevant information for each fishery case study. The goal of this review was to identify where improvements could be made in implementing the Healthcheck in future iterations, rather than rerunning any data collation exercises in this iteration. While this review of the case studies was undertaken by managers, and one industry peak body representative (total of four), wider consultation with industry on data quality could occur as the Healthcheck is implemented. Additional managers were unable to provide feedback in the time period we requested (3 weeks).

We received feedback for the ETBF, SESSF and HIMI fisheries. Review of the case studies and recipe section of the draft final report led to a range of comments, mainly around (i) editing and (ii) issues. Where we agreed, we dealt with edits in submitting the final report. The issues raised by these case study reviewers were characterised into seven issue categories (**Table 8**), some of which were addressed in the preparation of this final report.

The most common issues identified were (i) Additional justification required in the indicator recipe or information in case study (issue 6), (ii) suggestion for recipe improvement (issue 7). Updating data (issue 1) was not possible given the period of time required for collation of information, and we had recognized that with release of the SAFS 2019 assessments, our information on stock status was already out of date during the period between draft and final report delivery. The appearance of new data (issue 1) compared to when a case study was prepared will be an ongoing challenge and cannot be corrected until an operational Healthcheck system is implemented, and/or real time addition of new data is possible. Electronic monitoring and other improvements in data flow and coordination will also contribute to delivery of up to date information. In the case of alternative data (issue 4) updates to note these were made to the recipes for each indicator in this report. Where existing data were missed, the recipe was also updated (issue 2).

Table 8. Summary of review comments across all fisheries reviewed. Total is the number of times an issue was raised across the four reviewers. The full list of responses (excel spreadsheet) is available on request and was sent to those reviewers who provided detailed comments.

#	Issue	Suggested resolution or comment	Total
1	New data available	Update next time case studies completed	11
2	Existing data missed	Recipe updated to include missing data source	2
3	Incomplete data	Additional data checks needed Repository/source data incomplete	3
4	Alternative data suggested	Recipe updated to note alternative data	2
5	Data display/formatting Cross referencing	Will be implemented in operational delivery of case studies e.g. website	7
6	Additional justification required in recipe or information in case study	Layout of document led to separation of information. Intention was to have case study information and recipe document read simultaneously	23
7	Suggestion for recipe or report improvement	Clarified in document or to be addressed in subsequent iterations on Healthcheck	21

Publications

Two peer-reviewed publication have been released (**Appendix 6**), and two more are planned.

- Hobday, A. J., A. Fleming, E. Ogier, L. Thomas, J. R. Hartog, S. Hornborg and R. L. Stephenson (2018). Perceptions regarding the need for broad sustainability assessments of Australian fisheries. Fisheries Research **208**: 247–257
- Fleming, A, Ogier, E, Hobday, AJ, Thomas, L, Hartog, JR, Haas, B (2019). 'Stakeholder trust and holistic fishery sustainability assessments', Marine Policy: doi:10.1016/j.marpol.2019.103719

Planned

- Ogier et al. Objectives and assessment linkages.
- Hornborg et al. A comparison of sustainability assessments for shrimp fisheries in Australia and Sweden

Project materials developed

The project materials include

- the web address for the project (registered by FRDC) – no content yet, but can be populated with case studies when final report accepted
- logo for the project (Cover), and
- icons for the sub-categories, used in the Guidelines document (**Appendix 3**).

Project updates – updates on the project – included in **Appendix 6**

Papers published– included in **Appendix 6**

1. Hobday, A. J., A. Fleming, E. Ogier, L. Thomas, J. R. Hartog, S. Hornborg and R. L. Stephenson (2018). Perceptions regarding the need for broad sustainability assessments of Australian fisheries. Fisheries Research **208**: 247–257.
2. Fleming, A, Ogier, E, Hobday, AJ, Thomas, L, Hartog, JR, Haas, B (2019). 'Stakeholder trust and holistic fishery sustainability assessments', Marine Policy: DOI:10.1111/faf.12087.

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Appendix 1 – Project Staff

- Alistair Hobday (CSIRO) – Project leader and fisheries scientist
- Jason Hartog (CSIRO) – co-Project leader, fisheries scientist
- Aysha Fleming (CSIRO) – social scientist
- Linda Thomas (CSIRO) – fisheries scientist
- Emily Ogier (UTas) – social scientist
- Sara Hornborg (RISE, Sweden) –sustainable seafood production scientist
- Rob Stephenson (DFO Canada) – fisheries scientist, involved in a range of project meetings and discussions.

Appendix 2 – Interview questions

The phone interviews covered the following questions:

1. How would you rate your existing understanding of Australian fisheries?
2. What information is most relevant to you about fisheries? What are your top three current issues? What are your top three emerging issues?
3. Can you name a recent crisis or conflict in Australian fisheries? Do you have an opinion about that? For example, why it occurred? How it was portrayed, who was/wasn't involved?
4. Can you access information you need currently? If yes, where do you source the information? Are you satisfied with it?
5. What do you value about Australian fisheries (and the way that they are managed)?
6. How much does information inform your opinion of fisheries sustainability? Who generates this information/what is the source of this information?
7. Do you fact check information about fisheries? If yes, how? If no, why not? Who do you trust for information (media? Science?)
8. Is there any information you can't get currently that you would like?
9. Talk me through how you might use fisheries information in your day to day work? Follow up e.g. how is fish different from other products? Any species/indicators particularly of interest?
10. Scale – all fisheries everywhere or indicator specific.
11. Would you use a Healthcheck? If yes, why/what for? If no, why not?
12. Are there any risks involved in a Healthcheck? (prompts: For example, in the production and assessment stage? In the extension stage? When the Healthcheck is used and applied?
13. Would you trust information in a Healthcheck? If yes, why? If no, why not?
14. What would make the information more trustworthy? (Prompt for level of detail/interpretation/source?)
15. What format do you prefer for information?
16. What about MSC and other certifications? How much weight do you put in these assessments?
17. Who is responsible for ensuring sustainability of fisheries in Australia?

Appendix 3 – Guideline document

Australian Fisheries Healthcheck Phase II

Descriptions of categories, sub-categories and indicators

April 2019

Contents

Healthcheck Structure

Original Healthcheck structure (12 May 2016)

The Healthcheck assessment provides information on some 32 indicators that are arranged into 16 higher subcategories and four categories (Figure 1). These were described in the Phase 1 report (Hobday et al. 2016).

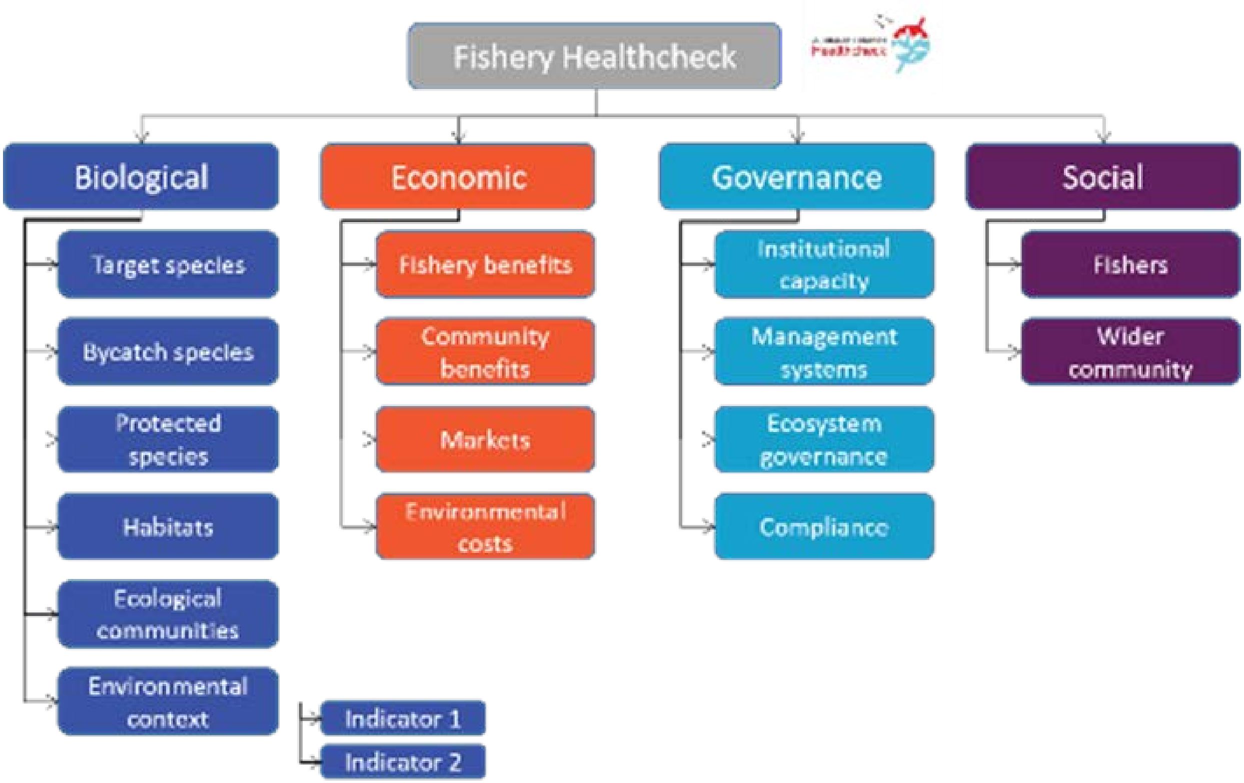
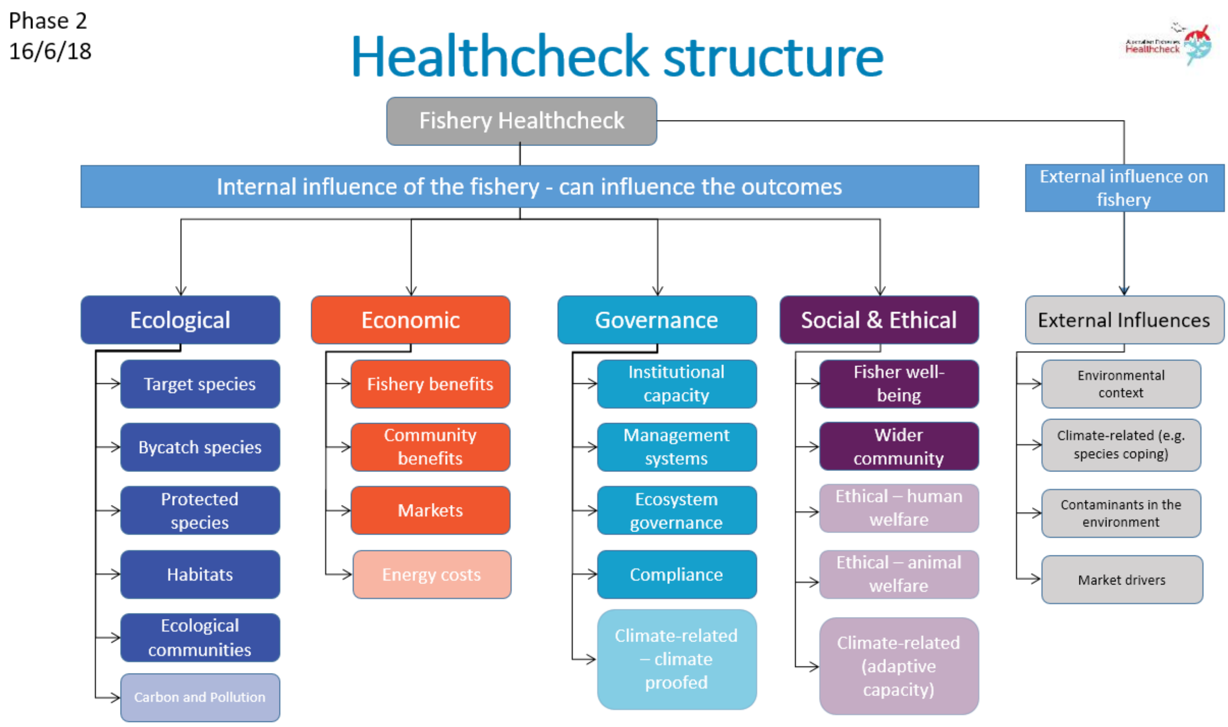


Figure 1. Original (phase 1) Healthcheck structure. This has now been revised in Phase 2 of the project.

Revised (Healthcheck II version, 20 June 2018)

The Healthcheck assessment provides information on some 50 indicators that are arranged into 24 higher subcategories and five categories. Four categories cover the issues in which a fishery can influence the outcome, while the fifth represents external influences on a fishery. This structure is flexible to further addition of sub-categories in future. A rationale for the importance of each category, subcategory and indicator is provided in the rest of this document.



Indicators, metrics, recipes and data quality

Each sub-category is represented by two indicators, each with a metric. These metrics can be quantitative, semi-quantitative, or qualitative, as described in the following sections. The "recipe" for determining each metric is described for each indicator. In some cases, a different recipe may be used to calculate a metric value in different fisheries, depending on the available data.

Different data or information qualities allow the metric to be reported at a gold (best), silver (medium) or bronze (weakest) level (**Table 1**). The recipe for each indicator will guide the determination of this data quality. These levels of data quality also offer insight into future work needed for a fishery, such as data collection, data processing, or data release. It is important that the use of low level data quality does not provide a better rating than using a higher level data source (as per ERA, precautionary).

Table 1. Generic description of the data quality levels for each metric in the Healthcheck.

	GOLD	SILVER	BRONZE
Interpretation	Direct information	Proxy or robust alternative	Weakest or most general evidence available
Example of information quality for a quantitative metric	Specific information is available for the fishery, species or habitat (and is obtained from the last 5 years)	Information is available for like fisheries, species or habitats in Australia (or as for Gold, but more than 5 years old)	Information is available for like fisheries, species or habitats elsewhere in the world
Example of information quality for a qualitative metric	A specific policy covering the fishery exists and is backed up by evidence of action in the fishery. National data that is consistently calculated and publicly available (e.g. exchange rates)	A specific policy covering the fishery exists	A national document exists

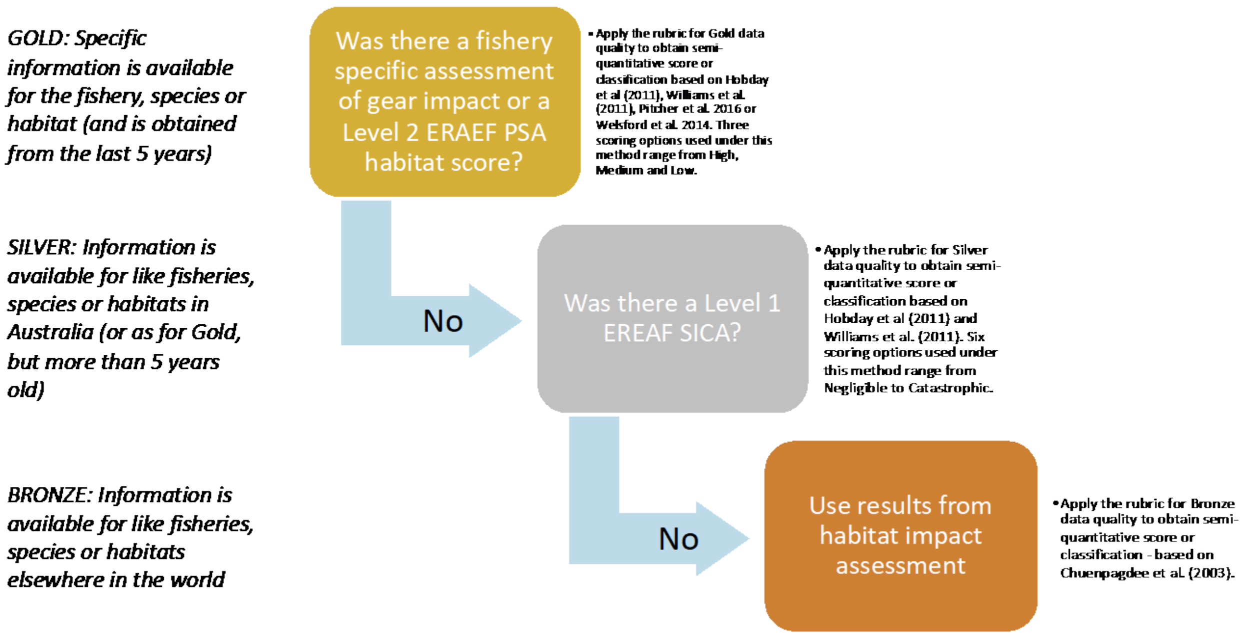
Data quality

The data quality for each of the indicator metrics is noted for each assessed fishery, and is based on specificity to the fishery.

	MEANING
Data available – Gold	Specific information is available
Data available – Silver	Information available for like fisheries
Data available -Bronze	A national document exists
Not found	
Not organised/analysed	Lack of resources to organise?
Not released	Is it protected or against a policy – worried about pressure?
Not collected	Is it not valued?
Not applicable	Indicator is not applicable for the fishery

As an example of how the data quality and rubric works in practice, we illustrate with a semi-quantitative indicator, **Habitat Impact**. The metric for this indicator is impact score. In order to determine the data quality, the recipe poses the questions of what methods are available. In the case of this metric, the first question is: "are there fishery specific reports or Ecological Risk Assessment for the Effects of Fishing (EREAF) based scores available?" and so on for each level. Depending on the answer, the metric is given a gold, silver or bronze data quality, and then the appropriate rubric is applied to present the impact score. In this way, we ensure that there is a consideration of the data quality alongside the metric score.

In the case studies, quantitative metrics will report the data quality (Gold, Silver or Bronze) and the data. In the case of the semi-quantitative indicators, the data quality and the categorization or summary score are presented. For qualitative indicators, the data quality and a statement are provided.



GOLD: Specific information is available for the fishery, species or habitat (and is obtained from the last 5 years)
Was there a fishery specific assessment of gear impact or a Level 2 ERAEF PSA habitat score?
• Apply the rubric for Gold data quality to obtain semi-quantitative score or classification based on Hobday et al (2011), Williams et al. (2011), Pitcher et al. 2016 or Welsford et al. 2014. Three scoring options used under this method range from High, Medium and Low.
SILVER: Information is available for like fisheries, species or habitats in Australia (or as for Gold, but more than 5 years old)
No
Was there a Level 1 EREAF SICA?
• Apply the rubric for Silver data quality to obtain semi-quantitative score or classification based on Hobday et al (2011) and Williams et al. (2011). Six scoring options used under this method range from Negligible to Catastrophic.
BRONZE: Information is available for like fisheries, species or habitats elsewhere in the world
No
Use results from habitat impact assessment
• Apply the rubric for Bronze data quality to obtain semi-quantitative score or classification - based on Chuenpagdee et al. (2003).

Biological category

Fisheries are biological systems made up of multiple fish species, including the fish being targeted by fishing activity, living habitats and ecological interactions between all the living parts. Objectives of fisheries management legislation in every Australian state and territory include the ecological sustainable harvest of fish and the protection of marine ecosystems from unacceptable impacts. This in accordance with the National Strategy for Ecological Sustainable Development 1992 [http://www.environment.gov.au/about-us/esd/publications/national-esd-strategy]. The Environmental Protection and Biodiversity Conservation Act 1999 [http://www.environment.gov.au/marine/fisheries] also requires the Australian Government to assess the environmental performance of Commonwealth species and other state fisheries where there is an export component to the fisheries, and in particular impacts on protected marine species. States and territories also have specific environmental legislation that is applied to fisheries.

Target species

Fisheries in Australia target one or, in many cases, multiple species of fish. The health of populations or stocks of target species is determined using a variety of measures which examine the size of the fish stock or population (or 'abundance', measured either by number or in weight/biomass), how much fish is caught each year (fishing mortality), or, in some cases, how much effort is put into catching fish. Objectives of fisheries management in every Australian state and territory require the regulation of fishing mortality and levels of fishing effort to ensure fish stocks or populations of target species are biologically sustainable.

Indicator 1: Stock status

A sustainable fish stock is defined under the national reporting framework for the Status of key Australian fish stocks report (SAFS 2018) as a stock for which biomass (or biomass proxy) is at a level sufficient to ensure that, on average, future levels of recruitment are adequate and for which fishing pressure is adequately controlled to avoid the stock becoming recruitment overfished. The status is determined by fishery experts, based on a range of analyses (SAFS 2018). Stocks represent a functionally discrete population that can be regarded as a separate entity for management or assessment purposes.

Metric: SAFS status

SAFS status, based on most recent assessment. If species sustainability information is not available in SAFS, using the ERAEF categories (Low, Medium, High) is a reporting option for some AFMA-managed commonwealth fisheries, but not for the state fisheries (Semi-quantitative).

Recipe

DATA QUALITY	METHOD	DRAWBACKS	DATA
GOLD	Define the target species list which is obtained from fisheries page (Commonwealth) at afma.gov.au/fisheries. An alternative source is the ABARES status reports for Commonwealth managed stocks. They may be more comprehensive and timelier. Obtain SAFS classifications for stocks in each fishery Note there may be multiple stocks for each fishery – report them all.	Not available for all target species.	afma.gov.au/fisheries ABARES
SILVER	ERA Risk Categories	Species specific, not stock specific. Commonwealth centric	ERA report or databases
BRONZE	N/A		

Indicator 2: Harvest level

The harvested biomass for each species does not indicate sustainability per se, but provides useful information on the levels of the catch.

Metric: Catch weight

Data on catch for the target species is collated annually by ABARES and responsible state agencies. The most recent year available for the fishery, along with the historical catch, in tons or number of individuals, depending on the fishery. (Quantitative)

Recipe

DATA QUALITY	METHOD	DRAWBACKS	DATA
GOLD	Define the target species list which is obtained from fisheries page (Commonwealth) at afma.gov.au/fisheries. Species specific catch weights as reported in Fisheries Statistics. This information can come from ABARES reports, SAFS stock status reports. For Commonwealth fisheries, Catch Disposal Records (CDR) can be obtained from the data.gov.au site.		For commonwealth fisheries, data is available at http://www.afma.gov.au/fisheries http://data.gov.au/dataset/reported-landed-annual-catch-from-commonwealth-fisheries https://data.gov.au/dataset/0cd2ec97-d13c-4b02-8071-fd778fdcdee7/resource/81d3d265-b21a-4b05-b62d-c315beec771e/download/annual-cdr-catch-data-30-05-2018.xlsx
SILVER	Taxa group catch weights Logbook data summarised at fishery level (e.g. Kennelly 2018) Data that are not the most recent years of fishing		http://data.gov.au/dataset/reported-retained-annual-catch-from-commonwealth-fisheries-logbooks For state fisheries, Kennelly has fishery summaries of retained catch. State agency websites
BRONZE	Raised observer coverage, raised port sampling to fishery wide statistics		Reports

Bycatch species

Fishing activity can include catching or interacting with fish species other than the species being targeted. These species are known as bycatch, and are either retained or returned to the sea. Our focus is on estimating waste and thus includes estimating the fraction of the catch that are typically discarded at sea. Fishing can impact on non-target species through either overfishing of by-catch species or physical damage to bycatch species which are discarded. Objectives of fisheries management in every Australian state and territory require the regulation of fisheries to ensure that any impacts on non-target species are kept to a minimum by ensuring the risks posed by fishing to the sustainability of bycatch species are kept within ecologically acceptable levels. Although TEP species can also be considered as bycatch, in this case they are treated under the Protected Species sub-category.

Indicator 1: Bycatch composition

The composition of the bycatch is a measure of the number of different taxa that are captured in the fishery

Metric: Mean trophic level

Mean trophic level based on the list of species captured in the fishery. This species list can come from the ERAEF assessments for Commonwealth fisheries, or lists of bycatch species for state fisheries. The trophic level for each species is derived from FishBase or ERAEF database. This metric is based on presence absence in the fishery and is not weighted by catch of each species. It does not include the TEP species, which are treated under another indicator. A time series of this metric is most useful. Caveats: Rapid changes in this measure of time should be a concern, although other factors can also explain rapid changes, such as environmental change. Careful interpretation is required, via accompanying text. (Quantitative)

Recipe

DATA QUALITY	METHOD	DRAWBACKS	DATA
GOLD	Obtain an up to date and comprehensive species list from logbook data analysis, and be able to obtain trophic level information in one of the following ways: • If there has been a recent ERA (within 5 years), use the ERA database to obtain the average min and max trophic level for the species that are classified as bycatch in the ERA process • Otherwise use FishBase to obtain trophic level of each identified bycatch species.		ERA database (CSIRO, or http://marine.csiro.au:8888/apex/f?p=127, access… Jason.Hartog@csiro.au
SILVER	As for Gold standard, but ERA is more than 5 years old, or a limited species list.		
BRONZE	N/A		

Indicator 2: Bycatch amount

The number, volume or weight of bycatch species relative to the target species reflects one impact of fishing other species. In some fisheries, there may be very little or no bycatch, while other fisheries using less specific fishing gears may catch a range of species. Low bycatch levels are considered desirable. Bycatch amount can be expressed in a range of ways such as total weight, weight per kg of target species, percentage of total catch. Some fisheries have little (or no) discarding, as the principal method used is hand-gathering. These include the abalone fisheries and tother dive fisheries harvesting Sea Urchins, Oysters, Whelks, Periwinkles, Clams, etc. For such fisheries, discard rates can be assumed to be negligible with only a small number of individuals likely to be discarded due to being undersize, in excess of bag limits or otherwise undesirable.

Metric: Total weight of bycatch

Total weight of bycatch from the most recent data available. Both the adequacy of the bycatch data and the quality of the bycatch estimate are important. This metric does not include protected species. A time series of this metric is most useful. (Quantitative)

Recipe

DATA QUALITY	METHOD	DRAWBACKS	DATA
GOLD	Kennelly provides a range of methods for estimating bycatch. E.g. the “retained:bycatch” ratio or the “fishing effort: bycatch” ratio method. (p13). Using fishing effort to extrapolate discards is considered the more accurate method (Kennelly 2018, p25). Estimates based on the following will be the most robust: • Ongoing and representative observer coverage and data collection • Representative or complete vessel sampling • Comprehensive trip and fishing operation sampling • Representative spatial coverage		Kennelly Consulting report FRDC 2015/208
SILVER	Sum of the logbook records for discards based on • Moderate periods of data collection, regardless of method of collection • Representative vessel coverage • Supporting observer coverage • Representative spatial coverage		
BRONZE	Raised observer or port sampling data based on • Short periods of data collection • Limited vessel coverage • No supporting observer coverage • Limited spatial coverage Estimates based on a similar fishery		

Protected species

Fishing activity can interact with species of animals which are listed as threatened, endangered or protected (TEPs) under various State and Territory legislation. Interactions can include capture and release of these species or physical contact between fishing gear or vessel and TEPS animals. In some cases, these interactions cause damage and death to individual animals. Commonwealth fishers are required by the Environmental Protection and Biodiversity Conservation Act 1999 [http://www.environment.gov.au/marine/fisheries] to report all interactions with TEPS species. Efforts by both fisheries management agencies and fishers to reduce such interactions and potential harm to TEPS species include changing or modifying fishing gear, avoiding/closing areas or seasons. There are two issues for protected species, whether fishing is preventing population recovery and for Commonwealth fisheries, whether all reasonable steps are taken to minimise capture.

Indicator 1: Capture amount

Fisheries sometimes accidentally capture protected species, which in some cases can be released alive. The annual reported mortality for protected species is an indicator of interest to many evaluating the health of a fishery (NB: these numbers do not count seahorses and pipefish – sygnathids – which are all protected, but not commonly recorded).

Metric: Total captures

The number of protected species captured by the fishery in the most recent year. If these data come from logbooks, observer programs, then the coverage of these data (e.g. 10%) should be noted. (Quantitative)

Recipe

DATA QUALITY	METHOD	DRAWBACKS	DATA
GOLD	Species specific, whole of fleet TEP interactions • Ongoing and representative observer coverage and data collection • Representative or complete vessel sampling • Comprehensive trip and fishing operation sampling • Representative spatial coverage		Fishery specific reports or independent observer programs
SILVER	All TEP interactions, but not at the species level • Moderate periods of data collection, regardless of method of collection • Representative vessel coverage • Supporting observer coverage • Representative spatial coverage		Fishery specific reports or independent observer programs
BRONZE	Patchy observer or logbook data, both spatially and temporally and with poor species resolution.		Fishery specific reports or independent observer programs

Indicator 2: Reporting

The quality of reporting is important in understanding trends in capture of unwanted TEP species

Metric: Fraction of monitoring by independent observers

The fraction of the fishing activity for the fleet that is monitored by independent observers. This may be the reported level of observer coverage (e.g. 5% of vessels), the fraction of the fishing activity (e.g. 5% of shots, etc). (Quantitative)

Recipe

DATA QUALITY	METHOD	DRAWBACKS	DATA
GOLD	Coverage estimated from well-designed observer programs with the following characteristics: • Independent observer coverage and data collection • Representative or complete vessel sampling • Comprehensive trip and fishing operation sampling • Representative spatial coverage • Includes Electronic Monitoring programs		Fishery Reports Kennelly 2018
SILVER	Coverage estimated from independent observation is occurring with the following characteristics: • Moderate periods of data collection, regardless of method of collection • Representative vessel coverage • Supporting observer coverage • Representative spatial coverage		
BRONZE	Coverage from independent observation is haphazard		

Habitats

Fishing activity can impact on marine habitats through contact between fishing gear, fishing vessels and the seafloor. Fishing can also indirectly affect habitat conditions by targeting and removing key species which play an important role in maintaining the ecological processes that ensure the continuation of habitats. Objectives of fisheries management in every Australian state and territory require the regulation of fisheries to ensure the long-term sustainability of the marine environment.

Indicator 1: Habitat impact

The impact of fishing gear on the environment is assessed by several data types. The area of the seafloor that is likely to have had one or more interactions with fishing gear, the fishing footprint, is also relevant in considering impact, as in the recovery time. The impact is also related to the structure of the habitat and rates of natural disturbance – impacts of the same gear may be greater on sponge gardens that on sandy bottoms in the surf zone. Here we use evaluations of fishing gear impact on the habitat type.

Metric: Impact score

For each fishing gear-habitat type interaction, an impact score can be reported.

Recipe

DATA QUALITY	METHOD	DRAWBACKS	DATA
GOLD	Fishery-specific study on impact of the gear, with impact scored. Takes into account the recoverability of the habitat. (Level 3) **Or** ERAEF PSA Level 2 habitat scores for the fishery. Provide the number and list of the high risk habitats for the fishery, using the most recent assessment for the fishery. The distribution of risk scores is the most informative, as is the number of potentially high risk habitats. (see Williams et al. 2011)	Limited availability. ERAEF assessments are for commonwealth fisheries. Some of the PSA assessments for Australia are now out of date.	Specific studies also provide ERA results for those not covered by Williams et al. 20111, e.g. Pitcher et al. 2016; Welsford et al. 2014
SILVER	Fishery-specific ERAEF Level 1 SICA scores for habitats, with consideration of the consequence scores (see Hobday et al. 2011 for methods).	Expert-based. ERAEF assessments are for Commonwealth fisheries. If risk is sufficiently low, then this information will not be provided at level 2. Some of the ERAEF assessments for Australia are now out of date.	ERA reports, and rubric below
BRONZE	Impact is based on generic gear impacts from published studies. Here we use Chuenpagdee et al (2003). More recent work by Pitcher et al (2016) is available for some fisheries.	Does not account for the local context for the fishing gear.	Based on rubric as below

Rubric

Gold: The scoring for habitat impact for gear type is based on Hobday et al (2011) and Williams et al. (2011). Three scoring ratings used under this method range from High, Medium and Low.

Silver: The scoring for habitat impact for gear type is based on Hobday et al (2011) and Williams et al. (2011). Six scoring options used under this method range from Negligible to Catastrophic.

RATING	SCORE	DESCRIPTION
Negligible	1	remote likelihood of detection at any spatial or temporal scale
Minor	2	occurs rarely or in few restricted locations and detectability even at these scales is rare
Moderate	3	moderate at broader spatial scale, or severe but local
Major	4	severe and occurs reasonably often at broad spatial scale
Severe	5	occasional but very severe and localized or less severe but widespread and frequent
Catastrophic	6	local to regional severity or continual and widespread

Bronze: The scoring for habitat impact for gear type is based on Chuenpagdee et al. (2003). Scoring options are very low, low, medium, high and very high, as described in this paper, but we convert to the equivalent silver level words when reporting for a fishery.

GEAR CLASS	IMPACT ON PHYSICAL HABITAT	EQUIVALENT SILVER LEVEL RATING
Dredge	Very high	Major or greater
Gillnet – bottom	Medium	Moderate
Gillnet – midwater	Very low	Negligible
Hook and line	Very low	Negligible
Longline- bottom	Low	Minor
Longline - pelagic	Very low	Negligible
Pots and traps	Medium	Moderate
Purse seine	Very low	Negligible
Trawl bottom	Very high	Major or greater
Trawl- midwater	Very low	Negligible
Hand collection	Very low	Negligible

Indicator 2: Habitat status

The status of the habitat types is a measure of the condition relative to a pristine state. Fishing may not be responsible for that habitat status, but it is important to note if fishing is taking place in pristine or disturbed habitats.

Metric: Habitat status

Habitat status is reported in a variety of specific reports, including ERAEF fishery-specific reports and State of Environment reports for bioregions of Australia. (Semi-quantitative)

Recipe

DATA QUALITY	METHOD	DRAWBACKS	DATA
GOLD	Reports specific to the area of the fishery, and may include information on the area that is protected from activities (including fishing) in the area of the fishery.		Area specific publications or reports
SILVER	Specific information for this habitat type in the area of the fishery which is not spatially explicit and does not consider direct fishing footprint.		Area specific publications or reports
BRONZE	SoE reports for the general state of the marine environment	A very large scale is used for the SoE assessments	Evans, K., N. J. Bax and D. C. Smith (2016). Marine environment: Marine environment. In: Australia state of the environment 2016, Australian Government Department of the Environment and Energy, Canberra, https://soe.environment.gov.au/theme/marine-environment, DOI 10.4226/94/58b657ea7c296

Rubric

For all Data quality levels (Gold, Silver, Bronze), score the metric as follows:

RATING	CLASSIFICATION
EXCELLENT	>90% of the area is considered to be pristine, and has not been modified by human activities.
GOOD	50-90% of the area is considered to be pristine, and has not been modified by human activities.
MODERATE	10-50% of the area is considered to be pristine, and has not been modified by human activities.
POOR	<10% of the area is considered in pristine condition

Ecological communities

The fish species targeted by fishing activity are parts of marine communities which also include many other species. Maintaining the diversity of marine life is a fundamental feature of ecological sustainability. Fishing activity can impact on marine biodiversity and specific communities through the catching of non-target species and through impacts of fishing gear on marine habitats. Objectives of fisheries management in every Australian state and territory require the regulation of fishing levels, locations and gear types to ensure that impacts on non-target species and habitats are kept to a minimum. Marine protected areas in which fishing is excluded have been established in each of the State and Territory marine waters, as well as Commonwealth waters. These are an important mechanism for protecting habitat types. A major challenge is to list the ecosystems that the fishery spans. The ERAEF for Commonwealth fisheries provides a list of ecosystems that are within the area of fishing.

Indicator 1: Ecosystem status

The status of the ecosystems in which fishing occurs provides context for the fishing activities, and can also provide information about non-fishing activities which have had an impact on the ecosystem. Fishing may be one of several pressures on the marine environment: coastal pollution, coastal development, oil and gas exploration and extraction, and shipping may all have impacts on ecosystem status.

Metric: Ecosystem status

Status of ecosystems at a broad scale is documented in State of Environment reporting (e.g. SoE 2011, 2016). Higher resolution information may also exist from studied based on ecosystem models. (Semi-quantitative)

Recipe

DATA QUALITY	METHOD	DRAWBACKS	DATA
GOLD	Ecosystem study specific to this fishery		
SILVER	Specific information for the ecosystems in the area of the fishery which is not spatially explicit and does not consider direct fishing impacts.		
BRONZE	SoE reports for the general state of the marine environment, using the following categories: 1. Very poor 2. Poor 3. Good 4. Very good	A very large scale is used for the SoE assessments. Hard to distinguish from habitat information	Evans, K., N. J. Bax and D. C. Smith (2016). Marine environment: Marine environment. In: Australia state of the environment 2016, Australian Government Department of the Environment and Energy, Canberra, https://soe.environment.gov.au/theme/marine-environment, DOI 10.4226/94/58b657ea7c296

Rubric

Gold or Silver

RATING	CLASSIFICATION
EXCELLENT	>90% of the ecosystem is considered to be pristine, and has not been modified by human activities.
GOOD	50-90% of the ecosystem is considered to be pristine, and has not been modified by human activities.
MODERATE	10-50% of the ecosystem is considered to be pristine, and has not been modified by human activities.
POOR	<10% of the ecosystem is considered in pristine condition

Bronze

RATING	EQUIVALENT CLASSIFICATION FROM GOLD OR SILVER
VERY GOOD	EXCELLENT
GOOD	GOOD
POOR	MODERATE
VERY POOR	POOR

Indicator 2: Ecosystem structure

Healthy ecological communities have a wide range of species and sizes, including large top predators.

Metric: Species diversity

Diversity of species relative to an unfished state (diversity index). These metrics typically come from ecosystem models. A range of different model types may provide this information (e.g. Ecopath, Atlantis, size-based models). As these models differ in assumptions and resolution of species groups, it is hard to compare across fisheries.

The mean size of species (e.g. top predators: average size captured relative to maximum size) as measured in fishery-independent or dependent (e.g. fishery catch data on target and bycatch species) may also be informative. Declines in the mean size may indicate loss of ecosystem structure, although other causes exist, such as targeting practices that avoid larger individuals. (Quantitative)

Recipe

DATA QUALITY	METHOD	DRAWBACKS	DATA
GOLD	Ecosystem model for the region. Extract the ratio of species diversity in fished vs unfished state. Simpson's Diversity Index is a measure of diversity which takes into account the number of species present, as well as the relative abundance of each species. As species richness and evenness increase, so diversity increases. $D = 1 - \left(\frac{\Sigma n(n-1)}{N(N-1)} \right)$ n = the total number of organisms of a particular species N = the total number of organisms of all species The value of ***D*** ranges between 0 and 1. With this index, 1 represents infinite diversity and 0, no diversity. (source: https://geographyfieldwork.com/SimpsonsDiversityIndex.htm)	Varying species resolution in different models from different regions. Species may not be represented as counts in these models (e.g. may be represented as biomass).	Atlantis Ecopath with Ecosim Size-based models.
SILVER	As for Gold, calculate the species diversity index, based on: Local, fishery-independent *in-situ* data for a region in which a fishery occurs. A measure of species diversity, preferably as a time series.	Species are not sampled comprehensively across the ecosystem.	e.g. Reef life survey BRUV data
BRONZE	As for Gold, calculate the species diversity index, based on: Fishery-specific data, preferably as a time series.	Species are not sampled comprehensively across the ecosystem. Changes in this index over time likely reflect changes in fishing practice, not ecosystem diversity.	

Carbon and pollution

Fishing activity impacts on broader environmental conditions through emission of greenhouse gases, intentional and unintentional at-sea disposal practices, (loss of fishing gear) and through the use of marine pollutants as part of maintaining vessels and processing catch.

Indicator 1: Macro plastics

These are plastics that are visible to the naked eye, such as food containers and wrapping, equipment packaging, and fishing equipment. This indicator is to assess attempts to reduce accidental or intentional introduction of macro-plastics to the ocean.

Metric: Plastic code of conduct

Commitment to a zero waste overboard code of conduct can be noted. (Qualitative)

Recipe

DATA QUALITY	METHOD	DRAWBACKS	DATA
GOLD	A plastic code of conduct that is independently audited for compliance		Commonwealth and state fishery management websites Or Industry or peak body websites/reports
SILVER	There is a code of conduct in place, accompanied by outreach to help achieve this goal		As above
BRONZE	Is there a stated plastic code of conduct for the fishery that members are provided with for vessels or gear?	Likely to be a national document	As above

Rubric

While there is in-fleet variation it may be necessary to measure a participation rate in order to rate the application of the data quality. In future, this would make this metric semi-quantitative and could be scored as follows:

RATING	CLASSIFICATION
EXCELLENT	>90% of the operators are participating
GOOD	50-90% of the operators are participating
MODERATE	10-50% of the operators are participating
POOR	<10% of the operators are participating

Indicator 2: Carbon footprint

Carbon footprint is the fishery's contribution to climate change. From this, seafood products can be compared to other food commodities, and if a fishery is tracked over time, areas that require attention by managers can be identified.

Metric: CO_2 equivalents (CO_2e)

Emissions of climate-forcing gases from combustion of different kinds of fuel and refrigerants are converted into CO_2e per kg based on their contribution to global warming relative to CO_2. Fuel use during fishing most often dominates footprint, but refrigerant contribution may also be substantial. (Quantitative)

Recipe

Finalise by documenting method, what is included in estimate, data sources and assumptions, reported in kg CO_2/kg seafood.

DATA QUALITY	METHOD	DRAWBACKS	DATA
GOLD	Use data from recently published LCAs (data not older than three years). Or 1) inventory fuel use (may use gold fuel use data from the Energy use indicator) and multiply with emission factors based on energy content from latest NGER technical guidelines: Fuel combustion — liquid fuels for transport energy purposes for post-2004 vehicles emission factors (Table 2.4.5A) to calculate the amount of CO_2, CH_4 and N_2O emitted; 2) inventory type of refrigerant used and potential yearly leakage (based on yearly purchase or general rate based on TEWI), check climate forcing based on NGER and multiply leakage rate with CO_2e kg/kg of the gas, divide by annual catch volume of the same vessel. If bait is used, repeat the procedure for bait fishing and calculate bait use and emissions per landing. Add all emissions into a total carbon footprint (CO_2e in kg/kg). State what is included and for which year.	Availability of full data very limited, time-consuming to collect, fuel data for bait fishing may not be available.	***Recent LCAs of Australian fisheries:*** -Hornborg et al. (accepted) ***NGER technical guidelines:*** Gasoline 2.31 kg CO_2e/L Diesel 2.72 kg CO_2e/L ***Refrigerant contribution to carbon footprint:*** NGER technical guidelines Appendix C ***Refrigerant leakage rate:*** TEWI Best practice 30%
SILVER	If only fuel use is available (silver or gold), transform into CO_2e by multiplying with emissions following NGER technical guidelines. State year of fuel estimate and that value only include direct fuel use from fishing (i.e. does not include potential contribution from leakage of refrigerants or bait use). If fuel type is not known, use average of gasoline and diesel.	Rough figure that may be lower than true value (if e.g. bait is used) and is positively or negatively affected by recent development in fuel use per catch volume. Affected by type of fuel used (gasoline or diesel), which may not be known.	Energy use indicator ***NGER technical guidelines:*** Gasoline 2.31 kg CO_2e/L Diesel 2.72 kg CO_2e/L
BRONZE	If only bronze level fuel use estimates are available, use these and transform into CO_2e as done for gold and silver and report likely ranges. State that value only include direct fuel use from fishing and data source.	Very rough figure.	Energy use indicator ***NGER technical guidelines:*** Gasoline 2.31 kg CO_2e/L Diesel 2.72 kg CO_2e/L

Economic category

Fisheries are resource-based industries which generate significant economic activity. Objectives of fisheries management legislation in every Australian state and territory include the development and use of publicly-owned fisheries resources within sustainable limits in order to generate economic benefits for the Australian community. Fishing activity generates direct costs and revenues for commercial enterprises and governments. It also generates indirect economic benefits and costs to fisher communities, regional and national communities and to the environmental systems from which it draws resources. Catches are sold on open markets and the economic performance of commercial fisheries is dependent on market conditions.

Fishery benefits

Fishing activities are influenced by a variety of economic factors at both the enterprise and fleet level which have a direct impact on fisher livelihoods and the profitability of firms. These include access and property-rights arrangements (and whether these are tradeable), vessel size, fleet size and capacity, gear types and distance to fishing grounds. Tracking indicators of economic performance provides information on whether management settings, stock levels, market conditions and operator behaviour enable intended benefits to fishers, firms and fishing communities to be generated and maintained.

Indicator 1: Net economic returns

A profitable fishery sector can deliver economic benefits to the Australian community through expenditure and re-investment of net economic returns, or industry surplus. Net Economic Returns (NER) is equal to fishing revenue less fishing costs and measures the economic profit that is derived from fishing activity. The measure is routinely reported at the fishery level by ABARES for key Commonwealth fisheries in the "Australian fisheries indicators report" series and equivalent indicators by a number of State jurisdictions.

Metric: Economic rent

A fishery's net economic return over a particular period is equal to returns fishing revenue less fishing costs. Fishing costs include fuel, fishery management costs, depreciation, repairs and maintenance as well as various economic costs such as the opportunity costs of labour and capital. These measure how much these resources would have been compensated had they been operating in the next best alternative. (Quantitative)

Recipe

DATA QUALITY	METHOD	DRAWBACKS	DATA
GOLD	On ABARES website - Search Publications – All products – Publications by topic (Fisheries and Aquaculture) Search for Australian fisheries economic indicators report of Commonwealth fishery interest Search for Net Economic Returns in report and download the supporting data tables associated with the report. In the spreadsheets look in the Economic Performance tab for "Net Return including management costs". Report these figures	Not released each year	Australian fisheries economic indicators report
SILVER	On state fishery website search for economic report for the fishery Look for Economic rent & report	Not released each year	State fisheries economic and social indicator reports
BRONZE	General search for "*Net economic returns/Economic rent for XX fishery*"	Data from limited responses/source	A variety of sources

Indicator 2: Gross Value of Production

The economic activity generated by the fishery sector provides an indication of the contribution that the fishery sector makes to the national economy. GVP is reported annually by ABARES in the Australian Fisheries and Aquaculture Statistics publication.

Metric: Gross Value of Production (GVP)

GVP calculated as the volume of catch multiplied by the average per unit beach price (AUD$). (Quantitative)

Recipe

DATA QUALITY	METHOD	DRAWBACKS	DATA
GOLD	<u>Commonwealth</u> On ABARES website - Search Publications – All products – Publications by topic (Fisheries and Aquaculture) Search for Fishery Status Report (most current year) OR financial and economic performance of XXX fishery Search for Gross Value of Production in Fishery Status reports OR In Australian fisheries economic indicators report of Commonwealth fishery interested in, search for Gross Value of Production (GVP) in report and download the supporting data tables associated with the report. In the spreadsheets look in the "Timeline" tab for "GVP" (this may be nominal). Report these figures. <u>States</u> On ABARES website - Search Publications – All products – Publications by topic (Fisheries and Aquaculture) Search for Australian fisheries and aquaculture statistics (most recent year) Search for Gross Value of Production by State Find species and report values	Not released each year	Australian fisheries status reports Australian fisheries financial and economic reports Australian fisheries and aquaculture statistics
SILVER	Search State government fisheries website for *Fisheries summary* OR *Economic indicators* OR *status reports of XX fishery* Search for GVP in report		
BRONZE	Search for "*GVP XX fishery STATE*"		

Alternative indicator: Profitability

Economic health of a fishery can be measured by the financial performance of the operators in the fleet.

Metric: Financial performance

Common financial measures of profitability include: boat gross margin; gross operating surplus; boat business profit; and profit at full equity. Fleet-wide averages or distributions of levels of profitability indicate the extent to which the fishery is generating economic benefits for fishers. (Quantitative)

Recipe

DATA QUALITY	METHOD	DRAWBACKS	DATA
GOLD	<u>Commonwealth</u> On ABARES website - Search Publications – All products – Publications by topic (Fisheries and Aquaculture) Search for Australian Fisheries Economic indicators Report (of fishery interested) Download the report and supporting data tables associated with the report. In the spreadsheets look in the Financial Performance tab for “Profit at full equity”. Report these figures. <u>States</u> Search State fisheries website for Economic Indicator report of XX fishery Search report for boat gross margin/gross operating surplus/boat business profit/profit at full equity. Report figure	Not reported each year	Australian fisheries economic indicators reports State fisheries economic indicators reports
SILVER	Search State fisheries site for either boat gross margin/gross operating surplus/boat business profit/profit at full equity for fishery interested in. Report figures		
BRONZE	Search for boat gross margin/gross operating surplus/boat business profit/profit at full equity for STATE XX fishery		

Alternative indicator: Latency

Often fishery concessions are not fully utilised by fishers, for example, often the annual total allowable catch is left partially or largely uncaught for a fishery. Latency in a fishery can be used to provide some information about the profitability of a fishery. Latency is fishing capacity that is authorised for use not currently being used; therefore, high levels of latency can suggest low expected profits in the fishery.

Metric 1: Uncaught TACC

An indicator of the extent of uncaught quota or underutilised effort is latency. Uncaught quota is expressed as % of uncaught TACC. (Quantitative)

Metric 2: Inactive licences/unused SFR

Another measure of latency is inactive licences or statutory fishing rights (SFR) in a fishery expressed as the number of inactive licences/unused vessel statutory fishing rights (SFR) for a given year (Quantitative)

Recipe

DATA QUALITY	METHOD	DRAWBACKS	DATA
GOLD	**Metric 1** Commonwealth On ABARES website - Search Publications – All products – Publications by topic (Fisheries and Aquaculture) Search for Australian Fishery Economic Indicators Report (of fishery interested) Search for quota latency/uncaught quota/latent effort/inactive licences Report as % of uncaught TACC States Search State fisheries websites for Status of Fisheries/Fisheries Summary/Fisheries Management Plan reports. Look for TACC/TAC and find % of caught TACC/TAC and calculate uncaught TACC/TAC. **Metric 2** States On State fishery website find report/information on number of licences with access to the fishery. Find information on number of active licences. Calculate number of inactive licences. Report figure OR Find Fishery Assessment reports and obtain total number of licences and total number of active licences and calculate number of inactive licences for given time period		Australian fisheries status reports Australian Fishery economic indicator reports State fishery summary reports State fishery management plans
SILVER	Obtain data for either metric as outlined above – report as silver if metric 1 or 2 is given as an average over several years		Australian fisheries status reports Australian Fishery economic indicator reports State fishery summary reports State fishery management plans
BRONZE	On ABARES website - Search Publications – All products – Publications by topic (Fisheries and Aquaculture) Search for *Fishery Status Report* (of fishery interested) Search for latency/uncaught quota/latent effort	Qualitative information in reports e.g. low uncaught quota high uncaught quota	Fishery status reports

Community benefits

Fish in Australian waters are a resource and integral part of marine ecosystems which are the common property of the Australian community. The goal of fisheries management is to gain the greatest benefit from fishing (whether from commercial, recreational or Indigenous fishing activity) for the broader community while maintaining the ecological health of fisheries. Benefits derived from commercial fisheries are measured using economic tools and can include contributions to State revenue from the sale of fish, and expenditure by fishers and its contribution to regional communities

Indicator 1: GDP value to communities

The value of the fishery is one measure of the economic health of the fishery and the contribution it makes to employment and incomes within a community. A fisheries contribution to Gross Domestic Production (GDP) or Gross State Product/Gross Regional Product (GSP/GRP) is the total economic value that it generates directly, plus the indirect contribution made to other industries, which is also measured in value-add terms.

Metric: Contribution to Australia’s GDP/State’s GSP/GRP

The total economic value of the commercial industry is measured by summing: direct value of production, direct value-added, plus Indirect value-added. An industry’s value added is measured by the value of what it produces (i.e. seafood product), and the net of inputs from other industries. The total economic value of a fishing industry is then presented as a percentage of Australia’s total GDP. (Quantitative)

Recipe

DATA QUALITY	METHOD	DRAWBACKS	DATA
GOLD	Search ABAREs or State fisheries website for economic indicator reports for the fishery. Search for either Gross Domestic Product or Gross State Product. Report figures	States use Gross State Product	Fisheries economic reports
SILVER	Search for fishery industry report	Based on generic cost structure data	Commercially produced reports
BRONZE	Search for GSP on State Treasury website Report figures for fishing	Fishing contribution to Gross State Product is combined with other sectors	Departmental GSP reports

Indicator 2: Wealth spread

The spread of profits to owners and crew members indicates how widely benefits of fishing are distributed across the fishing community. A wide spread of benefits may be important to some fishery stakeholders. A narrow spread may not indicate a lack of distribution of benefits in the case where all participating businesses are the same size, or if other mechanisms are present to capture and distribute benefits such as high levels of employment of crew.

Metric: Distribution of fishing firm size

Number of large business versus small business, classified by turnover (direct measure) or catch volume (proxy) may provide an indirect indicator: i.e. are economic returns from commercial fishing gained by one or two large businesses or a spread over many smaller businesses?

Quantitative value for the latest year for which data available of proportion of large to small “size” firms (where “size” measured by annual turnover, volume of landed catch, or number of employees). Any trend in distribution can indicate how the number of larger firms is increasing/decreasing relative to smaller firms. (Quantitative)

Recipe

DATA QUALITY	METHOD	DATA
GOLD	Number of firms in each turnover "size" range, at specific fishery level **Commonwealth** Search for fishery on AFMA fisheries website or ABARES Search for economic indicator reports Search for: annual turnover, either levels for the individual boats in the fleet or any analysis of distribution of annual turnover levels across the fleet Using ABS classification of Turnover size ranges Plot number of firms for each annual firm turn over category: Zero to less than \$50k \$50k to less than \$200k \$200k to less than \$2m \$2m to less than \$5m \$5m to less than \$10m \$10m or more **States** Search for fishery on State fisheries website Search for economic indicator reports Search for: annual turnover, either levels for the individual boats in the fleet or any analysis of distribution of annual turnover levels across the fleet Using ABS classification of Turnover size ranges Plot number of firms for each annual firm turn over category: Zero to less than \$50k \$50k to less than \$200k \$200k to less than \$2m \$2m to less than \$5m \$5m to less than \$10m \$10m or more	Fisheries economic reports Data exists in licensing and landings databases of managing agency but not commonly available for analysis of distributions, or presented in fisheries economic reports as a distributional analysis
SILVER	Number of firms in each turnover "size" range, but at State/fishery type level **Commonwealth and States:** Search for fishery by State and most specific Industry classification in: ABS data - *8165.0 Counts of Australian Businesses, including Entries and Exits, Jun 2013 to Jun 2017* Extract data for 'Operating at end of Financial year' Plot number of firms for each annual firm turn over category: Zero to less than \$50k \$50k to less than \$200k \$200k to less than \$2m \$2m to less than \$5m \$5m to less than \$10m \$10m or more	Data on counts of firms by annual turnover size range is available from the ABS at a state/territory scale for broad categories of fishing gear types ('Rock lobster and crab potting'; 'Prawn Fishing'; 'Line Fishing'; 'Fish Trawling, Seining and Netting'; 'Other fishing') ABS data - *8165.0 Counts of Australian Businesses, including Entries and Exits, Jun 2013 to Jun 2017*
BRONZE	Number of firms in each annual Catch volume-based or Revenue-based (i.e. GVP) "size" range (small, medium, large) **Applies to States or Commonwealth** Search for fishery on management agency website or ABARES	Fishery economic reports Industry reports on workforce

	Search for economic indicator or fishery assessment reports Search for vessel-level annual catch data, or any analysis of the distribution of annual landings by vessel Turn-over data: Search for data on boat-level revenue or earnings ($) If raw data, classify by “small”, “medium” or “Large” If already classified or grouped, using existing categories	Licensing data on number of crew/skippers per vessel Data exists in licensing databases of managing agency but not commonly available for analysis of distributions, or presented in fisheries economic reports as a distributional analysis

Markets

Australia’s commercial fisheries sell their catches to both domestic (local) and international markets. Market conditions have a direct impact on fishing activity through changes in seasonal demand, demand for live compared with processed fish, and the use of subsidies in countries supplying competing fish product.

Indicator: Fish Distribution

Metric: Fish Receivers

One way of measuring benefits from a fishery is by assessing the flow of seafood through the supply chain. In many fishery jurisdictions, the first step in the supply chain is via licensed fish receivers who are allowed to receive fish for sale. They can also trade fish with other receivers. In some jurisdictions, commercial fishers must sell their catch to a receiver (although they can sell small amounts on wharves). While this restricts fishers' options for landing their catch, it means that fish can be tracked, reduces illegal fish trading and ensures that the Quota Management Systems (QMS) work effectively by ensuring catches do not exceed the total allowable catch or quota amounts for individual species. Receivers of fish may be fish processors, wholesalers or retailers. (Quantitative)

Recipe:

Obtain the number of fish receivers by fishery for known years. A time series is useful.

1. Commonwealth - Fish receiver permits are granted under Section 91 of the *Fisheries Management Act 1991*. A list of licensed permit holders can be found on AFMA’s website (http://www.afma.gov.au/fisheries-services/fishing-rights-permits/ & http://www.afma.gov.au/wp-content/uploads/2014/12/Fish-Receiver-Permits-as-of-24-November-2015.xls) , however, this public list is not fishery–specific. A specific data request was made to AFMA Data Managers to provide data for the Commonwealth fisheries.
2. NT - A specific data request was made to Data Managers to provide data for the fisheries. https://nt.gov.au/marine/commercial-fishing/commercial-fishing-licences
3. NSW - A specific data request was made to Data Managers to provide data for the fisheries. https://ablis.business.gov.au/service/nsw/fish-receiver-registration/16759
4. Tasmania – checked with Matt Bradshaw
5. SA – A specific data request was made to Data Managers to provide data for the fisheries.
6. Victoria – A fish receivers' licence may be held by individuals and corporations in order to receive fish of any species to possess, store, process, sell or any other specified purpose. There are specific fish receiver licence for only abalone and scallops (suspended as scallop fishery was closed or catch was so low in recent years). https://ablis.business.gov.au/service/vic/fish-receiver-licence/30968.
7. QLD – do not require a fish receiver permit.

8. WA – A specific data request was made to Data Managers to provide data for the fisheries. Registered Receiver Certificate Holders (RRCs) and Processor Licence Holders (PROLs). http://www.fish.wa.gov.au/Fishing-and-Aquaculture/Commercial-Fishing/Fish-Eye/Pages/Registration.aspx
9. From AFMA's Compliance Section: It isn't generally permitted to sell product at the wharf, unless it is to an FRP holder. However, Scallop is an exception on landing product to a FRP holder. Squid is an exception also, as the audit system stops at the wharf. Operators are required to weigh the product at the wharf prior to the product being moved. Completion of logbooks and catch documents is still required, just no Part C. Point of origin documentation should still accompany loads or sales invoices etc in line with state/Business provisions.

DATA QUALITY	METHOD	DRAWBACKS	DATA
GOLD	Obtain fishery-specific number of fish receivers/processors/wholesale buyers Data will be recent, within the last 5 years	Some receivers are also the fisher.	Commonwealth – data request States: specific data requests.
SILVER	Use of a similar fishery, where the fish receivers are also in common (e.g. Bass Strait Scallop and Vic Scallop fishery).	Proxy only	As above
BRONZE	An estimate provided by industry expert.	Imprecise.	

Indicator 2: Volatility in market price

Variability in price can be problematic for producers as they cannot be guaranteed a stable form of income. While seasonal variability exists in many fisheries, annual measures of the range in ex-vessel value (per kg) over time represents one way of considering volatility.

Metric: Price volatility

Price volatility is the mean beach price for target species (top one or five species, normally based on beach price) over the given period (e.g. most recent ten years). The level of volatility is the standard deviation in mean price over this period, averaged over the species considered. Time period (e.g. month): AUD$/kg. (Quantitative)

Recipe

DATA QUALITY	METHOD	DRAWBACKS	DATA
GOLD	Fishery specific Search for fishery on ABARES/State fisheries website Search for economic indicator reports or fishery management reports Search for beach price of top species in fishery by time period. Calculate the amount the price is deviating by for that time period by: 1. Calculate the average price for the time period 2. Determine each time period’s deviation (price less mean price) 3. Square each period’s deviation 4. Sum the squared deviation 5. Divide the sum by the number of observations 6. The std deviation is then equal to the square root of that number Report value	Main source of information is Sydney Fish Market. Have to pay for data Annual average (redefine metric as needed) Not deflated using a consumer price index (CPI) deflator to adjust for inflation	Fish market beach price data Australian fisheries and aquaculture production Fisheries economic reports
SILVER	Annual average Search for fishery on ABARES/State fisheries website Search for economic indicator reports or fishery management reports Search for GVP and tonnage for fishery per year. Calculate back beach price (e.g. GVP/tonnage) and use this to find standard deviation from steps above		ABARES
BRONZE	Annual average by State Search ABARES website for *“Australian Fisheries and Aquaculture Statistics most current year”* Download supporting tables and use GVP and tonnage for species groups and calculate as outlined above.		ABARES

Energy costs

Energy costs are important to profitability of fisheries. Increasing fuel costs (energy prices) or use per landing (resource scarcity) may risk viability of fishing communities, especially for energy-intensive practices. Energy costs are also important from an environmental perspective, where different subsidies may foster development of both amount and energy sources used. In the FAO Code of Conduct for responsible fisheries, energy optimization is called for (sub-article 8.6) and all members of G-20 have agreed to phase out fossil-fuel subsidies. Fuel subsides are also belonging to the harmful subsidies and is the most economically valuable according to the OECD.

Indicator 1: Energy use

Energy use in the form of fuel use on fishing vessels, most often dominating the energy use of seafood product supply chains. Energy efficiencies may to some extent be achieved by industry, but predominantly from management decisions on gears, effort and quotas.

Metric: Fuel use per kg of fish harvested (L/kg)

Fuel use varies over time and between stocks and are best collected from industry on a yearly basis or recent Life Cycle Assessments (LCA). Proxies may also be derived from models, economic data collected or inventory data from older LCAs. If no data is available, likely fuel use ranges based on global data may be used as an indication. All measurement should be reported in L/kg. (Quantitative)

Recipe

Collecting data on fuel use per landing can be done in many ways and will determine the data quality rating as shown below.

DATA QUALITY	METHOD	DRAWBACKS	DATA
GOLD	**Collect data on fuel use through surveys to industry or used existing data not older than 3 years.** Create and send out surveys to a representative sub-sample of vessels in the fishery (based on contribution to landings or effort, or structure of fleet). The more variables collected, the better understanding of uncertainties and opportunities to predict for whole fleet. The data needed depend on characteristics of the fishery (e.g. gear use), but in general a combination of vessel characteristics (kW, GRT, etc.), targeting pattern (effort, distance, etc.), landings (total, i.e. target and byproduct) and different dimensions of fuel use (annual/per trip/during steaming vs fishing, etc.). If using annual fuel use of vessels, it might be needed to allocate use between different fisheries: based on effort if similar gears are used, if not, more detailed data is needed (e.g. fuel use and landings on a trip basis). If bait is used: inventory volume used per catch, quantify fuel use for bait fishing and add to estimate. If surveys are available with data on fuel use/cost no older than 3 years, this may be used as a basis for estimate instead (see silver recipe). Fuel use per landing is calculated by dividing different vessels annual fuel use for the specific fishery divided with total landing for the same vessels, or fuel use per fishing trip divided with landings per trip, etc.	Time-consuming, risk low respondent rate/not representative sample.	***Recent full LCAs of Australian fisheries:*** -Hornborg et al. (accepted manuscript) ***Fuel survey example:*** -Parker et al. (2017) ***Monitored fuel data:*** -PIRSA 2017 -ABARES economic indicator reports ***Energy audit:*** Wakeford (2010)
SILVER	**Use published, aggregated economic data for Australian fisheries.** If available, use published estimates of fuel use (in L/kg) available for many Australian fisheries. If economic reports are available, take total landing volume and fuel cost for the same and latest year from reports/excel sheets provided by e.g. ABARES economic indicator reports, PIRSA 2017. Calculate annual fuel use by dividing fuel cost with the average diesel price for the same year (e.g. from Fishery status reports) with tax credit subtracted for the same year (from ATO).	Fuel use from other fishing activities may be masked in the aggregated data, catch volume/fuel cost may not be reported in the same format (total vs vessel average), uncertainties regarding total catch volume (if all byproducts are included). Rough figure.	***Available fuel use estimates for Australia, older data:*** -Parker et al. (2015) -Farmery et al. (2015) ***Fishery status reports:*** -Patterson et al. (2017) -ABARES economic indicator reports -PIRSA 2017 ***Tax credits:*** -ATO 2017
BRONZE	Use ranges (min-max) from the global fuel use database based on targeted species, gear type and region (preferably Oceania, but if not available, Global).	Estimates may be outdated, as they vary with catch rates between years, and may not be fisheries-specific. Some fisheries may lack data. Indicative figure.	***Global fuel use database:*** -Parker & Tyedmers (2015)

Indicator 2: Fossil fuel subsidies

Fossil fuel subsidies informs status on efforts to reduce environmental costs of fossil fuel use. Fossil fuel subsidies (fuel rebates or concessions) are related to energy use but from an economic perspective, and illustrate to which extent these are present in the fishery. Note that tax exemption for fisheries in Australia is motivated from the sector not using roads: this tax is intended to cover road construction and maintenance. However, in general, fuel tax exemptions are seen as subsidies since they reduce the price of fuel relative to other users.

Metric: Fuel subsidies/rebates directed to the fishery (AUD/L)

This metric would be indirectly available from estimating fuel use from ABARES (see Indicator 1 Fuel use). (Quantitative)

Recipe

Available data on fuel subsidies will determine the data quality rating as shown below.

DATA QUALITY	METHOD	DRAWBACKS	DATA
GOLD	Use fuel data not older than three years. Take L/kg from fuel use (indicator excluding use from imported bait) and multiply rebate for same period (e.g. for All other business uses it was 40.3 cents/L since 1 August 2017 for diesel and petrol).	Rebate differs between years (with no information available from before 2014) and type of fuel used (not always known).	Fuel use indicator (primary data on total fuel use) Tax credits: -ATO 2017 http://www.agriculture.gov.au/abares/research-topics/fisheries/fisheries-data#australian-fisheries-and-aquaculture-statistics-2016
SILVER	Same as for gold but fuel use data older than three years.		***Tax credits:*** -ATO 2017: 1 July 2013 to 30 June 2014 ($0.38/L)
BRONZE	Obtain state-level claims from ATO and divide by total state landings. This estimate is not fisheries-specific.		***Tax credits:*** -ATO 2017: 1 July 2013 to 30 June 2014 ($0.38/L)

Governance Category

Governance of fisheries refers to the entire system of legal, social, economic and political arrangements used to manage fisheries. It includes legally binding rules, such as national or state and territory legislation and regulation, as well as co-management arrangements developed with fishing industries and with Indigenous customary fishing communities. Governance quality, or the ability to achieve the goals of governance, refers to the processes, the organisations and the method of managing fisheries.

Ecosystem governance

Objectives of fisheries management in every Australian state and territory require the regulation of fishing activity to ensure that any impacts on marine environments are kept to a minimum. Ecosystem-based fisheries management is being implemented in an increasing number of fisheries. It aims to assess and manage ecological impacts related to fish and fisheries at a broader ecosystem level. Ecosystem governance refers to the capacity to manage multiple activities (including fishing) and their interactions at the scale of a marine system.

Indicator 1: Bycatch mitigation

Mitigation measures include: Closure of fishing areas (seasonal, permanent or in-season when triggered) to prevent unacceptably high levels of bycatch, and Deployment of Bycatch Reduction Devices (BRDs). Assessment is by scoring the extent to which bycatch mitigation strategies for a fishery meet 7 standards for the effective mitigation of fisheries bycatch (Kirby and Ward 2013), developed for Australian fisheries. Alternatively, the FAO Guidelines recommend the implementation of 5 types of management measures to mitigate bycatch (FAO 2010).

Metric:

Description of the bycatch mitigation measures that are used/required/verified for the fishery. (Qualitative)

Recipe

DATA QUALITY	METHOD	DRAWBACKS	DATA
GOLD	Go to the fisheries' management plan and provide the bycatch reduction measures in place. These measures will be tested in efficacy. Measures are compulsory List pertinent measures for bycatch mitigation		A fisheries management plan
SILVER	Methods are being tested or be known to work in other settings. Methods are a mix of voluntary and compulsory		
BRONZE	Bycatch mitigation methods are experimental in nature. Methods are voluntary		

Indicator 2: Protected species mitigation

Protected (including threatened and endangered species) are a special category of bycatch identified by their status in legislation. Assessment of the adequacy of mitigation to reduce capture or impact in fisheries is based on the objectives and performance measures as specified in legislation. Additional assessment is based on the extent to which management arrangements meet national and international requirements for TEPS protection, and the degree of confidence that direct and indirect effects on TEPS from fishing are within acceptable limits (MSC 2014).

Metric:

Description of the protected species mitigation measures that are used/required/verified for the fishery, and evidence of effectiveness. (Qualitative)

Recipe

DATA QUALITY	METHOD	DRAWBACKS	DATA
GOLD	Go to the fisheries' management plan and provide the protected species mitigation measures that are in place. These measures will be tested in efficacy. Measures are compulsory. List pertinent measures for protected species mitigation		Lifted from management plan
SILVER	Methods are being tested or be known to work in other settings. Methods are a mix of voluntary and compulsory		
BRONZE	Protected species mitigation methods are experimental in nature. Methods are voluntary		

Management system

Fishing activity is managed on a day-to-day basis by a system of management which includes management policies and objectives, harvest tools and catch controls, record keeping, assessment and monitoring of fishing activity and fish stocks, and reporting. Effective management systems enable the objectives of the fishery, including ecologically sustainable development, to be implemented.

Indicator 1: Harvest strategy

Defined in the National Guidelines to Develop Fisheries Harvest Strategies (Sloan et al 2014) as "a framework that specifies the pre-determined management actions in a fishery for defined species (at the stock or management unit level) necessary to achieve the agreed ecological, economic and/or social management objectives".

Metric: Scope of Harvest Strategy

Assessment can be based on scoring presence of the following: a harvest strategy designed to achieve management objectives; harvest control rules and tools; collection of relevant information to support the harvest strategy; and, assessment of stock status (MSC 2014) or the presence of the following key elements: Defined operational objectives for the fishery; Indicators of fishery performance related to the objectives; Reference points for performance indicators; A statement defining acceptable levels of risk to meeting objectives; A monitoring strategy to collect relevant data to assess fishery performance; A process for conducting assessment of fishery performance relative to objectives; and Decision rules that control the intensity of fishing activity and/or catch (Sloan et al 2014). (Semi-quantitative)

Recipe

DATA QUALITY	METHOD	DRAWBACKS	DATA
GOLD	Information on the harvest strategy is formally documented in publicly available documents.		Documents for each fishery sourced from management websites.
SILVER	n/a		
BRONZE	A harvest strategy is informally applied.	These data are less reliable than formally required HS	

Indicator 2: Management plans

This is the main instrument that specifies how a fishery is to be managed.

Metric: Scope of management plan

Management plans can be assessed by evaluating the presence of minimum requirements, as follows: a description of the fishery, especially its current status and any established user rights: the management objectives; how these objectives are to be achieved; how the plan is to be reviewed and/or appealed, as well as the consultation process for review and appeal (Cochrane 2002). (Qualitative)

Recipe

DATA QUALITY	METHOD	DRAWBACKS	DATA
GOLD	Information on the management plan is formally documented in publicly available documents.		Documents for each fishery sourced from management websites.
SILVER	n/a		
BRONZE	n/a		

Institutional capacity

The ability to manage fisheries to ensure objectives for ecologically sustainable development are met relies on the capacity of managing agencies. Critical factors include the presence of fisheries management legislation and frameworks to guide and account for decision-making for specific fisheries.

Indicator 1: Accountability of decision making bodies

The level of accountability as defined by Principle 3.2.2 (d) 'Decision-making processes' of the MSC Fisheries Standard v2.0 (2014) states that "the fishery specific management system includes effective decision-making processes that result in measures and strategies to achieve the objectives and has an appropriate approach to actual disputes in the fishery". Its assessment framework considers the extent to which decision-making processes are consultative, the basis for decisions are fully explained, and information about decision making is publicly available.

Metric: Level of accountability

Level of accountability, assessed using a rubric based on the three tiers of Principle 3.2.2 (d) 'Decision-making processes: Accountability and transparency' of the MSC Fisheries Standard v2.0 (2014), as follows: Low - Some information on the fishery's performance and management action is generally available on request to stakeholders; Medium - Information on the fishery's performance and management action is available on request, and explanations are provided for any actions or lack of action associated with findings and relevant recommendations emerging from research, monitoring evaluation and review activity; High - Formal reporting to all interested stakeholders provides comprehensive information on the fishery's performance and management actions and describes how the management system responded to findings and relevant recommendations emerging from research, monitoring, evaluation and review activity. (Semi-quantitative)

Recipe

DATA QUALITY	METHOD	DRAWBACKS	DATA
GOLD	Obtain MSC assessment of fishery where current Search for Principle 3.2.2 (d) 'Decision-making processes', 'Accountability and transparency' Extract MSC assessed result/score for fishery		Existing MSC assessment documents
SILVER	Search managing agency website for all formal/approved policy documents for the relevant fisheries management unit Obtain all operational management information generated by the management agency as publicly provided on agency website (i.e. operating guidelines, advisory group procedures and terms of reference, stock assessment updates, technical reports, advice about recent decisions) Review availability, coverage and content of information against rubric Qualitative scoring	Reliant on assessor's interpretation	Management plans, policies Fisheries legislation (primary and subsidiary) Fishery webpages and web-based information as provided on management agency's website
BRONZE			NA

Rubric

Semi-quantitative (qualitative categories that could be converted to score of 1, 2 and 3, for example) (source: Principle 3.2.2 (d) MSC Fisheries Standard v2.0 (2014)).

Gold, Silver or Bronze

RATING	CLASSIFICATION
HIGH	Formal, annual or biannual reports are consistently available on the agency website, and intra-seasonal updated information is available to interested stakeholders, which provide comprehensive information on the: • fishery's performance and status (i.e. in addition to effort and catch, ecological, economic and social indicators of performance are included). The fisheries management system includes an advisory committee or equivalent. Information on management decisions and description of how the management system responded to findings and relevant recommendations emerging from research, monitoring, evaluation and review activity by the advisory committee is regularly provided to interested stakeholders.
MEDIUM	Annually-updated information is consistently available in regular, periodic agency reports and webpages on: • fishery's performance (effort and catch, as well some further assessment of biomass/stock status); and • management action (changes to input/output controls and regulations). Explanations are documented for any actions or lack of action associated with findings and relevant recommendations emerging from research, monitoring evaluation and review activity and these are available on request to the management agency.
LOW	Limited, basic information is generally available in agency reports and webpages on: • fishery's performance (i.e. annual catch levels); • management action (i.e. changes to input/output controls and regulations).

Indicator 2: Uncertainty management

The explicit incorporation of uncertainties in decision support processes used to inform and make appropriate choices of management actions (FAO 1996).

Metric: Extent of incorporation of uncertainty in management of the targeted stock

Use existing MSC assessments where available. Undertake semi-quantitative scoring of fishery, based on the following materials:

1. Stock/status assessments
2. Technical reports on any model development, MSEs
3. MSC assessments
4. Expert knowledge as required - Fisheries managers and stock assessments scientists

Each fishery is rated as follows: Low level of incorporation of uncertainty; Medium level of incorporation of uncertainty; High level of incorporation of uncertainty as described in the rubric for this metric.

Extent of incorporation of uncertainty in management of the targeted stock, scored using Principle 1.2.4 (c & d) 'Assessment of stock status: Uncertainty in the Assessment' of the MSC Fisheries Standard v2.0 (2014), based on the extent to which: Major sources of uncertainty are identified; Assessment takes uncertainty into account; Frequency of monitoring of indicators is high; Monitoring of more than one indicator to support management decisions; Assessment evaluates stock status relative to reference points in a probabilistic way; Robustness of assessments are tested, Alternative hypotheses and assessment approaches are rigorously explored (MSC 2014), as described in the rubric. If MSC information is not available, see the silver data section below. (Semi-quantitative)

Recipe

DATA QUALITY	METHOD	DRAWBACKS	DATA
GOLD	Obtain MSC assessment of fishery where current Search for *extent of incorporation of uncertainty in management of the targeted stock* Extract MSC assessed result/score for fishery		Existing MSC assessment documents
SILVER	Search managing agency website for latest stock assessment report, technical reports on fishery models, MSEs Contact relevant stock assessment scientist/s and managers to elicit expert knowledge Review and determine: A. Whether, and how many, major sources of uncertainty are identified in the report; B. Whether assessment stipulates the bounds of probability/certainty accepted for key indicators and performance measures; C. Number of indicators of stock status that are monitored and used to inform decisions; D. Frequency of monitoring of indicators; E. Use of reference points in a probabilistic way; F. Assessments are peer reviewed for robustness periodically ("robustness of assessments are tested"?); G. Alternative hypotheses are rigorously explored Semi-quantitative scoring using rubric	Reliant on assessor's interpretation	Stock/status assessments Technical reports on any model development, MSEs MSC assessments Expert knowledge as required - Fisheries managers and stock assessments scientists
BRONZE			NA

Rubric

Semi-quantitative (assessment requires 4 or more conditions to be present at that assessment level) and one of the three following categories is assigned to each fishery.

Silver

RATING	CONDITIONS PRESENT
HIGH	A. Multiple sources of major and minor uncertainty are identified B. Bounds of acceptability levels of uncertainty are identified for all major indicators C. 3 or more indicators used D. Inter and intra-annual monitoring of all indicators E. Use of reference points in a probabilistic way F. Assessments are peer reviewed for robustness periodically G. Alternative hypotheses are rigorously explored
MEDIUM	A. Sources of major uncertainty are identified B. Bounds of acceptability levels of uncertainty are identified for the major indicator C. 2 or more indicators used D. Annual monitoring of all indicators E. Use of reference points F. Assessments are peer reviewed for robustness periodically G. Alternative hypotheses are qualitatively explored
LOW	A. No or only 1 source of major uncertainty are identified B. No bounds of acceptability levels of uncertainty are identified for each major indicator C. 1 or more indicators used D. Bi-annual monitoring of all indicators E. Use of trigger points F. Assessments are internally reviewed G. Alternative hypotheses are not explored

Compliance

Effective management of a fishery to meet biological, social and economic objectives requires fishers to comply with rules and regulations established by managing agencies to safeguard the Australian community's interest in fisheries resources. Non-compliance attracts formal penalties. High levels of compliance indicate that rules and regulations are appropriate and widely understood, and that surveillance and monitoring of fishing activity is routinely undertaken.

Indicator 1: Compliance regime (catch)

The adequacy of management programs implemented to manage the harvest of a fishery such that it protects the fisheries resource and any access and property-like rights granted.

Metric: Level of compliance

Level of compliance with rules and regulations controlling catch can be assessed by audits that measure the agreement between 1) logbook and observer records; 2) catch disposal records submitted by fishers and fish receivers. It might also be assessed by counting the annual number of breaches/observed offences or enforcement actions, preferably scaled to the level of enforcement effort (e.g. $). This indicator can be scored on the basis of the presence of key monitoring, control and surveillance elements and capacities (see Flewwelling et al 2002) (Qualitative).

Recipe

DATA QUALITY	METHOD	DRAWBACKS	DATA
GOLD	Audited statement of compliance with regard to catch limits, or a record of catch limit breaches	Enforcement effort may vary between fisheries and years	Fishery management websites
SILVER	The data from an independent observer programme or electronic monitoring system (or equivalent) used to assess compliance with catch limits		Fishery management websites
BRONZE	Is there a plan/policy that describes the catch compliance for the fishery		Fishery management websites

Indicator 2: Surveillance (compliance monitoring)

The degree (%) and types of observations required to manage compliance with regulatory controls (Flewwelling et al 2002). Types include logs and catch reporting, on-board observer programs, vessel inspections, vessel monitoring systems, and visual or electronic surveillance using radar or satellite by boat or by air. Higher degrees of surveillance, or coverage using multiple methods, provide greater levels of certainty in estimates of effort, fishing mortality, bycatch and discard levels, and interactions with protected/listed species.

Metric: Surveillance effort

Annual number of hours of surveillance carried out on the fishery, as reported by the compliance branch responsible for the fishery. In future, this could be scaled by some measure of the size of the fishery (e.g. number of days compliance activity divided by the number of days of fishing). (Quantitative)

Recipe

DATA QUALITY	METHOD	DRAWBACKS	DATA
GOLD	Fishery specific information of the amount of effort spent on surveillance (e.g. hours/days, trips, vessel inspections)		Compliance branch of agency
SILVER	Region specific information of the amount of effort spent on surveillance (e.g. hours/days, trips, vessel inspections)		Compliance branch of agency
BRONZE	Information that the fishery was subject to surveillance but the level unknown/not released		Compliance branch of agency

Rubric

Gold, Silver

RATING	CLASSIFICATION
EXCELLENT	>90% of vessels (gold) or regions (silver) are checked in a year
GOOD	50-90% of vessels (gold) or regions (silver) are checked in a year
MODERATE	10-50% of vessels (gold) or regions (silver) are checked in a year
POOR	<10% of vessels (gold) or regions (silver) are checked in a year
UNDEFINED	% of vessels or regions checked in a year not stated

Adaptive capacity – climate related

Fisheries will face a range of challenges under climate change, and have the capacity to reduce exposure (allow fishing in new areas), sensitivity (allow a range of fishing options) and increase adaptive capacity (provide assistance to cope with the stresses imposed) via governance arrangements. These arrangements could also be considered as specific elements of the sub-categories “Management system”, and “Institutional capacity”, however, this sub-category reflects the importance in responding to climate change.

Indicator 1: Governance arrangements

Governance arrangements relevant to the fishery consider the impact of climate change on the fishery, as evidenced by documentation, policies and plans that describe how management is addressing climate change impacts.

Metric: Climate change recognition

Does the fishery management plan, harvest strategy or research activity suggest that climate change is recognised, and is it integrated into management planning? (Qualitative)

Recipe

DATA QUALITY	METHOD	DRAWBACKS	DATA
GOLD	Climate change impacts are recognised in fisheries management plan, harvest strategy.		Search in the current management plan for evidence of climate change recognition.
SILVER	Climate impacts recognised by agency responsible for the fishery, but no specific governance.		Agency website
BRONZE	Fishery peak body or equivalent recognise potential need for governance arrangement.		Newsletters and other methods of communication. High level adaptation plan (e.g. QLD govt climate adaptation plan.

Indicator 2: Coping strategies for climate change

The fishery has initiated coping strategies (directed) to reduce the impacts of climate change. Evidence of strategies that have been specifically implemented for the fishery might include codes of practice, restocking programs, early warning systems, and so on. The coping strategies may be for long-term change or for extreme events.

Metric: Climate responses

Description of the climate change responses that have been implemented or explored in research or application. (Qualitative)

Recipe

DATA QUALITY	METHOD	DRAWBACKS	DATA
GOLD	Evidence of climate responses is in the fisheries management plan, harvest strategy.		Search in the current management plan for evidence of climate change action.
SILVER	Research exists to support management arrangements in the face of climate change.		Agency research reports E.g. Fulton et al. 2018, Pecl et al. 2011.
BRONZE	Research or management activities are underway to determine appropriate management responses.		

Social and ethical category

The social and ethical category of fisheries relates to both the communities of fishers themselves and to the broader regional and national communities which are affected by fisheries. Objectives of fisheries management legislation in every Australian state and territory includes the development and use of publicly-owned fisheries resources within sustainable limits in order to generate social benefits for the Australian community. Fishing activity provides livelihoods to fishing communities, and provides recreation and cultural benefits to recreational and Indigenous fishers. It also impacts on broader regional and national communities through its use of a common resource and provision of seafood. The social and ethical dimensions of fisheries are notably less data-rich than the biological components of fisheries with data typically being difficult to collect (time consuming and expensive) and difficult to interpret (subjective, from diffuse sources). However, as the social and ethical considerations of fisheries is likely to face increasing scrutiny and expectations, this is an area where development and new approaches both nationally and overseas is required.

Fisher well-being

The sustainability of fisheries includes the social sustainability of fisher communities. Factors which affect the well-being of fishers include equity of entry into the fishery, levels of income and indebtedness, alternative livelihood strategies, work health and safety, social networks, literacy and levels of participation in fisheries management. These indicators can be qualitative or quantitative.

Indicator 1: Fisher satisfaction

Self-reported levels of well-being can be assessed via surveys, for example as conducted by EconSearch (SA fisheries). Although these surveys are not conducted every year, recent distributions of satisfaction scores will provide insight into one aspect of individual well-being of fishers that is easily measured and tracked over time and individual fisheries can set up a survey to monitor aspects of well-being. In the absence of satisfaction surveys, other indicators may include – the average age of fishers and the retention of fishers and/or levels of new entrants into the fishery. Caveats: Satisfaction (as with well-being) is likely to be interpreted differently for each individual and can be related to the sustainability and security of their livelihood, perceptions of the adequacy of fisheries management, and/or the extent to which they have the opportunity to be involved in co-management.

Metric: Satisfaction scores

If available, fishery specific surveys of well-being or satisfaction, with interpretation required for the types of questions and sample. This is necessarily qualitative. When surveys are not available other sources of data may need to include broader surveys (e.g. not fishery specific) or discussions with industry representatives, managers or fishers about the industry and their opinion of general fisher-wellbeing (note this will be subjective).

Recipe

DATA QUALITY	METHOD	DRAWBACKS	DATA
GOLD	Search for management, research and social impact assessment reports of a specific fishery on industry websites or google. Econsearch reports or socio-economic reports that specifically report on fisher satisfaction are particularly useful. If survey data exists, determine the definition of wellbeing/satisfaction used and the sample (i.e. how representative is the sample, how current is the data?). If the data is sufficient to represent satisfaction/wellbeing for the survey, score results using the rubric below.	Data may not exist or may not be documented (formalised). Survey data may have a low sample size, low representative ability or have asked questions not easily related to wellbeing.	Econsearch reports, management, research or socio-economic reports that specifically report on fisher wellbeing and/or satisfaction
SILVER	If survey data is unavailable, other options include: phoning the relevant fishery manager to discuss (noting this represents one opinion) and asking for any relevant data or scouting around for any other possible information – port visit data for example, or number of fishers attending fishery meetings, or co-management arrangements. Additional options include discussing with a selection of local fishers. Describe any descriptive/anecdotal results, in which case interpretation and judgement is necessary concerning what is relevant to consider and appropriate to report. Considerations include who respondents are, number spoken to, what questions were used and timing of the survey (contextual considerations).	Time consuming and difficult to reconcile a range of views into an overall assessment.	Fisheries managers, fishers, industry representatives.
BRONZE	If no specific data can be found a generic survey of fisher wellbeing (e.g. FRDC) may represent a starting point.	Difficult to ascertain how much of a general score is really appropriate for a specific fishery.	National Survey of Fisher Health and Well-being, University studies into fisheries wellbeing in general.

Rubric

Gold

RATING	CLASSIFICATION
High	High >71% High-levels of fisher satisfaction: 71% or more of fishers express positive satisfaction when averaged across the components of satisfaction assessed in the most recent survey.
Medium	31-70% Medium-levels of fisher satisfaction: between 31% - 70% of fishers express positive satisfaction when averaged across the components of satisfaction assessed in the most recent survey.
Low	30% or less of fishers express positive satisfaction when averaged across the components of satisfaction assessed in the most recent survey.

Silver or Bronze

RATING	CLASSIFICATION
High	Reports from managers or other sources are confident that fisher satisfaction is high
Medium	Reports from managers or other sources are mixed but generally confident that fisher satisfaction is medium
Low	Reports from managers or others sources indicate low or low confidence in fisher satisfaction

Indicator 2: Age structure

Age structure in a fishery that provides a range of social benefits there will be a good spread of ages participating in the fishery.

Metric: Proportion of fishers in standard age cohorts

Proportion of fishers in standard age cohorts that were involved in the fishery at any point in the previous 5 years. If the fishery is not attractive or difficult to enter, the age distribution will be skewed to older ages in comparison with the general population. (Quantitative)

Recipe

DATA QUALITY	METHOD	DATA
GOLD	Search for Age structure data collected as part of fishery participation survey (i.e. social and economic performance reports for the given fishery) OR, request extract of age structure data from relevant management agency based on licensing records Calculate % of fishers in each age cohort as a per cent of the total fish population Compare this with % of Australian labour force in each age cohort (source ABS: 31010DO001_201606 Australian Demographic Statistics, Jun 2016	Fishery participation surveys
SILVER	Search Census database for employment data by State by Industry classification and by Age. Note, this data can only be used where the fishery can be identified on the basis of Industry classifications used in the Census (i.e. pot fishing = rock lobster and/or crab fishery) Data: see TableBuilder – ABS. Look for: Census - Employment, Income and Education INDP - 4 Digit Level by STATE (UR) Counting: Persons, Place of Usual Residence Select 'Industry of Employment' as the key variable for the 'Row', then picked level 4 (the most detailed level – see drop down). Then selected relevant State/Territory in the 'Major State' category as a 'Column'	State licence registrations
BRONZE	N/A	

Rubric

Number of people in age bracket (e.g. 15-20 years; 21-25 year; 26-30 years...)

Wider community

Fishing activity has a direct impact on the supply of fresh seafood to the Australian consumer. More indirect effects on the well-being of the broader Australian community include effects on coastal landscape values, sea country values, national and identity values, and on other marine-based industries (such as tourism). Indigenous fishers might have particular considerations regarding wider community participation and well-being and require tailored approaches to engagement and inclusion. Community benefit includes both statutory processes for public consultation and advisory processes, as well as informal mechanisms for stakeholder engagement.

Indicator 1: Community satisfaction with fishery

A wide range of the community also derive benefits from fishery resources and the general marine environment. Feedback on industry performance by the community can indicate areas that are valued and provide mutual benefits into the future. Feedback can also monitor areas that are in conflict or potential conflict and be an important avenue for keeping commercial interests and community interests in balance. Community satisfaction can be described as social license, but as a social license is intangible, the absence of complaints or conflict may seem like endorsement. Ideally, regular and direct engagement with diverse members of the community will enable direct lines of communication and feedback to ensure that community satisfaction is actually achieved. There is a lack of specific data measuring community perceptions of fisheries. The best metric at the moment is likely to be the FRDC community perception survey. In the future, surveys tailored to different fisheries or regions may give more insight.

Metric: Community feedback (Qualitative)

Direct engagement with the community to gather feedback. This is likely to be qualitative, and depend on the sample of people engaged with. Options for engagement include surveys, focus groups, or community events or directly to the manager or in response to calls for public consultation (for example on management plans). Community perceptions may also be indirectly gleaned through media content analysis – letters to the editor or opinion pieces and in extreme cases protests or boycotts.

Recipe

DATA QUALITY	METHOD	DRAWBACKS	DATA
GOLD	Check the fishery management plan for strategies for (diverse) community engagement and records of incorporating community feedback in to decision making. Management reports which include gender participation and Indigenous participation in management may form part of a measure of inclusion of the wider community. MSC certification or other sustainability assessment that may include a community component may also be taken in to account, as in some communities these are accepted as a good indication of sustainable fishing practices, but in other cases this may not be perceived as sufficient (judgment required).	Difficult to find. May not exist or may not be documented. Difficult to judge if feedback is both sought and responded to (i.e. honest engagement).	Community surveys tailored to different fisheries and/or regions. Management reports describing strategies to gather (and respond to) community feedback.
SILVER	Discuss with the fishery manager how community feedback might be collected – do they discuss the fishery with the community, do they get questions or complaints, how are these dealt with? Or whether social media/media is monitored. Direct lines of communication from individuals in the fishery to individuals in the community and responses given to feedback (feedback taken in to account) or accreditation which includes direct assessment of community satisfaction.	Difficult to capture a range of views and settle on an overall assessment. Data may not be captured or considered 'data' (e.g. informal conversations not recorded or thought of as 'feedback').	
BRONZE	If no specific data can be found a generic survey of community perceptions (e.g. FRDC) may represent a starting point. MSC or other types of accreditation may be regarded as a generic measure of community perceptions in some cases.	Difficult to differentiate if the community has views that are not captured, or if they have no particular opinions.	FRDC community perceptions survey University studies into community perceptions of fisheries generally. MSC accreditation.

Rubric

(scoring is an aspirational goal, but generally not possible)

RATING	CLASSIFICATION
HIGH	More than 60% satisfaction reported in surveys, consistent and transparent processes in place for stakeholder engagement in decision making, including adequate representation of gender and indigenous stakeholders.
MEDIUM	30-60% satisfaction reported in surveys, clear avenues to provide feedback and records kept of feedback received and changes made.
LOW	less than 30% satisfaction reported in surveys, or a majority of 'unsure/unknown' responses. OR Insufficient or inadequate gender and indigenous representation and lack of process for stakeholder engagement in decision making.

Indicator 2. Levels of local employment

Employment provides social and economic benefits directly to people employed, as well as indirect benefits to surrounding communities through expenditure. The communities surrounding and supporting fisheries benefit from those fisheries when the majority of employees (direct and indirect) associated with the fishery activity are local.

Metric: Percentage of local employment versus overseas as reported by for example, the ABS. (Quantitative)

Recipe

DATA QUALITY	METHOD	DRAWBACKS	DATA
GOLD	Search for fishery on State fisheries website Search for economic indicator reports Search for direct employment/jobs	Doesn't give list of indirect jobs	Fishery economics reports
SILVER	Search Fishing Industry website for reports on industry e.g. to government OR On ABARES website - Search Publications – All products – Publications by topic (Fisheries and Aquaculture) Search for Australian Fisheries and Aquaculture Statistics Year Search for employment Report employment level for fishery (e.g. line fishing)	Not released every year State level reporting	Australian Fishery & Aquaculture Statistics reports
BRONZE	Search Census database for employment 899212 – Fishing hand 899211 – Deck hand 231211 – Master fisher for specific region	Need to know what region/s a fishery covers, might mix fisheries. Doesn't cover indirect jobs	Census data

Ethical – Human welfare

The safety and fair work of human workers is an important part of ethical fisheries. This category area is about whether ethical labour principles are protected by legislation or industry standards, and whether such protections are complied with. Such ethical labour principles include: fair and transparent wage rates, ability to join a union, access to necessary training and professional development opportunities, and safe workplaces. It also includes whether there are provisions for enabling access for customary/cultural fishing and that customary and cultural community interests in relation to fish are recognised (as appropriate). As fisheries workers are often an ageing demographic, safe working environments are particularly important to consider.

Indicator 1: Protections in place

In addition to legislation addressing fisheries management itself, other relevant and necessary legislation includes those which address: Workplace Health and Safety; Industrial relations; Fair wage and entitlement conditions. The first of these is administered by States and Territories, while the latter two are administered under Commonwealth legislation. Recognition of Indigenous customary and cultural community interests in relation to fish resources is dealt with under separate State, Territory and Commonwealth fisheries management legislation. As fisheries are made up of different individual businesses and different individuals it can be difficult to provide an overarching assessment of which protections are strictly adhered to and which entitlement conditions are offered. In general, there is considered to be a lack of awareness of occupational health and safety, or a safety culture, in most fisheries in Australia (Brooks 2011). To address this, the FRDC has recently implemented a new project 2017-194 “Fishing Industry Safety Hub - Delivering Industry Safety through Electronic Learning” to develop and enact a national occupational health and safety extension strategy. As part of this process a new system is being developed to make reporting of incidents and accidents more consistent and make OH&S a more accepted (and prioritised) part of daily operations. Another complexity in OH&S is that rules are usually state based and directed at organisations or businesses, but fisheries commonly move across state boundaries and operate at a range of mixed scales (large scale corporate to recreational individual).

Metric: Legislation exists

Is legislation actively in place to protect workers, such as Workplace Health and Safety? This is a qualitative indicator because although all workers are automatically covered under legislation according to their state or territory to a safe work place, the extent to which there is awareness of the relevant Acts, and use of these if required, is highly variable and may be different for each business or individual operation within each fishery. This metric is likely to be qualitative in order to factor in to account the most appropriate approach for each context. (Qualitative)

Recipe

DATA QUALITY	METHOD	DRAWBACKS	DATA

GOLD	Look for reference to workplace health and safety legislation in management reports, including legislation that supports worker's rights and mental health, training in regard to safety and guidelines or procedures about what to do if an incident occurs.	Often not very specific in terms of OH&S compliance records (or if there are records).	Management reports. OH&S reports.
SILVER	Other options include discussing with the fishery manager or a fisher about safety and fairness in the fishery.	Often vague and not uniform.	Fishery managers and fishers.
BRONZE	State based or general information only.	Not clear how/if implemented in fisheries.	State based OH&S acts and policy documents.

Rubric

Rating of the extent to which the fishery has implemented specific procedures, guidelines, training or specific fishery legislations to foster a safe and fair work culture:

RATING	CLASSIFICATION
HIGH	Attempts made to foster a safe work culture in all aspects, including training offered to staff, accreditation or other monitoring systems implemented and consideration of a wide range of safety factors beyond physical injuries, as well as a commitment to maintain high standards in safety as developments occur in this area.
MEDIUM	Some attempts made to foster a safe work culture, beyond the basic provisions. This may include mandatory training and refresher courses, voluntary record keeping and recognition of the growing importance of safety in fisheries, with a commitment that this will be improved in the future.
LOW	No attempt to go beyond basic state and territory level work place safety legislation, no training is offered and compliance is not recorded.

Indicator 2: Level of compliance

Changes in the number of reported breaches by fishing industry employers of legislative protections and industry standards addressing Workplace Health & Safety, Industrial relations, and Fair wages and entitlement conditions indicate changes in levels of compliance with these ethical standards. A number of Commonwealth, State and Territory authorities administer these provisions, monitor compliance and report on numbers of breaches annually. This is an area which is likely to become more consistent as national or state systems are introduced to standardise reporting.

Metric: Levels of compliance (or violations of) with Workplace Health and Safety.

This metric may be considered quantitative if reports are only given numerically, but is more likely to involve some level of judgement and interpretation (qualitative) as to the extent and sufficiency of reporting and compliance.

Recipe

DATA QUALITY	METHOD	DRAWBACKS	DATA
GOLD	If references to Workplace Health and Safety exist in relation to the specific fishery, determine whether these are voluntary or recorded in anyway. If they are recorded, note the level of compliance. As they are likely to be voluntary, there will not likely be a record of compliance, but this may become more readily available in the future.	Difficult to find, even if it is recorded it may not be reported.	Management reports. OH&S reports.
SILVER	Other options include discussing with the fishery manager or a fisher about how the safety is implemented and their thoughts on training, compliance and reporting and the overall attitude to safety and progress in developing approaches to foster a safe work culture.	Often vague and not uniform.	Fishery managers and fishers.
BRONZE	Regional or national reports of OH&S compliance.	Not clear how/if specific to fisheries.	State based, sectoral or national OH&S reports.

Rubric

Rating of the extent to which the fishery monitors and reports on compliance:

RATING	CLASSIFICATION
HIGH	Compliance is strongly encouraged and even if it is voluntarily recorded, there are high levels of completions and cases on record.
MEDIUM	Compliance is actively encouraged and voluntarily recorded and some cases are on record.
LOW	Compliance is not monitored and very rarely reported.

Ethical – Animal welfare

The ethical treatment of animals used for human consumption is a growing area of public concern. Legislation and codes of conduct protecting the welfare of fish and other aquatic organisms relevant to the fishery may be relevant at harvesting, discarding, handling and transport. For example, CleanGreen accreditation requires the ethical treatment of rock lobsters which are transported live on fishing vessels. The ethical treatment of animals also relates to implementing practices to avoid unnecessary interactions with non-target species and processes for dealing with any unintended interactions.

Indicator 1: Animal welfare protections

Animal Welfare protections– The existence of Animal Welfare or Prevention of Cruelty to Animals legislation, and the inclusion or exemption of fish from any such protections, provides an indication of the extent to which the ethical dimensions of animal welfare are addressed for a given fishery. For example, in some states, despite fish being included under animal welfare legislation, there are specific exemptions to some sections in relation to any activity that occurs under fisheries legislation. In other cases, industry codes of practice have been developed by the commercial fishing sector to take account of fish welfare considerations, often in combination with quality assurance and food safety programs.

Metric: Animal welfare protections in place for fish (Qualitative)

Is legislation or other forms of formal procedures actively in place to protect animal welfare, such as bycatch handling guidelines? This is a qualitative indicator because animal welfare will be different for each fishery depending on the types of species involved, the methods of handling and transport and the time taken.

Recipe

DATA QUALITY	METHOD	DRAWBACKS	DATA
GOLD	Animal welfare protections in place and are audited to a high level of coverage.	Does not yet exist	N/A
SILVER	Determine whether there is any reference to animal welfare protections (whether target species or other) in management plans. Although this is likely to be in place only in rare cases, this is an area which we predict will be required more in to the future.	A new, developing area, so difficult to find information.	Management reports.
BRONZE	If no mention of animal welfare can be found, other options include discussing with fishers or fishery managers if and how animal welfare is being considered in the fishery and if and how that might change in to the future.	Anecdotal and variable.	Fishery managers and fishers.

Indicator 2: Level of compliance

Where animal welfare protections for targeted species and other species are in place, levels of compliance and/or breaches of compliance are likely to need to be recorded. As this is a new area, this is not yet expected to be in place but is likely to become more of an issue in the future and likely to become required for fisheries that have some animal welfare interactions.

Metric: Levels of compliance or violations of animal welfare (Qualitative)

The metric for this indicator does not yet exist in most cases, but reports on levels of compliance and incident reports for animal welfare are likely to become more common as this area develops.

Recipe

DATA QUALITY	METHOD	DRAWBACKS	DATA
GOLD	Publicly accessible performance reporting on level of compliance.	Does not exist	N/A
SILVER	If there are any references to animal welfare protections or guidelines in fishery management plans determine how this is to be reported on and if reports exist, the level of compliance or violations of these. This is likely to require a discussion with fishery managers or fishers in the first instance, but in the future, there could be reports made available about best practices and compliance breaches.	A new, developing area, so difficult to find information.	Management reports. Fishery managers.
BRONZE	If no mention of animal welfare can be found, other options include discussing with fishers or fishery managers if and how animal welfare is being considered in the fishery and if and how that might change in to the future.	Anecdotal and variable.	Fishery managers and fishers.

Rubric

RATING	CLASSIFICATION
YES	The guidelines to support animal welfare are followed in the majority of cases (70% or more), reports are made as appropriate and compliance is monitored in some way.
NO	Does not meet criteria for a 'YES'.

Adaptive capacity of the fishery

The effect of the impacts changes (such as climate change) can be reduced if the adaptive capacity of the system participants, such as the people involved in fisheries, can be improved. A range of research [2, 3] indicates that the capacity of the participants can be improved in primary industries with access to information and development of social networks that can support and disseminate new information. This indicator refers to autonomous rather than institutional capacity (which is captured in the Governance category). It is also around general access to information, with climate change as one example.

Indicator 1: Access to information

Access to information on fishery conditions, changing rules and regulations, market conditions, and the types and rate of changing environmental conditions is critical in enabling fishers to make informed decisions about optimal fishing strategies in the context of constant change (e.g. climate-driven change). How much information is necessary will be different in different contexts and the quality of information will also vary. Newsletter, websites and social media (covered more directly in indicator 2) can link users up to good quality, accurate and timely information, but can also proliferate inaccurate or biased information.

Metric: Availability of information (Qualitative).

The metric for this indicator is difficult to measure, as each individual or business is likely to use different sources of information to make decisions and these can vary day to day for individuals as well as across the fishery and the availability of information does not necessarily translate to that information being used. The metric aims to capture, in a general sense, whether there is a good flow of information in the fishery.

Recipe

DATA QUALITY	METHOD	DRAWBACKS	DATA
GOLD	Determine whether there is a regular fishery specific newsletter, website or group for the fishery. An interpretation will need to be made about how active it is and how widespread it is – view counts or other circulation data may be available in some cases. Other factors may be how easy it is to access, whether it includes links to further information and the general scope/appeal of the information – how long is it, does it cover many topics, is it interesting to a range of readers, is it interactive (include links to other sources), does it appear to give credible information supported by references and finally is it appropriate to the fishery (or are other personal forms of information delivery more suited).	A case by case assessment will need to be made, based on the right fit for the fishery. This can be difficult to assess.	Dedicated fishery website. Evidence of active industry representation. Fishery newsletters.
SILVER	Discuss with the fishery manager or fishers whether information is easy to access.	Anecdotal and subjective.	Fishery managers and fishers.
BRONZE	Generic information sources only – not specific to the fishery and not necessarily regular or timely.		Generic fishery website. Generic newsletters.

Rubric

RATING	CLASSIFICATION
HIGH	High levels of information. Clear sources of useful information that is easy to access and appears to be widely used.
MEDIUM	Medium levels of information. Some sources of information or networks but uncertainty around the accuracy or engagement with the information.
LOW	Low levels of information. No newsletter, website or group activity found. Little evidence of regular information flow.

Indicator 2: Access to networks

Networks within communities of interest, such as harvesters within a fishery, generate social capital which is associated with higher levels of adaptive capacity. These networks also play a role in knowledge dissemination and brokerage. These networks facilitate the sharing of local ecological knowledge, cultural practices and values and alternative fishing and business strategies. In the primary industries, personal sources of information and networks can be particularly influential and while social networks can be difficult to measure and little work has been done to map network interactions in Australian fisheries, how active the fishery members are in professional associations, clubs and social media groups can give some indications as to whether networks are active sources of information. It can be difficult to know what networks exist, and how active they are, without being a part of the network or engaging with someone who is.

Metric: Level of membership of industry association (Qualitative)

The percentage of operators within a fishery who are members of the representative organisation (industry association or peak body) is a measure of strength of formal networks. Active professional networks are likely to have strong social activities which are often the basis for informal networks and social capital. This is qualitative because interpretation is required as to whether the industry association is appropriate for the specific fishery (in some small fisheries another professional or amateur network may be more appropriate) and to assess how active and the network is, whether there are activities and events or whether only a small number of people participate.

Recipe

DATA QUALITY	METHOD	DRAWBACKS	DATA
GOLD	Determine whether there is a fishery specific social media account or network, professional network or association or volunteer or community group/club. An interpretation will need to be made about how active it is and how widespread it is – member numbers may be able to be found. Other factors may be how easy it is to access information about their activities, when and how often they meet and the kinds of activities undertaken.	A case by case assessment will need to be made, based on the right fit for the fishery. This can be difficult to assess.	Dedicated fishery social media account. Evidence of active industry representation and network. Fishery newsletters include social activities and events.
SILVER	Discuss with the fishery manager or fishers or industry representative whether there is a social network active in the fishery.	May be anecdotal and subjective – hard to represent all views.	Fishery managers and fishers. Industry representatives.
BRONZE	Generic social activity – not specific to the fishery and not necessarily regular or timely.		Generic fishery social media. Generic fishery events calendar.

Rubric

Rating of the extent to which the fishery monitors and reports on compliance:

RATING	CLASSIFICATION
YES	Is there a professional and/or social network for the fishery (including industry membership or social media group)? In future, the activity level may be assessed if possible, as high, medium or low, but it may be difficult to determine whether the level of apparent activity corresponds to actual activity and vice versa – no apparent activity may not reflect what is really happening. Further activity may be related to, but not specific to the fishery itself, such as with community volunteer groups.
NO	Not meeting criteria for a 'YES'.

External influences on a fishery

Fisheries are subject to a range of external influences that impact on the long-term sustainability of activities and seafood supply, but which are outside the control of fishery participants and specific fishery managers. This category reports on these external issues that are of interest to seafood businesses, managers, distributors and consumers. It could go to a very long list, but here we focus on several established areas.

Environmental context

Fisheries are reliant on healthy supporting marine ecosystems. Marine environments can differ substantially around Australia and also have a range of natural variability. It is important to understand the fishing activity relative to the environmental context.

Indicator 1: Environmental productivity

A measure of environmental productivity is the biomass of phytoplankton, which in oceanic waters can be approximated by chlorophyll a concentration, as estimated from satellite. The mean value for the fishery region, compared to the mean value for Australia, provides some indication of relative productivity. Australia has generally low productivity waters.

Metric: Mean chlorophyll

Chlorophyll a values for the area of the fishery, relative to a baseline for the Australian EEZ. These data provide information on the relative environmental productivity in the fishery area. Missing data for some months can be due to ice cover. Variability in chlorophyll a concentration between years can indicate high environmental variability, while similar seasonal patterns indicate relative environmental stability (Quantitative).

Recipe

DATA QUALITY	METHOD	DRAWBACKS	DATA
GOLD	Obtain spatial extents of fishery or a region that describes the ocean influences on the fishery • A 5 x 5 degree square centred on the main fishery grounds Calculate the mean chlorophyll as a time series by month over the past 10 years. Plot as a climatology to show the comparison over years	Coastal problem with ChlA.	Satellite products • MODIS ChlA
SILVER	n/a		
BRONZE	n/a		

Indicator 2: Ecosystem character

Fisheries take place in a range of ecosystems, from enclosed (estuarine) to open ocean waters and from oligotrophic to eutrophic waters. This indicator provides context for the fishery harvest levels that can be taken from different regions.

Metric: Description of the ecosystems

This metric provides a qualitative description of the ecosystem(s) in which the fishery occurs. The goal is to provide a general overview of these environments. The knowledge about which ecosystems are encountered during fishing activity is the indicator (rather than the response of the ecosystems to fishing).

Marine ecosystems are defined for the purposes of this indicator as the composition of plants, animals, and the marine environment (water masses, geomorphology). Types of marine ecosystems include estuaries, the sea floor, the mesopelagic zone, the pelagic zone, the inter-tidal zones, coral reefs, lagoons, and mangroves. A pelagic zone ecosystem for example, is defined by physical, chemical and biological features of the marine water column of the open ocean[1]. (Qualitative)

Recipe

DATA QUALITY	METHOD	DRAWBACKS	DATA
GOLD	Determine the marine bioregions (e.g. IMCRA) or ecosystems (e.g. from Bioregional Profiles) in which the fishery occurs (e.g. based on maps in fishery agency website, ABARES status reports, or effort maps in ERAEF reports) Describe the ecosystem in which the fishery occurs, based on dedicated study or report.	Boundary of the fishery is not always a good representation of where the fishing effort occurs (generally a smaller area). Effort distribution maps for fisheries may not be publicly available.	ABARES Fishery Status reports e.g. http://www.agriculture.gov.au/abares/research-topics/fisheries/fishery-status/ Fishery agency website with map e.g. https://www.afma.gov.au/fisheries/eastern-tuna-and-billfish-fishery-page Information on the ecosystem from dedicated reports, such as Bioregional Plans (e.g. https://parksaustralia.gov.au/marine/management/resources/scientific-publications/east-marine-bioregional-plan-bioregional-profile-description-ecosystems-conservation-values/)
SILVER	Determine the large marine regions in which the fishery occurs. Obtain relevant information from SoE reporting Describe the ecosystem in which the fishery occurs, based on dedicated study.	These areas contain a large number of ecosystems, and so descriptions are aggregated across different ecosystems.	Australia: Status of the Environment 2016.
BRONZE	Description of the ecosystems in which the fishery occurs	Not primary data	Fishery-provided information, based on ERAEF reports, or agency webpages or reports

Rubric

RATING	CLASSIFICATION
High	The ecosystems in which fishing occurs are known
Medium	The ecosystems in which fishing occurs are inferred
Low	The ecosystems are not known

[1] Game, E. T., H. S. Grantham, A. J. Hobday, R. L. Pressey, A. T. Lombard, L. E. Beckley, K. Gjerde, R. H. Bustamante, H. P. Possingham and A. J. Richardson (2009). Pelagic protected areas: the missing dimension in ocean conservation. Trends in Ecology and Evolution **24**(7): 360-369 doi:310.1016/j.tree.2009.1001.1011.

Climate-related fishery impacts

Climate change impacts on species, habitats and ecological communities are already occurring and will continue to affect a range of fisheries. There may be climate-related changes in the distribution and abundance of fished species which may influence supply to markets. This sub-category provides information on the threats to fishing sustainability as a result of climate change. These may indirectly influence sustainability, and fisheries confronted by these challenges may need additional support – see **Governance** category. For example, fisheries that target species that are changing distribution may also need to relocate but the infrastructure may not exist in the new location.

Indicator 1: Susceptibility of target species captured by the fishery to climate change.

Climate change directly affects the distribution, abundance and phenology of individual species. These changes then affect the fisheries that harvest these species, and can be a strong external influence on the fishery. These impacts can be positive (e.g. increased abundance), or negative (e.g. movements further from fishing ports), and to long-term warming, or short-term extreme events such as marine heatwaves.

Metric: Target species impacted by climate change (Semi Quantitative (Gold, Silver) or Qualitative (Bronze))

A short description of the known or projected susceptibility or impacts on the target species, including on their distribution, abundance, phenology, or distribution. This can be based on published observations, model-based inference, or semi-quantitative risk assessment.

Recipe

DATA QUALITY	METHOD	DRAWBACKS	DATA
GOLD	Comprehensive assessment of known climate impacts for the target species within a fishery, based on empirical data.	Reliance on a single publication or report.	Project reports, publications
SILVER	Assessment of climate impacts for some of the target species within a fishery. OR Comprehensive assessment of projected climate sensitivity or impacts for the target species within a fishery Sensitivity assessment: Take the sensitivity calculation from Fulton et al. 2018 for each species in the fishery. Model based inference: Take the abundance change % from Fulton et al. 2018 for the species in the fishery.	Model-based. Reporting is disparate and organising this information is difficult.	Project reports, publications e.g. Fulton et al. 2018. (Sensitivity analysis) e.g. Fulton et al. 2018 (model based inference) Dispersed publications and reports
BRONZE	Limited information for some of the target species, in some of the areas of change (distribution, abundance, phenology).		Unpublished model results, anecdotal reports.

Rubric (Silver)

RATING	CLASSIFICATION (SENSITIVITY SCORE BASED)	CLASSIFICATION (MODEL INFERENCE BASED)
HIGH	> 6 sensitivity score	> 60% change
MODERATELY HIGH	5.5 < sensitivity score <= 6	40% - 60% change
MODERATE	5.25 <= sensitivity score <= 5.5	20% - 40% change
LOW	< 5.25 sensitivity score	< 20% change

Indicator 2: Susceptibility of key fishery habitats to climate change

Metric: Habitat impacts of climate change (Qualitative)

A short description of the known or projected susceptibility or impacts on the habitats used by species in the fishery. The climate impacts can be due to long-term warming, or short-term extreme events such as marine heatwaves.

Recipe

DATA QUALITY	METHOD	DRAWBACKS	DATA
GOLD	Comprehensive assessment of known climate impacts for the habitats within a fishery, based on empirical data.	Reliance on a single publication or report.	Project reports, publications
SILVER	Assessment of climate impacts for some of the habitats within a fishery. OR Comprehensive assessment of projected climate sensitivity or impacts for the habitats within a fishery	Model-based. Reporting is disparate and organising this information is difficult.	Project reports, publications Dispersed publications and reports
BRONZE	Limited information for some of the habitats, such as occurring within a global warming hotspot (e.g. south-east or south-west Australia).		Unpublished model results, general publications or anecdotal reports.

Rubric

RATING	RATIONALE
HIGH	Climate change, including climate related extreme events, has already modified the habitat
MODERATE	Climate change, including climate related extreme events, projected to modify the habitat
LOW	Climate change, including climate related extreme events, has not and is not projected to modify the habitat

Contaminants in the environment

Contaminants occur in the environment from a range of human activities on land and at sea influence the safety of seafood products and fishing opportunities. Pollutants such as mercury can accumulate in the tissues of some species, such as sharks. This may require management arrangements (e.g. maximum size limits) to prevent human exposure to high levels. Seafood may also be contaminated from natural causes. For example, toxins from harmful algal blooms resulting in Paralytic Shellfish Poisoning (PSP) can require temporary fishery closures for species such as bivalve molluscs. Australia has a Food Standards Code that fisheries needs to comply with and may require certain management arrangements from a food safety perspective.

Indicator 1: Detection system for seafood contaminants

Detection system for seafood contaminants – addresses potential risk for contamination from the marine environment combined with monitoring arrangements to be able to address risks needed to ensure food safety. Contaminants include those with maximum levels set for by Food Standards Code Australia (Standard 1.4.1 Contaminants and natural toxicants): metal contaminants, non-metal contaminants, natural toxicants, and average and maximum levels of mercury in fish. Contaminants from poor handling after landing are not included.

Metric: Risk for concentration of contaminants

Contamination of different pollutants may vary depending on fishing season and area, catch composition (species and sizes), and may or may not be above the maximum level set for human consumption. (Qualitative).

Recipe

DATA QUALITY	METHOD	DRAWBACKS	DATA
Gold	Information is available on current detection system for the fishery on webpages concerning the specific fishery, up to date and appropriate based on risk. Find out through searching on fisheries' webpages for information on monitoring arrangements. Cross-check for risk of contamination level for the targeted species based on present knowledge concerning potentially contaminated seafood (Safe Seafood Australia 2006; Food Standards). Risk contaminants are those with maximum levels set for by Food Standards Code Australia (Standard 1.4.1 Contaminants and natural toxicants): metal contaminants, non-metal contaminants, natural toxicants, and average and maximum levels of mercury in fish. Apply risk score based on rubric (below).	Difficult to define what is appropriate monitoring.	Fisheries' webpages **General information on seafood safety and risks:** Safe Seafood Australia (2006) Food standards
Silver	Information is available for like fisheries in Australia. Apply risk score based on rubric (below).		
Bronze	Information is available for like species in the world. Apply risk score based on rubric (below).		

Rubric

RATING	CLASSIFICATION
HIGH	Permanent diet restrictions of species caught to vulnerable consumers such as children or pregnant women
MEDIUM	There may be seasonal/area/species/size-based risks of contaminants for some species.
LOW	There are no documented levels of contaminants from the marine environment causing risk/diet restrictions to any consumer group in the fishery.

Indicator 2: Management arrangements to ensure food safety related to contaminants

Metric: Evidence for arrangements

Formal rules for closures that are implemented in response to risk or detection (Qualitative).

Recipe

DATA QUALITY	METHOD	DRAWBACKS	DATA
Gold	Information is available on evidence for arrangements on fisheries-specific webpages. Contact, if needed, responsible state/territory to get information on monitoring and management arrangements for seafood safety. Document outcome in the form of text		Contact with seafood safety authorities Contact with industry http://www.foodstandards.gov.au/about/foodenforcementcontacts/pages/default.aspx
Silver	Information is available for like fisheries in Australia		
Bronze	Information is available for like species in the world		

Rubric

Text on management arrangements, or motivation if not needed.

Market drivers

Markets play a central role in Australian's mixed economy and for fisheries as an economic activity and highly-traded commodity in particular. Market drivers are those factors which cause changes in demand for fisheries products, and these factors are external to (i.e. outside the influence of) the fishing industry. Drivers of product markets include factors such as consumer trends, exchange rates for exported products, population increase, terms of trade, certification requirements.

Indicator 1: Macroeconomic factors

Macroeconomic factors directly affect the profitability of Australia's fisheries through both market prices per unit and quantity of sales. Prices for Australia's export-oriented fisheries are strongly influenced by exchange rate movements. The strength of the Australian dollar against the currencies of major trading partners, particularly the United States and Japan, reduces the competitiveness of Australian fisheries exports. The terms of trade also influence the price competitiveness of imported seafood in contrast to locally-produced seafood, and hence levels of domestic consumption. Fuel is a significant cost item for fishing businesses and can affect the price competitiveness of Australian-produced seafood in export markets, and in domestic markets relative to imported product.

Metric 1: Exchange rates (AUD$)

A depreciating Australian dollar (or, increasing exchange rate) generally results in producers receiving a higher export price in Australian dollar terms, while an appreciating Australian dollar (or, decreasing exchange rate) results in a lower export price. Domestically, a depreciation of the Australian dollar encourages substitution from imported seafood to domestically produced seafood, as imported products become relatively more expensive. A lower exchange rate also makes Australian exports more competitive in world markets, as exported seafood become relatively cheaper in foreign currency terms. [4]. This is not fishery-specific. (Quantitative)

Recipe

DATA QUALITY	METHOD	DRAWBACKS	DATA
Gold	Download latest 'Australian fisheries and aquaculture statistics' report from ABARES website Search for 'Australian dollar exchange rate against US dollar and Japanese yen' Extract relevant numbers and chart Paste	None, other than less applicable to non-export oriented fisheries (in which case use metric 2)	Australian dollar exchange rate against US dollar and Japanese yen, 2005–06 to 2015–16 (default) The foreign currencies selected should reflect relevant markets

Metric 2: Diesel price (AUD$/L)

At a national level, higher diesel prices generally result in higher market prices for Australian-produced seafood and therefore lower competitive advantage compared with imported seafood, and on global markets as an export product. Fishing firms may not pass on higher diesel costs and effects can then include reduced economic returns. This is not fishery-specific. (Quantitative)

Recipe

DATA QUALITY	METHOD	DATA
Gold	Download latest ‘Australian fisheries and aquaculture statistics’ report from ABARES website Search for ‘Diesel price’ Extract relevant numbers and chart Paste	Diesel price, 2005–06 to 2015–16

Indicator 2: Consumer trends

Trends in the amount of seafood Australian and overseas consumers of Australian seafood consume is an indicator of changing demand and therefore market conditions. Apparent consumption is a measure often used to track the consumption of agricultural commodities over time. Increased consumption indicates increasing demand for seafood products, therefore potentially improved market conditions for seafood producers. If an export-oriented fishery, decline in Australian apparent consumption of seafood per capita is not an indicator of market conditions for this product. Global levels of per capita seafood consumption are a more relevant indicator. If a domestic market-oriented fishery, decline in apparent consumption by Australian consumers may not worsen market conditions if that fishery is targeting higher unit prices rather than larger volumes of sales.

Metric: Per capita annual consumption of seafood (kg)

Annual apparent consumption is estimated by adding the total edible quantity of seafood supplied domestically—that is, total production plus imported seafood— less exports of seafood. Apparent consumption provides an estimate of the total amount of seafood consumed in Australia assuming zero change in stocks.

The production quantity of Australian fishery and aquaculture products is reported [by ABARES] on a whole weight basis, whereas trade data are reported on a processed basis. To align the units of measurement between production and trade data, it is necessary to convert production volume to a processed edible equivalent.

Production volumes are adjusted to an edible quantity basis using species-specific conversion rates and excluding species that are known to be predominantly supplied for non-human consumption purposes, such as for aquaculture feed or bait. Imports and exports of seafood are sourced from Australian Bureau of Statistics (ABS) trade data and are reported as edible weight. The apparent consumption per person is calculated as the total apparent consumption divided by the total Australian population in each year. The method applied here is consistent with that used by ABARES to estimate apparent consumption of other agricultural commodities produced in Australia.

The FAO also compiles statistics on apparent consumption of seafood, applying a consistent method across all countries. FAO estimates indicate that annual consumption of seafood in Australia is around 26 kilograms per person in 2013—around 11 kilograms higher than the estimates presented here for 2013–14 (FAO 2016). The discrepancy between FAO and ABARES estimates reflects differences in methodological approaches to estimating consumption. Moreover, ABARES estimates seafood consumption on a processed edible basis, whereas the FAO provides its estimates on a whole weight basis. This is not fishery-specific. (Quantitative)

Recipe

DATA QUALITY	METHOD	DRAWBACKS	DATA
Gold	Download latest 'Australian fisheries and aquaculture statistics' report from ABARES website Search for 'Apparent seafood consumption per person' Extract relevant numbers and chart (Figure 6) Paste	ABARES reports Australian apparent seafood consumption per person but not global apparent consumption	Weight (kgs) of processed edible seafood product consumed per capita per year in Australia

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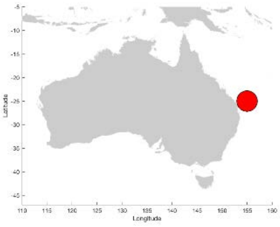
Appendix 4 – Case studies

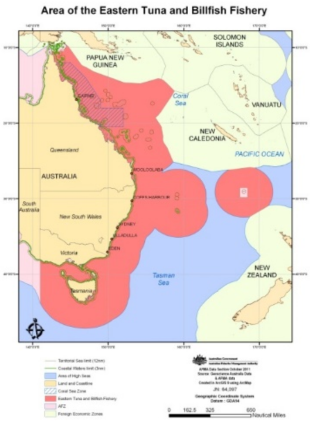
Case studies (20) included in this appendix.

Case study	Fishery	Jurisdiction
1	Eastern Tuna and Billfish (ETBF)	Comm
2	South East Scalefish and Shark Fishery (SESSF) Otter trawl sub-fishery	Comm
3	Northern Prawn	Comm
4	Heard Island and McDonald Island Fishery	Comm
5	Spanner Crab - Ocean Trap and Line	NSW
6	Ocean Haul	NSW
7	Mud Crab	NT
8	Offshore snapper	NT
9	Coral reef finfish	QLD
10	Blue swimmer crab	QLD
11	Spencer Gulf Prawn	SA
12	Lakes and Coorong - Pipi	SA
13	Lakes and Coorong - Net	SA
14	Turbo	SA
15	Scalefish	TAS
16	Abalone	TAS
17	Rock Lobster	VIC
18	Scallop	VIC
19	Abalone	WA
20	Southern & West Coast demersal gillnet & longline	WA

Commonwealth Eastern Tuna and Billfish Fishery

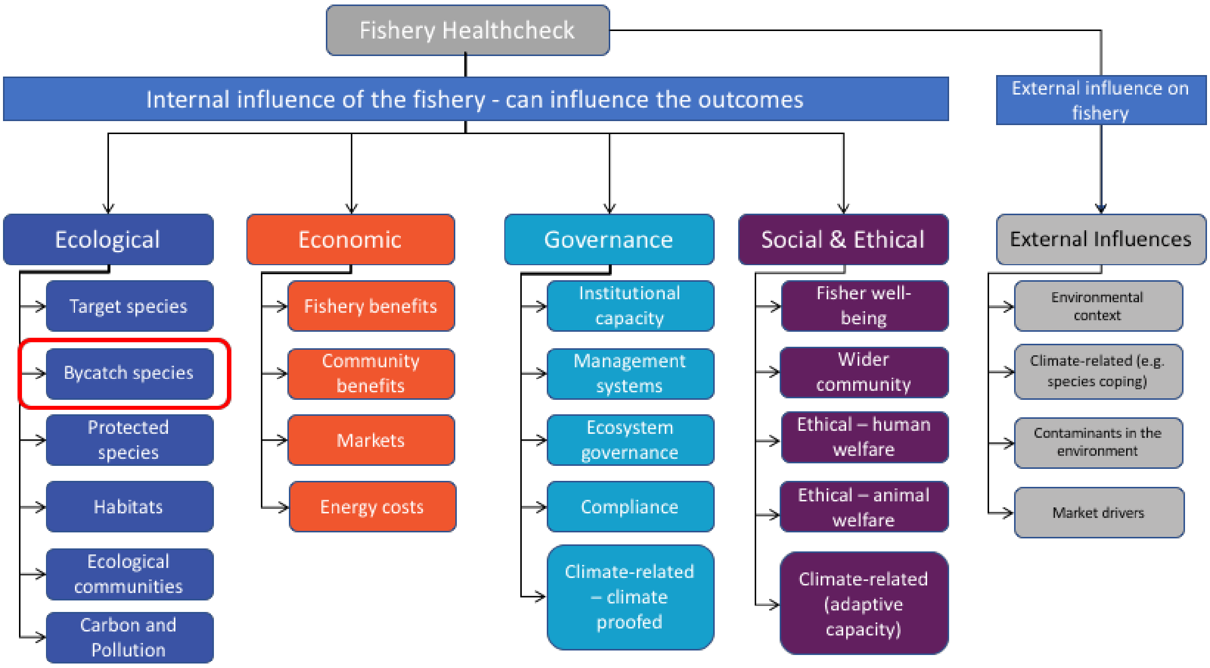


The Commonwealth Eastern Tuna and Billfish Fishery extends from Cape York in Queensland to the South Australian/Victorian border. Fishing occurs in both the Australian Fishing Zone and adjacent high seas. Longline and minor line (including handline, troll, rod and reel) fishing gear is used in this fishery. Fishers mainly use longline fishing gear to catch the targeted species. These are very long lengths of fishing line with hooks that hang down and have bait attached. The longlines are set into the water near the surface and catch the fish individually. The Eastern Tuna and Billfish Fishery is managed by limiting the catch of tuna and billfish species, restricting how many boats can fish and regulating what gear they can use. The species targeted by commercial fishers in the Eastern Tuna and Billfish Fishery are albacore tuna (*Thunnus alalunga*, bigeye tuna (*Thunnus obesus*), yellowfin tuna (*Thunnus albacares*), broadbill swordfish (*Xiphias gladius*), striped marlin (*Tetrapturus audux*). (Source: http://www.afma.gov.au/fisheries/eastern-tuna-and-billfish-fishery-page/).



Case Study Presentation Format

The case study documents are a collection of metrics, organised by the healthcheck structure:



The presentation of metrics will follow the following heading format:

Ecological > Bycatch species > Bycatch composition > Mean Trophic Level

Understand this to be an indicator (**Bycatch composition**) of the **Ecological** Component, **Bycatch species** subcomponent where the (in the figure and heading example above, is being measured by presenting Mean Trophic Level as the metric.

Ecological > Target species > Stock Status > Status of Australian Fish Stocks (SAFS)

Target species in each fishery are the primary focus for this indicator. Status of these species is ideally assessed with the SAFS approach, however this may not cover all target species for each fishery. In that case, we indicate the number of unassessed species. These species could also be assessed by individual states or by alternative methods.

SpeciesName	StockName	StockStatus	Year
Albacore	South Pacific Ocean	Sustainable	2016
Bigeye Tuna	Pacific Ocean	Overfished	2016
Striped Marlin	Eastern Australia	Not-assessed	2016
Swordfish	South-West Pacific Ocean	Undefined	2016

Yellowfin Tuna	Western and central Pacific Ocean	Sustainable	2016

Data Quality: Gold

Ecological > Target Species > Harvest Level > Catch weight

This metric is a proxy for harvest level. The harvested biomass for each species, provides information on the level of the catch. Trends in this metric over time can indicate declining availability of fish, quota restrictions, or changes in market demand. For Australian fisheries, trends are expected to be stable for most species.

The ETBF has five target species (http://www.afma.gov.au/fisheries/eastern-tuna-and-billfish-fishery-page/). These species are also caught by many other countries. Australia's catch of tuna and billfish is a very small part of the total catch internationally. A range of other species are also landed as byproduct. The recent catches of target species[2] are:

TABLE 21.2 Main features and statistics for the ETBF

Fishery statistics a	2016			2017		
Stock	TACC (t)	Catch (t)	Real value (2015–16)	TACC (t)	Catch (t)	Real value (2016–17)
Striped marlin	351	244	$1.4 million	351	286	$1.0 million
Swordfish	1,373	1,161	$9.2 million	1,285	1,175	$9.3 million
Albacore	2,500	1,101	$3.9 million	2,500	992	$4.1 million
Bigeye tuna	1,056	872	$8.1 million	1,056	449	$7.3 million
Yellowfin tuna	2,200	1,765	$25.1 million	2,400	1,713	$12.6 million
Total fishery	**7,480**	**5,143**	**$49.6 million**	**7,592**	**4,615**	**$35.7 million**

The landings from the catch disposal records[3] show the breakdown of catch of these species for recent years.

Year	Common Name	Scientific Name	CAAB	Retained Catch (Kg)	Data Source
2007	Albacore	Thunnus alalunga	37441005	1924554	CDR
2008	Albacore	Thunnus alalunga	37441005	1276728	CDR
2009	Albacore	Thunnus alalunga	37441005	1522827	CDR
2010	Albacore	Thunnus alalunga	37441005	872291	CDR

[2] Patterson, H, Larcombe, J, Nicol, S and Curtotti, R 2018, Fishery status reports 2018, Australian Bureau of Agricultural and Resource Economics and Sciences, Canberra. CC BY 4.0.

[3] https://data.gov.au/dataset/0cd2ec97-d13c-4b02-8071-fd778fdcdee7/resource/81d3d265-b21a-4b05-b62d-c315beec771e/download/annual-cdr-catch-data-30-05-2018.xlsx

Year	Common Name	Scientific Name	CAAB	Retained Catch (Kg)	Data Source
2011	Albacore	Thunnus alalunga	37441005	770966	CDR
2012	Albacore	Thunnus alalunga	37441005	708857	CDR
2013	Albacore	Thunnus alalunga	37441005	772856	CDR
2014	Albacore	Thunnus alalunga	37441005	736898	CDR
2007	Bigeye Tuna	Thunnus obesus	37441011	1007455	CDR
2008	Bigeye Tuna	Thunnus obesus	37441011	1026491	CDR
2009	Bigeye Tuna	Thunnus obesus	37441011	726367	CDR
2010	Bigeye Tuna	Thunnus obesus	37441011	521935	CDR
2011	Bigeye Tuna	Thunnus obesus	37441011	445056	CDR
2012	Bigeye Tuna	Thunnus obesus	37441011	552749	CDR
2013	Bigeye Tuna	Thunnus obesus	37441011	488941	CDR
2014	Bigeye Tuna	Thunnus obesus	37441011	489847	CDR
2007	Striped Marlin	Tetrapturus audax	37444002	358722	CDR
2008	Striped Marlin	Tetrapturus audax	37444002	425335	CDR
2009	Striped Marlin	Tetrapturus audax	37444002	360631	CDR
2010	Striped Marlin	Tetrapturus audax	37444002	278604	CDR
2011	Striped Marlin	Tetrapturus audax	37444002	330148	CDR
2012	Striped Marlin	Tetrapturus audax	37444002	261937	CDR
2013	Striped Marlin	Tetrapturus audax	37444002	251008	CDR
2014	Striped Marlin	Tetrapturus audax	37444002	273455	CDR
2007	Swordfish	Xiphias gladius	37442001	1352719	CDR
2008	Swordfish	Xiphias gladius	37442001	1483149	CDR
2009	Swordfish	Xiphias gladius	37442001	1315034	CDR
2010	Swordfish	Xiphias gladius	37442001	1176081	CDR
2011	Swordfish	Xiphias gladius	37442001	1080446	CDR
2012	Swordfish	Xiphias gladius	37442001	1156787	CDR
2013	Swordfish	Xiphias gladius	37442001	1062103	CDR
2014	Swordfish	Xiphias gladius	37442001	1183082	CDR

Year	Common Name	Scientific Name	CAAB	Retained Catch (Kg)	Data Source
2007	Yellowfin Tuna	Thunnus albacares	37441002	1389632	CDR
2008	Yellowfin Tuna	Thunnus albacares	37441002	1650281	CDR
2009	Yellowfin Tuna	Thunnus albacares	37441002	1386763	CDR
2010	Yellowfin Tuna	Thunnus albacares	37441002	1548976	CDR
2011	Yellowfin Tuna	Thunnus albacares	37441002	2156459	CDR
2012	Yellowfin Tuna	Thunnus albacares	37441002	1258916	CDR
2013	Yellowfin Tuna	Thunnus albacares	37441002	1341231	CDR
2014	Yellowfin Tuna	Thunnus albacares	37441002	1685263	CDR

Data quality: Gold

Ecological > Bycatch species > Bycatch composition > Mean Trophic Level

The trophic level is a measure of the position of an organism in a food web, starting at level 1 with primary producers, such as phytoplankton, then moving through the primary consumers at level **2** that eat the primary producers to the secondary consumers at level **3** that eat the primary consumers, and so on. The **bycatch mean trophic level** is an indicator of the mean level of the food chain for bycatch in a fishery.

Recent ERAEF report available:

	Min trophic level	Max trophic level	Sample size (species)
ERAEF data (2017)	3.36	4.38	142 out of 146 possible

Data Quality: Gold

Ecological > Bycatch species > Bycatch amount > Total weight of bycatch

Bycatch weights for fishery are typically developed by specific projects, and require a range of assumptions due to issues with reporting and retention of bycatch. **Bycatch** estimates typically cover species that are not target species, while **discard** rates may also include undersized individuals of the target species. Kennelly (2018) provides estimates of discard rates, which include both target and bycatch species, and when discard rates are used, that information is noted for each fishery. Animals can be returned to the ocean alive or dead. The intention of this metric is to provide information on animals that are dead on return to the ocean.

Reference:

Kennelly, S.J., 2018. *Developing a National Bycatch Reporting System.* Final FRDC Report, ISBN 978-0-9924930-5-9, March, 2018. 99 pp.

These data are available for the fishery, but the project team has not compiled a summary. A continuation of Kennelly (2018) is underway and will provide these data shortly.

Data Quality: Not organised/analysed

Ecological > Protected species > Capture amount > Captures

The number and diversity of TEP species captured by a fishery in the most recent year, provided as annual numbers.

As a commonwealth managed fishery, interactions are reported quarterly here.

In 2017, the reported number of protected species interactions by quarter is:

QUARTER 1

Eastern Tuna and Billfish Fishery

Gear Type	Common name	Total	Life Status				Interaction type[1]	Comments
			Alive	Dead	Injured	Unknown		
Pelagic longline	Albatrosses	**9**	3	6			Hooked	-
	Black Browed Albatross	**1**		1			Hooked	-
	Dolphins*	**1**	1				Hooked	-
	Green Turtle	**44**	36	8			Hooked	-
	Grey nurse shark*	**4**				4	Hooked	-
	Leatherback Turtle	**15**	15				Hooked	-
	Loggerhead Turtle	**3**	3				Hooked	-
	Porbeagle**	**2**				2	Hooked	-
	Shearwaters	**2**		2			Hooked	-
	Shortfin Mako**	**252**		124		128	Hooked	-
	Short-finned pilot whale*	**4**	4				Hooked	-
	Silky Shark***	**48**				48	Hooked	-
	Turtles	**7**	6	1			Hooked	-
	Whales (mixed)*	**1**	1				Hooked	-
	Total Interactions	**393**	**69**	**142**		**182**		

QUARTER 2

Eastern Tuna and Billfish Fishery

Gear Type	Common name	Total	Life Status				Interaction type[1]	Comments
			Alive	Dead	Injured	Unknown		
Pelagic longline	Albatrosses	2		2			Hooked	-
	Dolphins*	4	4				Hooked	-
	Green Turtle	30	23	7			Hooked	-
	Grey nurse shark*	1				1	Hooked	-
	Hawksbill Turtle	1	1				Hooked	-
	Leatherback Turtle	7	7				Hooked	-
	Loggerhead Turtle	13	8	5			Hooked	-
	Longfin Mako**	10				10	Hooked	-
	Melon-headed Whale*	1		1			Hooked	-
	Pacific (Olive) Ridely Turtle	2	1	1			Hooked	-
	Porbeagle**	25		15		10	Hooked	-
	Shearwaters	1	1				Hooked	-
	Shortfin Mako**	563		202		361	Hooked	-
	Short-finned pilot whale*	1		1			Hooked	-
	Silky Shark***	117				117	Hooked	-
	Turtles	5	4	1			Hooked	-
	Whales (mixed)*	3	3				Hooked	-
	Total Interactions	**786**	**52**	**235**		**499**		

QUARTER 3

Eastern Tuna and Billfish Fishery

Gear Type	Common name	Total	Life Status				Interaction type[1]	Comments
			Alive	Dead	Injured	Unknown		
Pelagic longline	Albatrosses	1		1			Hooked	-
	Black Browed Albatross	1		1			Hooked	-
	Bottlenose dolphin*	1		1			Hooked	-
	Dolphins*	1	1				Hooked	-
	False killer whale*	1	1				Hooked	-
	Green Turtle	6	5			1	Hooked	-
	Leatherback Turtle	21	20			1	Hooked	-
	Loggerhead Turtle	4	3	1			Hooked	-
	Longfin Mako	8				8	Hooked	-
	Long-finned pilot whale*	3	3				Hooked	-
	Melon-headed whale*	2	2				Hooked	-
	Porbeagle	108	1	13		94	Hooked	-
	Shearwaters	1		1			Hooked	-
	Shortfin Mako	803		243		560	Hooked	-
	Short-finned pilot whale	1	1				Hooked	-
	Silky Shark	27				27	Hooked	-
	Turtles	3	1	1		1	Hooked	-
	Whales (mixed)*	2	2				Hooked	-
	Total Interactions	994	40	262	0	692		

QUARTER 4

Eastern Tuna and Billfish Fishery

Gear Type	Common name	Total	Life Status				Interaction type[1]	Comments
			Alive	Dead	Injured	Unknown		
Pelagic longline	Albatrosses	21	7	14			Hooked	-
	Black Browed Albatross	1		1			Hooked	-
	Cormorants	1	1				Hooked	-
	Dolphins*	3	3				Hooked	-
	Dugong	1		1			Hooked	-
	Flesh Footed Shearwater	2		2			Hooked	-
	Green Turtle	15	13	2			Hooked	-
	Hawksbill Turtle	1		1			Hooked	-
	Leatherback Turtle	9	9				Hooked	-
	Loggerhead Turtle	6	6				Hooked	-
	Long-finned pilot whale*	1	1				Hooked	-
	Melon-headed whale*	1	1				Hooked	-
	Pacific (Olive) Ridley Turtle	3	3				Hooked	-
	Porbeagle	18				18	Hooked	-
	Seals	2	2				Hooked	-
	Shearwaters	2		2			Hooked	-
	Shortfin Mako	663		261		402	Hooked	-
	Silky Shark	203				203	Hooked	-
	Sooty Shearwater	1		1			Hooked	-
	Turtles	3	2	1			Hooked	-
	Wandering Albatross	1	1				Hooked	-
	Total Interactions	958	49	286	0	623		

The reported number of species interactions as reported by the fishery[4] are:

"In 2017, logbooks indicated that 2,281 shortfin mako sharks (*Isurus oxyrinchus*) were hooked in the ETBF. Of these, 830 were dead and 1,451 were released in unknown condition. Eighteen longfin mako sharks (*I. paucus*) were also hooked and released in unknown condition. One hundred and fifty-three porbeagle sharks (*Lamna nasus*) were

4 http://data.daff.gov.au/data/warehouse/9aam/fsrXXd9abm_/fsr18d9abm_20180928/21_FishStatus2018EstnTunaBillfish_1.0.0.pdf

hooked and released, with 1 alive, 28 dead and 124 in unknown condition. Three hundred and ninety-five silky sharks (*Carcharhinus falciformis*) and five grey nurse sharks (*Carcharias taurus*) were also released in unknown condition. Ninety-five green turtles (*Chelonia mydas*) were hooked; 77 were released alive, 17 were dead, and 1 was released in unknown condition. Fifty-two leatherback turtles (*Dermochelys coriacea*) and 26 loggerhead turtles (*Caretta caretta*) were also hooked; all were released alive except for 1 leatherback turtle in unknown condition and 6 dead loggerhead turtles. Two hawksbill turtles (*Eretmochelys imbricata*) were hooked, with 1 dead and 1 released alive. Five olive ridley turtles (*Lepidochelys olivacea*) were caught, with four alive and one dead. Eighteen unidentified turtles were hooked, with 13 alive, 4 dead and 1 in unknown condition.

Three black-browed albatrosses (*Thalassarche melanophris*) were caught—all dead—and one wandering albatross (*Diomedea exulans*) was released alive. Thirty-three unidentified albatrosses were hooked, with 10 released alive and 23 dead. Two flesh-footed shearwaters (*Ardenna carneipes*), 1 sooty shearwater (*A. grisea*) and 6 unidentified shearwaters were hooked, with all being dead except 1 unidentified shearwater. One unidentified cormorant was released alive.

Several interactions with marine mammals were recorded; these comprised nine unidentified dolphins (released alive), one dead bottlenose dolphin (*Tursiops truncatus*), six unidentified whales (released alive), one false killer whale (*Pseudorca crassidens*; released alive), four melon-headed whales (*Peponocephala electra*; three alive and one dead), two toothed whales (Parvorder Odontoceti; released alive), six short-finned pilot whales (*Globicephala macrorhynchus*; one alive and five dead), four long-finned pilot whales (*G. melas*; released alive), one dead dugong (*Dugong dugon*) and two unidentified seals (released alive). "

Species	Interactions
Shortfin Mako	2281
Longfin Mako	18
Poprbeagle	153
Silky shark	395
Green turtle	95
Leatherback turtle	52
Loggerhead turtle	26
Hawksbill turtle	2
Olive ridley turtle	5
Turtle	18
Black browed albatross	3
Wandering albatross	1
Bottlenose dolphin	1
Whales	6
False killer whale	1
Melon headed whale	4
Toothed whale	2
Short finned pilot whale	6
Long finned pilot whale	4
Dugong	1
Seal	2

Data quality: Gold

Ecological > Protected species > Reporting > Level of monitoring

This indicator is to provide information on the level of coverage for a fishery. Annual measures are preferred.

AFMA has electronic monitoring systems on all fishing boats in the ETBF. These systems have sensors linked to surveillance cameras that record fishing activity, including the catch. These recordings can then be collected and monitored by AFMA. Electronic monitoring helps support monitoring and data collection[5].

Data quality: Gold

Ecological > Habitats > Habitat impact > Impact score

The habitat impact is an indicator of the effect the fishing gear has on the habitat. Different gear types have different impacts. See the scoring rubric.

Habitat Impact: Minor

A total of 309 habitat types (10 pelagic, 299 benthic) were considered in the most recent ERAEF analysis[6]. Longline gear used in the ETBF has minor impact on the all habitats as a direct result of the fishing activity. The SICA scores were all less than 3 (i.e. minor or negligible). Assessment of Habitats at a Level 2 ERAEF standard was not required for this fishery, which would have provided a gold data quality.

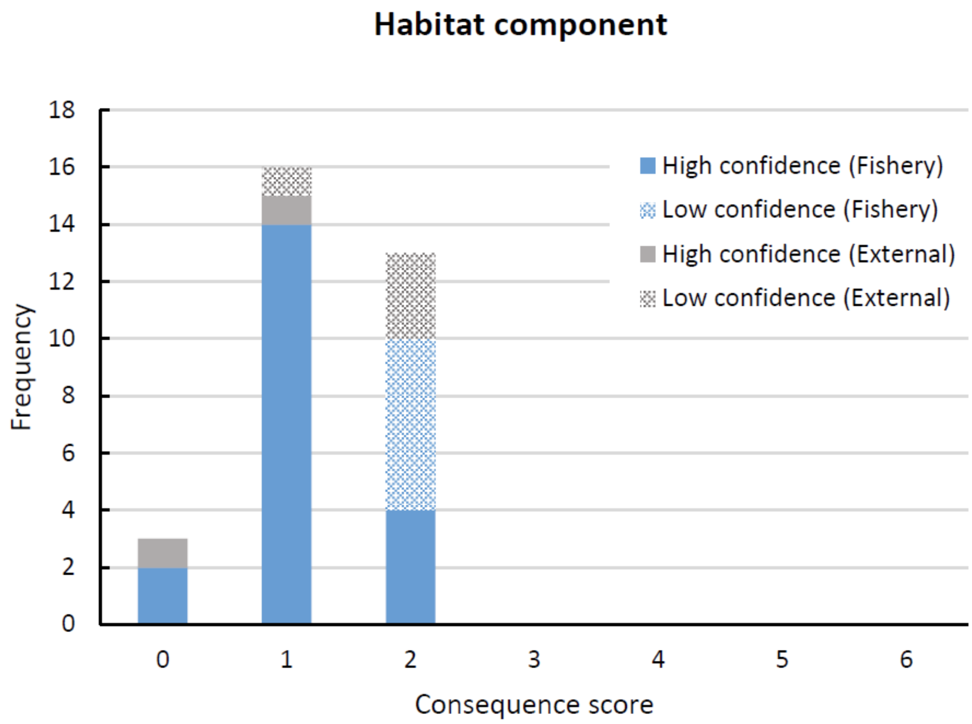


Figure 2.4. Habitat: Frequency of consequence score by high and low confidence.

Data quality: Silver

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[5] http://www.afma.gov.au/fisheries/eastern-tuna-and-billfish-fishery-page/

[6] Sporcic, M., Hobday, A., Hartog, J., Bulman, C., Fuller, M. (2017). Ecological Risk Assessment for the Effects of Fishing: Eastern Tuna & Billfish Fishery: Longline Sub-fishery, data to 2015. Report for the Australian Fisheries Management Authority. 258p.

Ecological > Habitats > Habitat impact > Habitat status

The status of the habitat types is a measure of the condition relative to a pristine state. Fishing may not be responsible for that habitat status, but it is important to note if fishing is taking place in pristine or disturbed habitats.

Habitat status: Excellent

Data quality: Bronze

Ecological > Ecological communities > Ecosystem status > Ecosystem status

This metric reports the ecosystem status in the region of the fishery.

Ecosystem Status: Good

The offshore waters in which the ETBF fishery occurs were judged to be in GOOD status - *There has been some minor loss of habitats and communities in some areas, leading to minimal degradation but no persistent substantial impacts on populations of dependent species*[7]

Data Quality: Bronze

Ecological > Ecological communities > Ecosystem status > Species diversity

The measure of species diversity as a ratio between fished and unfished states.

Data quality: Not organised/analysed

Ecological > Carbon and Pollution > Macro-plastics > Plastic code of conduct

Macro-plastics are plastics that are visible to the naked eye, such as food containers and wrapping, equipment packaging, and fishing equipment. The metric notes a commitment to a zero waste overboard code of conduct to assess attempts to reduce accidental or intentional introduction of macro-plastics to the ocean. There are stated guidelines detailing Australia's guidelines regarding marine pollution from the Australian Maritime Safety Authority[8]:

> *Pollution of the marine environment by ships, including fishing vessels, is strictly controlled by the International Convention for the Prevention of Pollution from Ships (known as MARPOL).*

To minimise pollution, MARPOL prohibits ships from discharging garbage into the sea except in very limited circumstances.

Australian MARPOL regulations apply to Australian fishing vessels wherever they are operating.

Data Quality: Bronze

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[7] https://soe.environment.gov.au/assessment-summary/marine-environment/state-and-trends-habitats-and-communities

[8] https://www.amsa.gov.au/marine-environment/marine-pollution/pollution-fishing-vessels
https://www.amsa.gov.au/marine-environment/marine-pollution/marpol-and-its-implementation-australia

Ecological > Carbon and Pollution > Carbon footprint > CO_2-equivalents

The emissions of climate forcing gases in kg CO_2-equivalents (CO_2e) per kg live weight fish caught, not including the supply chain after landing.

Data Quality	Gear	Target species	Min (kg CO_2e/kg)	Average (kg CO_2e/kg)	Max (kg CO_2e/kg)	Reference	Description
Gold							
Silver	Hooks and lines	Yellowfin tuna, Swordfish		2.8		Parker et al 2015	Eastern tuna (CW), 2009-2011, assume diesel, bait and refrigerants not included.
Bronze	Hooks and lines	Large pelagics	2.6		9.0	Parker and Tyedmers 2015	Oceania region, year not specified, assume diesel, refrigerants not included, unclear if bait fishing is included.

Economic > Fishery Benefits > Net Economic Returns > Economic Rent

Net Economic Returns (NER) is equal to fishing revenue less fishing costs and measures the economic profit that is derived from fishing activity, it is measured by the Commonwealth as Net Economic Returns and by some States as Economic Rent.

Data Quality	Indicator	Year	Amount	Reference	Note
Gold	Net economic returns	2016-2017	$7,344,543	Mobsby, D & Bath, A (2018) Australian fisheries economic indicators report 2017:financial and economic performance of the Eastern Tuna and Billfish Fishery, ABARES, Canberra, May CC BY 4.0 Supporting data tables	Includes management costs Preliminary non-survey based estimates (for estimation method, see Appendix C of Mobsby & Bath (2018))
Gold	Net economic returns	2015-2016	$15,734,439	Mobsby, D & Bath, A (2018) Australian fisheries economic indicators report 2017:financial and economic performance of the Eastern Tuna and Billfish Fishery, ABARES,	Includes management costs Preliminary non-survey based estimates (for estimation method, see Appendix C of

				Canberra, May CC BY 4.0 Supporting data tables	Mobsby & Bath (2018))
Gold	Net economic returns	2014-2015	$6,512,406	Mobsby, D & Bath, A (2018) Australian fisheries economic indicators report 2017:financial and economic performance of the Eastern Tuna and Billfish Fishery, ABARES, Canberra, May CC BY 4.0 Supporting data tables	Includes management costs
Gold	Net economic returns	2013-2014	-$571,458	Mobsby, D & Bath, A (2018) Australian fisheries economic indicators report 2017:financial and economic performance of the Eastern Tuna and Billfish Fishery, ABARES, Canberra, May CC BY 4.0 Supporting data tables	Includes management costs
Gold	Net economic returns	2012-2013	$225,412	Mobsby, D & Bath, A (2018) Australian fisheries economic indicators report 2017:financial and economic performance of the Eastern Tuna and Billfish Fishery, ABARES, Canberra, May CC BY 4.0 Supporting data tables	Includes management costs
Gold	Net economic returns	2011-2012	$2,892,927	Mobsby, D & Bath, A (2018) Australian fisheries economic indicators report 2017:financial and economic performance of the Eastern Tuna and Billfish Fishery, ABARES, Canberra, May CC BY 4.0 Supporting data tables	Includes management costs
Gold	Net economic returns	2010-2011	$506,549	Mobsby, D & Bath, A (2018) Australian fisheries economic indicators report 2017:financial and economic performance of the Eastern Tuna and Billfish Fishery, ABARES,	Includes management costs

				Canberra, May CC BY 4.0 Supporting data tables	
Gold	Net economic returns	2009-2010	-$4,372,356	Mobsby, D & Bath, A (2018) Australian fisheries economic indicators report 2017:financial and economic performance of the Eastern Tuna and Billfish Fishery, ABARES, Canberra, May CC BY 4.0 Supporting data tables	Includes management costs
Gold	Net economic returns	2008-2009	-$4,450,910	Mobsby, D & Bath, A (2018) Australian fisheries economic indicators report 2017:financial and economic performance of the Eastern Tuna and Billfish Fishery, ABARES, Canberra, May CC BY 4.0 Supporting data tables	Includes management costs

Economic > Fishery Benefits > Gross Value of Production > Gross Value of Production

GVP calculated as the volume of catch multiplied by the average per unit beach price (AUD$).

Data Quality	Species/Fishery	Year	Amount	Reference	Note/Comment
Gold	ETBF	2016-2017	$35.7 million	Mobsby, D & Bath , A (2018) Australian fisheries economic indicators report 2017:financial and economic performance of the Eastern Tuna and Billfish Fishery, ABARES, Canberra, May CC BY 4.0 Supporting data tables	
Gold	ETBF	2015-2016	$48.8 million	Mobsby, D & Bath , A (2018) Australian fisheries economic indicators report 2017:financial and economic performance of the Eastern Tuna and Billfish Fishery, ABARES, Canberra, May CC BY 4.0 Supporting data tables	
Gold	ETBF	2014-2015	$35 million	Mobsby, D & Bath , A (2018) Australian fisheries economic	

				indicators report 2017:financial and economic performance of the Eastern Tuna and Billfish Fishery, ABARES, Canberra, May CC BY 4.0 Supporting data tables	
Gold	ETBF	2013-2014	$31.2 million	Mobsby, D & Bath , A (2018) Australian fisheries economic indicators report 2017:financial and economic performance of the Eastern Tuna and Billfish Fishery, ABARES, Canberra, May CC BY 4.0 Supporting data tables	
Gold	ETBF	2012-2013	$24.8 million	Mobsby, D & Bath , A (2018) Australian fisheries economic indicators report 2017:financial and economic performance of the Eastern Tuna and Billfish Fishery, ABARES, Canberra, May CC BY 4.0 Supporting data tables	
Gold	ETBF	2011-2012	$28 million	Mobsby, D & Bath , A (2018) Australian fisheries economic indicators report 2017:financial and economic performance of the Eastern Tuna and Billfish Fishery, ABARES, Canberra, May CC BY 4.0 Supporting data tables	
Gold	ETBF	2010-2011	$30.9 million	Mobsby, D & Bath , A (2018) Australian fisheries economic indicators report 2017:financial and economic performance of the Eastern Tuna and Billfish Fishery, ABARES, Canberra, May CC BY 4.0 Supporting data tables	
Gold	ETBF	2009-2010	30.1 million	Mobsby, D & Bath , A (2018) Australian fisheries economic indicators report 2017:financial and economic performance of the Eastern Tuna and Billfish Fishery, ABARES, Canberra, May CC BY	

				4.0 Supporting data tables	
Gold	ETBF	2008-2009	38.9 million	Mobsby, D & Bath , A (2018) Australian fisheries economic indicators report 2017:financial and economic performance of the Eastern Tuna and Billfish Fishery, ABARES, Canberra, May CC BY 4.0 Supporting data tables	

Economic > Fishery Benefits > Profitability > Financial Performance

Economic health of a fishery can be measured by the financial performance of the operators in the fleet. Fleet wide averages or distributions of levels of profitability indicate the extent to which the fishery is generating economic benefits for fishers.

Data Quality	Indicator used	Year	Amount	Reference	Note
Gold	Profit at full equity	2014-2015	$250,973 RSE (25)	Mobsby, D & Bath, A (2018) Australian fisheries economic indicators report 2017: financial and economic performance of the Eastern Tuna and Billfish Fishery, ABARES, Canberra, May CC BY 4.0 Supporting data tables	Vessel level average RSE are relative standard errors. An RSE will be higher for estimates closer to zero. A guide to interpreting RSEs is included in Appendix A of the main report.
Gold	Profit at full equity	2013-2014	$63,074 RSE (161)	Mobsby, D & Bath, A (2018) Australian fisheries economic indicators report 2017: financial and economic performance of the Eastern Tuna and Billfish Fishery, ABARES, Canberra, May CC BY 4.0 Supporting data tables	Vessel level average RSE are relative standard errors. An RSE will be higher for estimates closer to zero. A guide to interpreting RSEs is included in Appendix A of the main report.
Gold	Profit at full equity	2012-2013	$86,492 RSE (50)	Mobsby, D & Bath, A (2018) Australian fisheries economic	Vessel level average

				indicators report 2017: financial and economic performance of the Eastern Tuna and Billfish Fishery, ABARES, Canberra, May CC BY 4.0 Supporting data tables	RSE are relative standard errors. An RSE will be higher for estimates closer to zero. A guide to interpreting RSEs is included in Appendix A of the main report.
Gold	Profit full equity	2011-2012	$139,612 RSE (26)	Mobsby, D & Bath, A (2018) Australian fisheries economic indicators report 2017: financial and economic performance of the Eastern Tuna and Billfish Fishery, ABARES, Canberra, May CC BY 4.0 Supporting data tables	Vessel level average RSE are relative standard errors. An RSE will be higher for estimates closer to zero. A guide to interpreting RSEs is included in Appendix A of the main report.
Gold	Profit at full equity	2010-2011	$45,509 RSE (9)	Mobsby, D & Bath, A (2018) Australian fisheries economic indicators report 2017: financial and economic performance of the Eastern Tuna and Billfish Fishery, ABARES, Canberra, May CC BY 4.0 Supporting data tables	Vessel level average RSE are relative standard errors. An RSE will be higher for estimates closer to zero. A guide to interpreting RSEs is included in Appendix A of the main report.
Gold	Profit at full equity	2009-2010	-$1,616 RSE (7)	Mobsby, D & Bath, A (2018) Australian fisheries economic indicators report 2017: financial and economic performance of the Eastern Tuna and Billfish Fishery, ABARES, Canberra, May CC BY 4.0 Supporting data tables	Vessel level average RSE are relative standard errors. An RSE will be higher for estimates closer to zero. A guide to interpreting RSEs is included in Appendix A of the main report.

Gold	Profit at full equity	2008-2009	-$2,027 RSE (1,678)	Mobsby, D & Bath, A (2018) Australian fisheries economic indicators report 2017: financial and economic performance of the Eastern Tuna and Billfish Fishery, ABARES, Canberra, May CC BY 4.0 Supporting data tables	Vessel level average RSE are relative standard errors. An RSE will be higher for estimates closer to zero. A guide to interpreting RSEs is included in Appendix A of the main report.
Gold	Profit at full equity	2007-2008	-$12,287 RSE (219)	Mobsby, D & Bath, A (2018) Australian fisheries economic indicators report 2017: financial and economic performance of the Eastern Tuna and Billfish Fishery, ABARES, Canberra, May CC BY 4.0 Supporting data tables	Vessel level average RSE are relative standard errors. An RSE will be higher for estimates closer to zero. A guide to interpreting RSEs is included in Appendix A of the main report.

Economic > Fishery Benefits > Latency > Underutilised Effort

Latency is fishery concessions that are not being fully utilised by fishers, for example, often the annual total allowable catch is left partially or largely uncaught for a fishery. Latency may appear as effort or uncaught TAC or inactive licences.

Data Quality	Indicator used	Year	Amount	Reference	Note
Gold	Uncaught TAC	2016	31% of TACC	Mobsby, D & Bath, A (2018), Australian fisheries economic indicators report 2017: financial and economic performance of the Eastern Tuna and Billfish Fishery, ABARES, Canberra, May CC BY 4.0.	Whole fishery
Gold	Uncaught TAC	2015	1% of TACC	Mobsby, D & Bath, A (2018), Australian fisheries economic indicators report 2017: financial and economic performance of the Eastern Tuna and Billfish Fishery,	Yellowfin tuna

				ABARES, Canberra, May CC BY 4.0.	
Gold	Uncaught TAC	2014	22% of TACC	Mobsby, D & Bath, A (2018), Australian fisheries economic indicators report 2017: financial and economic performance of the Eastern Tuna and Billfish Fishery, ABARES, Canberra, May CC BY 4.0.	Striped Marlin
Gold	Uncaught TAC	2014	23% of TACC	Mobsby, D & Bath, A (2018), Australian fisheries economic indicators report 2017: financial and economic performance of the Eastern Tuna and Billfish Fishery, ABARES, Canberra, May CC BY 4.0.	Yellowfin tuna
Gold	Uncaught TAC	2015	1% of TACC	Mobsby, D & Bath, A (2018), Australian fisheries economic indicators report 2017: financial and economic performance of the Eastern Tuna and Billfish Fishery, ABARES, Canberra, May CC BY 4.0.	Striped Marlin
Gold	Uncaught TAC	2015	26% of TACC	Mobsby, D & Bath, A (2018), Australian fisheries economic indicators report 2017: financial and economic performance of the Eastern Tuna and Billfish Fishery, ABARES, Canberra, May CC BY 4.0.	Bigeye tuna
Gold	Uncaught TAC	2015	16% of TACC	Mobsby, D & Bath, A (2018), Australian fisheries economic indicators report 2017: financial and economic performance of the Eastern Tuna and Billfish Fishery, ABARES, Canberra, May CC BY 4.0.	Swordfish - average
Gold	Uncaught TAC	2014	16% of TACC	Mobsby, D & Bath, A (2018), Australian fisheries economic indicators report 2017: financial and economic performance of the Eastern Tuna and Billfish Fishery, ABARES, Canberra, May CC BY 4.0.	Swordfish - average

Gold	Uncaught TAC	2011-2013	24% of TACC	Mobsby, D & Bath, A (2018), Australian fisheries economic indicators report 2017: financial and economic performance of the Eastern Tuna and Billfish Fishery, ABARES, Canberra, May CC BY 4.0.	Swordfish - average
Gold	Uncaught TACC	2016	56% of TACC	Mobsby, D & Bath, A (2018), Australian fisheries economic indicators report 2017: financial and economic performance of the Eastern Tuna and Billfish Fishery, ABARES, Canberra, May CC BY 4.0.	Albacore
Gold	Uncaught TACC	2015	63% of TACC	Mobsby, D & Bath, A (2018), Australian fisheries economic indicators report 2017: financial and economic performance of the Eastern Tuna and Billfish Fishery, ABARES, Canberra, May CC BY 4.0.	Albacore
Gold	Uncaught TACC	2011-2015	68% of TACC	Mobsby, D & Bath, A (2018), Australian fisheries economic indicators report 2017: financial and economic performance of the Eastern Tuna and Billfish Fishery, ABARES, Canberra, May CC BY 4.0.	Albacore

Economic > Community benefits > Value to community > GDP or GSP value

A fisheries contribution to Gross Domestic Production (GDP)/Gross State Product (GSP) is the total economic value that it generates directly, plus the indirect contribution made to other industries, which is also measured in value-add terms.

Data Quality: Not found

Economic > Community benefits > Wealth Spread > Distribution of fishing firm size

The spread of profits to owners and crew members indicates how widely benefits of fishing are distributed across the fishing community. A wide spread of benefits may be important to some fishery stakeholders. A narrow spread may not indicate a lack of distribution of benefits in the case where all participating businesses are the same size, or if other mechanisms are present to capture and distribute benefits such as high levels of employment of crew. The number of large business versus small business, classified by turnover (direct measure) or catch volume (proxy) may provide an indirect indicator: i.e. are economic returns from commercial fishing gained by one or two large businesses or a spread over many smaller businesses? **Data Quality:** Not released

Economic > Markets > Fish distribution > Fish receivers

One way of measuring benefits from a fishery is by assessing the flow of seafood through the supply chain. In many fishery jurisdictions, the first step in the supply chain is via licensed fish receivers who are allowed to receive fish for sale. They can also trade fish with other receivers. In some jurisdictions, commercial fishers must sell their catch to a receiver (although they can sell small amounts on wharves). While this restricts fishers' options for landing their catch, it means that fish can be tracked, reduces illegal fish trading and ensures that the Quota Management Systems (QMS) work effectively by ensuring catches do not exceed the total allowable catch or quota amounts for individual species. Receivers of fish may be fish processors, wholesalers or retailers.

In some jurisdictions, the fishers and fish receivers are integrated, such that they are effectively the same "business". In Commonwealth fisheries, the total number of fish receivers per year may differ to the sum of the fish receivers per fishery because some receivers operate in more than one fishery.

Fish taken in the ETBF can only be landed or disposed of to holders of a Commonwealth Fish Receiver Permit (FRP). The FRP holder must verify the species and weight of all fish received and sign the **blue copy** of the Catch Disposal Record (CDR) immediately after the fish are received (within 50m of unload area unless the FRP holder has an 'exempt' certification). A CDR must be completed for each consignment of fish sent to each different receiver and all fish landed in the ETBF must be recorded on the CDR. After completing a CDR: the **white** copy (filled in by the permit holder or authorised agent) must be sent to AFMA within 3 calendar days of unloading. Data obtained from AFMA for this demonstration phased of the project are:

	number of active fish receivers								
Fishery	2009	2010	2011	2012	2013	2014	2015	2016	2017
ETBF	36	40	49	37	34	31	35	42	40

Data Quality: Gold

Economic > Markets > Volatility in market price > Price volatility

Price volatility is the mean beach price for the target species (top one or five depending on price) over the given period (most recent ten years). The level of volatility is the standard deviation in mean price over this period.

Data Quality	Species/Fishery	Year/Time period	Amount	Reference	Note
Silver	ETBF	2007-08 to 2016-17	\$0.87/kg	Mobsby, D & Bath, A (2018), Australian fisheries economic indicators report 2017:financial and economicperformance of the Eastern Tuna and Billfish Fishery, ABARES, Canberra, May CC BY 4.0 Supporting data tables	

Economics > Energy costs > Energy Use > Fuel use per kg of fish harvested

Fuel use varies over time and between stocks and are best collected from industry on a yearly basis. Estimates for different fisheries should be compared with caution, and in particular comparing energy use between fisheries with different data quality which is not recommended (different data availability, may be e.g. old or not fisheries-specific). Estimates are provided for all levels of data quality if available and are given in L per kg live-weight.

Data Quality	Gear	Target species	Min (L/kg)	Average (L/kg)	Max (L/kg)	Reference	Description
Gold							
Silver	Hooks and lines	Yellowfin tuna, Swordfish		1.0		Parker et al 2015	Eastern tuna (CW), 2009-2011, bait fishing not included
Bronze	Hooks and lines	Large pelagics	0.9	1.7	3.3	Parker and Tyedmers 2015	Oceania region

Economic > Energy costs > Fossil fuel subsidies > Fuel subsidies directed to the fishery

Fossil fuel subsidies (fuel rebates) illustrate to which extent the fuel cost is reduced in the fishery, measured in AUD/kg live weight fish. Note that this form of tax exemption for fisheries is in Australia motivated from the sector not using roads (i.e. costs embedded in fuel price for road construction and maintenance), and are not formally reported as fuel subsidies in Australia.

Data Quality	Gear	Target species	Subsidy (AUD/kg)	Reference	Description
Gold					
Silver	Hook and lines	Yellowfin tuna, Swordfish	0.41	Parker et al 2015	Fuel use from Eastern tuna fishery (CW), 2009-2011.
Bronze	All SA	All SA	0.10	Total tax claims per total landings in South Australia	Assuming SA (closest), 2015-16 (2016-17 also available), state level figures on landings are preliminary for 2015-16

Governance > Ecosystem governance > Bycatch mitigation > Description of the bycatch mitigation measures

Bycatch measures can be spatial (e.g. area closure), temporal (time closure, e.g. night setting only) or technical (bycatch reduction devices, hook size). This indicator describes the measures that are in place for a fishery – but not the rates of compliance. For example, spatial closures for different gear types are shown here for AFMA fisheries http://www.afma.gov.au/sustainability-environment/fishing-closures/.

Longlines can catch a variety of bycatch species. Regulations described in the management plan - http://www.afma.gov.au/wp-content/uploads/2018/03/2018-ETBF-Management-Arrangements-booklet-FINAL.pdf include

- Prohibition for a range of species (e.g. black marlin)
- Trip limits for the bycatch species listed in the management plan (e.g. Table 4, Victoria)
- Statutory fishing rights for Southern Bluefin Tuna (SBT) before fishing in an area likely to have SBT.[9]

Data Quality: Gold

Governance > Ecosystem governance > Protected species mitigation > Description of the protected species mitigation measures

TEP mitigation measures can be spatial (e.g. area closure), temporal (time closure, e.g. night setting only) or technical (bycatch reduction devices, hook size). This indicator describes the measures that are in place for a fishery – but not the rates of compliance.

Longlines can catch TEP species like sharks, turtles, marine mammals and seabirds. Capture of TEP species can be reduced in a variety of ways including circle hooks to prevent catching turtles, and setting deeper lines to reduce catches of turtles, sharks and marine mammals. Techniques such as setting lines quickly and at a greater depth, using bird scarers, and setting at night can reduce the number of seabirds that get caught on hooks and drown when diving for bait.

Regulations described in the management plan - http://www.afma.gov.au/wp-content/uploads/2018/03/2018-ETBF-Management-Arrangements-booklet-FINAL.pdf are summarised as follows:

- Seabird mitigation measures include (p35 of Management Plan 2018)
  - Carry one or more assembled tori lines on board; and use as described in the management plan and a range of additional measures, including
    - Not discharge offal while setting longlines
    - Use only non-frozen bait;
    - Weighting longlines to rapidly sink away from surface
- Turtle mitigation measures include (p35 of Management Plan 2018)
  - Large circle hooks must be used if less than eight hooks per bubble are set.
  - A minimum of one de-hooking device must be carried on board, with the following specifications.
  - At all times you must carry on board a minimum of one line cutting device
- Protected sharks – live sharks must be returned to the water. Only dead on line Longfin Mako, Shortfin Mako and Porbeagle Sharks may be retained[10]

Data Quality: Gold

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[9] AFMA (ed) 2018, Eastern Tuna and Billfish Fishery Management Arrangements Booklet 2018, Australian Fisheries Management Authority. Canberra, Australia.
[10] AFMA (ed) (2018), Eastern Tuna and Billfish Fishery Management Arrangements Booklet 2018, Australian Fisheries Management Authority. Canberra, Australia.

Governance > Management system > Harvest strategy > Scope of the harvest strategy

Assessment can be based on scoring presence of the following: a harvest strategy designed to achieve management objectives; harvest control rules and tools; collection of relevant information to support the harvest strategy; and, assessment of stock status or the presence of the following key elements: Defined operational objectives for the fishery; Indicators of fishery performance related to the objectives; Reference points for performance indicators; A statement defining acceptable levels of risk to meeting objectives; A monitoring strategy to collect relevant data to assess fishery performance; A process for conducting assessment of fishery performance relative to objectives; and; Decision rules that control the intensity of fishing activity and/or catch.

The primary ETBF tuna and billfish species are managed through total allowable catches allocated as individual transferable quotas (ITQs). The Commonwealth Fisheries Harvest Strategy Policy (HSP; DAFF 2007[11]) is not prescribed for fisheries managed under international agreements. However, a harvest strategy framework has been developed for the ETBF (Campbell 2012[12]). The framework has been used to set the total allowable commercial catch (TACC) for swordfish (Xiphias gladius) and striped marlin (Kajikia audax) since 2011, but is not currently used for tuna species.[13]

Data Quality: Gold

Governance > Management system > Management plans > Scope of management plan

Management plans can be assessed by evaluating the presence of minimum requirements, as follows: a description of the fishery, especially its current status and any established user rights: the management objectives; how these objectives are to be achieved; how the plan is to be reviewed and/or appealed, as well as the consultation process for review and appeal.

The Eastern Tuna and Billfish Fishery is managed under the Eastern Tuna and Billfish Fishery Management Plan 2010[14] which contains the following minimum requirements:

Area of the fishery
Objectives (Act s 17 (5))
Measures by which objectives attained
Performance criteria for assessing measures to achieve objectives
Statutory fishing rights and fishing permits

Data Quality: Gold

Governance > Institutional capacity > Accountability of decision making bodies > Level of Accountability

Accountability of Decision-making bodies. Performance of a fisheries management agency is based on the degree to which decision-making processes are consultative, the basis for decisions are fully

[11] DAFF (2007) Commonwealth Fisheries Harvest Strategy: policy and guidelines, Australian Government Department of Agriculture, Fisheries and Forestry, Canberra.

[12] Campbell, R (2012) 'Implementation of the ETBF harvest strategy and calculation of the recommended biological commercial catches for 2013/14', working paper presented to the fifth meeting of the Tropical Tuna Resource Assessment Group, Canberra, 4–5 September 2012

[13] Patterson, H, Noriega R, Georgeson, L, Larcombe, J and Curtotti, R (2017) Fishery status reports 2017, Australian Bureau of Agricultural and Resource Economics and Sciences, Canberra. CC BY 4.0

[14] http://www.afma.gov.au/wp-content/uploads/2014/08/ETBF-Management-Plan.pdf

explained, and information about decision making is publicly available. The assessment applied the three tiers of Principle 3.2.2 (d) 'Decision-making process' of the MSC Fisheries Standard v2.0 (2014) to determine whether the level of accountability was low, medium or high.

High level of accountability. This is demonstrated by publicly-available management plan, harvest strategy and fishery assessment reports, and the availability of decision-making procedures and outcomes online.

Data Quality: Silver

Governance > Institutional capacity > Uncertainty management > Extent of incorporation of uncertainty in management of the targeted stock

This metric reports on the explicit incorporation of uncertainties in decision support processes used to inform and make appropriate choices of management actions. We recognise three levels of uncertainty: Low level of incorporation of uncertainty; Medium level of incorporation of uncertainty; High level of incorporation of uncertainty. These are based on: Major sources of uncertainty are identified; Assessment takes uncertainty into account; Frequency of monitoring of indicators is high; Monitoring of more than one indicator to support management decisions; Assessment evaluates stock status relative to reference points in a probabilistic way; Robustness of assessments are tested, Alternative hypotheses and assessment approaches are rigorously explored.

High level of incorporation of uncertainty in management of the targeted stock.	The assessment applied Principle 1.2.4 (c & d) 'Assessment of stock status: Uncertainty in the Assessment' of the MSC Fisheries Standard v2.0 (2014) to assess extent of incorporation of uncertainty in management of the targeted stock.

Data Quality: Silver

Governance > Compliance > Compliance regime > Level of Compliance

Level of compliance with rules and regulations controlling catch can be assessed by audits that measure the agreement between 1) logbook and observer records; 2) catch disposal records submitted by fishers and fish receivers. It might also be assessed by counting the annual number of breaches/observed offences or enforcement actions, preferably scaled to the level of enforcement effort (e.g. $). This indicator can be scored on the basis of the presence of key monitoring, control and surveillance elements and capacities.

Catch taken in the ETBF can be verified using the catch disposal records in two ways.
Firstly, data are taken from two different sources (receivers and permit holders) and then verified by AFMA. Holders of a Commonwealth Fish Receiver Permit (FRP) verify the species and weight of all fish received and sign the **blue copy** of the Catch Disposal Record (CDR) immediately after the fish are received (within 50m of unload area unless the FRP holder has an 'exempt' certification). A CDR must be completed for each consignment of fish sent to each different receiver and all fish landed in the ETBF must be recorded on the CDR. After completing a CDR: the **white** copy (filled in by the permit holder or authorised agent) must be sent to AFMA within 3 calendar days of unloading.

The second way that catch is verified is with Electronic monitoring. AFMA has electronic monitoring systems on all fishing boats in the ETBF. These systems have sensors linked to surveillance cameras that record fishing activity, including the catch. These recordings can then be collected and monitored by AFMA. Electronic monitoring helps support monitoring and data collection.[15]

Data Quality: Gold

Governance > Compliance > Surveillance > Surveillance Effort

Regulatory controls include logs and catch reporting, on-board observer programs, vessel inspections, vessel monitoring systems, and visual or electronic surveillance using radar or satellite by boat or by air. Higher degrees of surveillance, or coverage using multiple methods, provide greater levels of certainty in estimates of effort, fishing mortality, bycatch and discard levels, and interactions with protected/listed species. Report on the surveillance carried out on the fishery, as reported by the compliance branch responsible for the fishery

Surveillance effort score: undefined
AFMA uses different methods to monitor fishing activities in the Eastern Tuna and Billfish Fishery.

Cameras on fishing boats – electronic monitoring - AFMA has electronic monitoring systems on all fishing boats in the ETBF. These systems have sensors linked to surveillance cameras that record fishing activity, including the catch. These recordings can then be collected and monitored by AFMA. Electronic monitoring helps support monitoring and data collection.

On-board observers - One of the main monitoring methods used by AFMA is on-board scientific observers. These observers are people employed by AFMA to go out on boats and independently record the catch, effort and biological information of each fishing trip. They take samples from fish, such as the otoliths or ear bones, and use these to determine the age of the fish caught. Observers also record the length, weight and sex of each fish caught during a trip and report on the other wildlife that may be seen, the weather conditions, the composition of commercial catch fate of species that are caught as bycatch. Boats in the Eastern Tuna and Billfish Fishery must carry an AFMA observer when requested by AFMA.

Satellite tracking - A satellite monitoring system called a Vessel Monitoring System (VMS), is fitted to every boat in the fishery. This system helps AFMA to monitor vessel position, course and speed. The tracking unit regularly transmits the information through a communications satellite to a station on land. This information is sent by secure internet connection to a database at AFMA.

Compliance - AFMA fisheries officers regularly inspect fishing boats and fish receivers. They often visit fishing ports and board boats at sea to try to ensure the rules of fishing are being followed.[16]

Data Quality: Bronze

Governance > Adaptive capacity > Governance arrangements > Climate change recognition

Governance arrangements relevant to the fishery consider the impact of climate change on the fishery, as evidenced by documentation, policies and plans that describe how management is

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[15] http://www.afma.gov.au/fisheries/eastern-tuna-and-billfish-fishery-page/
[16] http://www.afma.gov.au/fisheries/eastern-tuna-and-billfish-fishery-page/

addressing climate change impacts. Does the fishery management plan, harvest strategy or research activity suggest that climate change is recognised, and integrated into management planning?

The influence of the environment on the distribution of target species in this fishery have been documented in published literature, and species sensitivity assessments completed[17]. Impacts of climate change have been recognised by AFMA and the fishery. Fishery-specific plans are being developed under the AFMA –led project "Adaptation of Commonwealth Fisheries Management to Climate Change (FRDC 2016-059)". This project will conclude in June 2019.

The National Harvest Strategy also recognizes that "*Variability in ocean conditions, due to natural variability, climate change or other factors, can affect the productivity of stocks. Fisheries should seek to account for that variability when developing and implementing harvest strategies*"[18]. The Guidelines for the Harvest Strategy provide explicit approaches for fisheries[19].
Data quality: Silver

Governance > Adaptive capacity > Coping strategies > Climate responses

The fishery has initiated coping strategies (directed) to reduce the impacts of climate change. Evidence of strategies that have been specifically implemented for the fishery might include codes of practice, restocking programs, early warning systems, and so on. The coping strategies may be for long-term change or for extreme events. A description of the climate change responses that have been implemented or explored in research or application are provided.

Long term changes in the distribution of the ETBF target and byproduct species, including Yellowfin Tuna and Southern Bluefin Tuna, have been projected in published literature [20][21][22]. This large body of work shows that southward movement of most species is expected. There may also be appearance of new spawning grounds for albacore in the Tasman Sea after 2080[23]. Ongoing projects seek to understand the movement, and how it might be predicted using seasonal and multi-year forecasts. This would allow management decisions to be developed.

Data quality: Silver

Social and Ethical > Fishers wellbeing > Fisher satisfaction > Satisfaction scores

If available, fishery specific surveys of well-being or satisfaction, with interpretation required for the types of questions and sample. When surveys are not available other sources of data may need to include broader surveys (e.g. not fishery specific) or discussions with industry representatives,

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[17] www.frdc.com.au/Archived-Reports/FRDC%20Projects/2016-139-DLD.PDF
[18] Department of Agriculture and Water Resources 2018, *Commonwealth Fisheries Harvest Strategy Policy*, Canberra, June. CC BY 4.0.
[19] Department of Agriculture and Water Resources 2018, *Guidelines for the Implementation of the Commonwealth Fisheries Harvest Strategy Policy*, Canberra, June. CC BY 4.0.
[20] Hartog, J., A. J. Hobday, R. Matear and M. Feng (2011). Habitat overlap of southern bluefin tuna and yellowfin tuna in the east coast longline fishery - implications for present and future spatial management. Deep Sea Research Part II **58**: 746-752.
[21] Hobday, A. J. (2010). Ensemble analysis of the future distribution of large pelagic fishes in Australia. Progress in Oceanography **86**(1-2): 291-301 doi:210.1016/j.pocean.2010.1004.1023.
[22] Robinson, L., A. J. Hobday, H. P. Possingham and A. J. Richardson (2015). Trailing edges projected to move faster than leading edges for large pelagic fish under climate change. Deep Sea Research II **113**: 225-234.
[23] Lehodey, P., I. Senina, S. Nicol and J. Hampton (2015). Modelling the impact of climate change on South Pacific albacore tuna. Deep Sea Research II **113**: 246-259.

managers or fishers about the industry and their opinion of general fisher-wellbeing (note this will be subjective).

Satisfaction score: Medium
Fishers in the ETBF have an opportunity to be consulted through forums, meetings and port visits and management by AFMA aims to take into account the interest of diverse stakeholders (commercial, recreational and indigenous) in managing the fishery.

Data Quality: Silver

Social and Ethical > Fishers wellbeing > Age Structure > Proportion of fishers in standard age cohorts

Proportion of fishers in standard age cohorts that were involved in the fishery at any point in the previous 5 years. If the fishery is not attractive or difficult to enter, the age distribution will be skewed to older ages. **Data Quality:** Not released

Social and Ethical > Wider community > Community satisfaction with fishery > Community feedback

Evidence of processes in place to gather direct engagement with the community (diversely represented) to listen and respond to feedback. This may be through a range of means including formal and informal processes and may not be appropriate to all fisheries in the same way. In some cases Marine Stewardship Council accreditation may demonstrate some evidence of community engagement.

Community feedback: Silver – Unknown, Bronze – Medium.

Processes are in place for management to consult with stakeholders in decision making and respect the range of stakeholders involved. The fishery also adheres to sustainability assessments including Ecological Risk Assessments and some companies operating in this fishery have Marine Stewardship Certification. It has a management advisory committee, which could oversee a feedback process.

Data quality: Silver.

Social and Ethical > Wider Community > Level of local employment > Percentage of local employment

The communities surrounding and supporting fisheries benefit from those fisheries when the majority of employees (direct and indirect) associated with the fishery activity are local. Can be reported as direct, indirect and downstream levels. **Data Quality:** Not found

Social and Ethical > Ethical - Human welfare > Protections in place > Legislation exists

Although all workers are automatically operating under legislation according to their state or territory to a safe work place, the extent to which there is awareness of the relevant Acts, and use of these if required, is highly variable and may be different for each business or individual operation within each fishery. See http://workplaceohs.com.au/legislation for a list of state acts and regulations.

Protections in Place: Medium

The ETBF is a commonwealth fishery located in the eastern part of the Australian Fishing Zone (AFZ) which includes Commonwealth waters off Queensland, NSW, Victoria and Tasmania. It operates under Commonwealth regulations (administered by Comcare) – WHS Act 2011 and WHS Regulations 2011. State level requirements may also apply. In the ETBF, at sea observers may have considerable OH&S concerns and therefore cameras are being implemented to replace people in this role to reduce safety risks.

Data Quality: Gold

Social and Ethical > Ethical > Human welfare > Levels of compliance

Levels of compliance (or violations of) with Workplace Health and Safety. If references to Workplace Health and Safety exist in relation to the specific fishery, determine whether these are voluntary or recorded in anyway. If they are recorded, note the level of compliance. As they are likely to be voluntary, there will not likely be a record of compliance, but this may become more readily available in the future. **Data Quality:** Not found

Social and Ethical > Ethical-animal welfare > Animal welfare protections > Protections in place

At this early stage of development of animal welfare, any type of mention of animal welfare exists, it is probably the most appropriate. As this develops in to the future, assessments as to the level of engagement may become more relevant.

The ETBF implement close to 100% electronic monitoring of fishing operations and has guidelines (AFMA 2017 – Bycatch handling guidelines) and education processes in place.

Data Quality: Silver

Social and Ethical > Ethical-animal welfare > Level of Compliance > Levels of compliance or violations of animal welfare

If there are any references to animal welfare protections or guidelines in fishery management plans and if reports exist, the indicator reports on the level of compliance or violations with welfare provisions.

Compliance in place: Yes
The ETBF has a compliance team to follow up on issues, although to date these have been rare. There are 'wildlife interaction' forms to complete in the case of incidents but these are not accessible to the public.

Data Quality: Silver

Social and Ethical > Climate-related > Access to information > Availability of information

This indicator describes available information that will help participants in the fishery adapt to changes. The assumption behind this indicator is that good information availability and flow will help fishers to adapt.

Availability of information: High
AFMA maintains a websites, newsletter and a membership based site 'GoFish' to provide a range of

information to fishers. A number of committees have fishing representatives and receive communications directly via publications such as booklets sent to all fishery operators.

Data Quality: Gold.

Social and Ethical > Climate-related > Access to networks > Level of membership of industry association

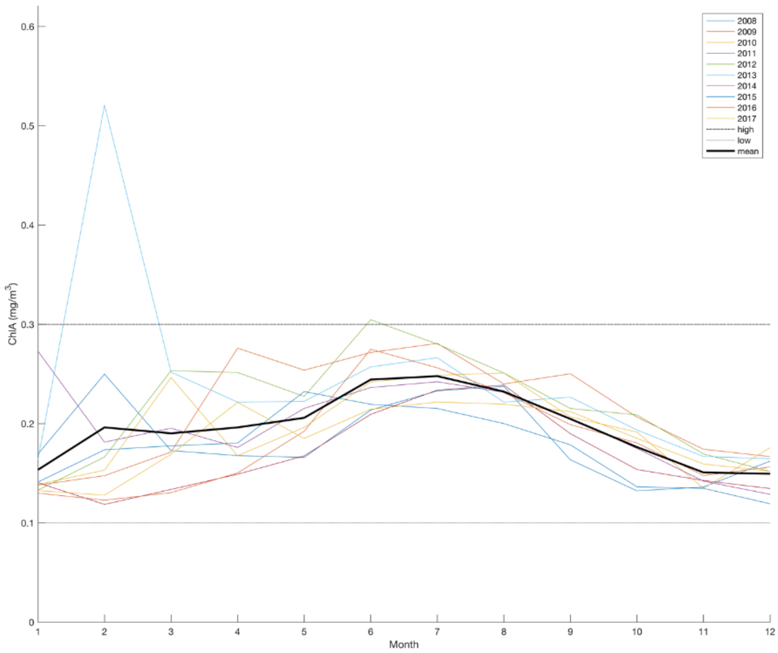
This metric assesses the presence or absence of a dedicated social media or social network group for the fishery. The fishery may still have a strong social network without a social media presence.

Network in place: Yes
There are a number of active committees with fishing representatives and AFMA is active on Facebook.

Data Quality: Silver

External > Environmental Context > Productivity > Mean chlorophyll

A measure of environmental productivity is the biomass of phytoplankton, which in oceanic waters can be approximated by chlorophyll a concentration, as estimated from satellite (MODIS, oceandata.sci.gsfc.nasa.gov). Monthly chlorophyll values for a representative area of the fishery are shown with the mean productivity shown in solid black and references levels of low chlorophyll at 0.1 mg $m^{-3}$and high chlorophyll levels at 0.3 mg m^{-3}. This indicator shows the mean chlorophyll by month for the years 2008-2017. These data provide information on the relative environmental productivity in the fishery area. Missing data for some months can be due to ice cover. Variability in chlorophyll a concentration between years can indicate high environmental variability, while similar seasonal patterns indicate relative environmental stability.



Data Quality: Gold

External > Environmental Context > Environmental character > Description of the ecosystems

This metric provides a qualitative description of the ecosystem(s) in which the fishery occurs. The goal is to provide a general overview of these environments. The knowledge about which ecosystems are encountered during fishing activity is the indicator (rather than the response of the ecosystems to fishing).

Marine ecosystems are defined for the purposes of this indicator as the composition of plants, animals, and the marine environment (water masses, geomorphology). Types of marine ecosystems include estuaries, the sea floor, the mesopelagic zone, the pelagic zone, the inter-tidal zones, coral reefs, lagoons, and mangroves. A pelagic zone ecosystem for example, is defined by physical, chemical and biological features of the marine water column of the open ocean[24].

Description of the ecosystems: High

This fishery takes place over a wide geographic range, generally in waters deeper than 200 meter. The Eastern Tuna and Billfish Fishery extends from Cape York in Queensland to the South Australian/Victorian border. Fishing occurs in both the Australian Fishing Zone and adjacent high seas.

The fishery occurs in pelagic ecosystems in depths of several hundred metres to waters more than 3000 meters deep. Fishing can also occur around and over seamounts which rise to within several hundred meters of the surface. Fishing gear does not contact the seafloor. More information on the ecosystems is available in the East Marine Region Bioregional Plan: Bioregional Profile[25].

Data quality: Gold

External > Climate related > Susceptibility of target species > Impacts on target species

Climate change directly affects the distribution, abundance and phenology of individual species. These changes then affect the fisheries that harvest these species, and can be a strong external influence on the fishery. These impacts can be positive (e.g. increased abundance), or negative (e.g. movements further from fishing ports), and to long-term warming, or short-term extreme events such as marine heatwaves.

Sensitivity of some of the target species to climate change has been assessed[26]. Species in this fishery have a sensitivity of low.

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[24] Game, E. T., H. S. Grantham, A. J. Hobday, R. L. Pressey, A. T. Lombard, L. E. Beckley, K. Gjerde, R. H. Bustamante, H. P. Possingham and A. J. Richardson (2009). Pelagic protected areas: the missing dimension in ocean conservation. Trends in Ecology and Evolution **24**(7): 360-369 doi:310.1016/j.tree.2009.1001.1011.

[25] https://parksaustralia.gov.au/marine/management/resources/scientific-publications/east-marine-bioregional-plan-bioregional-profile-description-ecosystems-conservation-values/

[26] Fulton EA, Hobday AJ, Pethybridge H, Blanchard J, Bulman C, Butler I, Cheung W, Gorton B, Hutton T, Lozano- Montes H, Matear R, Pecl G, Villanueva C, Zhang X (2018). *Decadal scale projection of changes in Australian fisheries stocks under climate change*. CSIRO Report to FRDC. FRDC Project No: 2016/139 – ONLINE.

Common name	Species	Fishery	Score	Sensitivity
Yellowfin tuna	Thunnus albacares	Eastern Tuna and Billfish Fishery	4.75	LOW
Bigeye tuna	Thunnus obesus	Eastern Tuna and Billfish Fishery	4.75	LOW

Data Quality: Silver

External > Climate related > Susceptibility of key habitats > Habitat Impacts

Habitat impact: Moderate

Changes in the waters in which the fishery occurs have already been documented[27]. Projected changes in the distribution of target species[28][29] in the fishery have been published, as have projections of changing fishery catches[30].

Data Quality: Silver

External > Contaminants in the environment > Detection system for seafood contaminants > Risk of contaminants

Potential risk for contamination from the marine environment combined with monitoring arrangements to be able to address risks needed to ensure food safety. Contaminants include those with maximum levels set for by Food Standards Code Australia: metal contaminants, non-metal contaminants, natural toxicants, and average and maximum levels of mercury in fish. Contaminants from poor handling after landing are not assessed but may be indirectly addressed.

Rubric for risk level:

Low risk	Medium risk	High risk
There are no documented levels of contaminants from the marine environment causing risk/diet restrictions to any consumer group in the fishery.	There may be seasonal/area/species/size-based risks of contaminants for some species.	Permanent diet restrictions of species caught to vulnerable consumers such as children or pregnant women.

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[27] Suthers, I. M., J. D. Everett, M. Roughan, J. W. Young, P. R. Oke, S. A. Condie, J. R. Hartog, A. J. Hobday, P. A. Thompson, K. Ridgway, M. E. Baird, C. S. Hassler, G. B. Brassington, M. Byrne, N. L. Holbrook and H. A. Malcolm (2011). The strengthening East Australian Current, its eddies and biological effects - an introduction and overview. Deep Sea Research Part II: Topical Studies in Oceanography **58**: 538–546.

[28] Hartog, J., A. J. Hobday, R. Matear and M. Feng (2011). Habitat overlap of southern bluefin tuna and yellowfin tuna in the east coast longline fishery - implications for present and future spatial management. Deep Sea Research Part II **58**: 746-752.

[29] Hobday, A. J. (2010). Ensemble analysis of the future distribution of large pelagic fishes in Australia. Progress in Oceanography **86**(1-2): 291-301 doi:210.1016/j.pocean.2010.1004.1023.

[30] Dell, J. T., C. Wilcox, R. J. Matear, M. A. Chamberlain and A. J. Hobday (2015). Potential impacts of climate change on the distribution of longline catches of yellowfin tuna (Thunnus albacares) in the Tasman Sea. Deep Sea Research II **113**: 235-245.

Risk of Contaminants: High

No specific monitoring arrangements found for marine contaminants on the fishery webpage: http://www.afma.gov.au/fisheries/eastern-tuna-and-billfish-fishery-page/. High potential risk, several large pelagics (e.g. sharks, tunas) have high levels of mercury which cause diet restrictions to women and children.

Data Quality: Silver

External > Contaminants in the environment > Management arrangements to ensure food safety related to contaminants > Evidence for arrangements

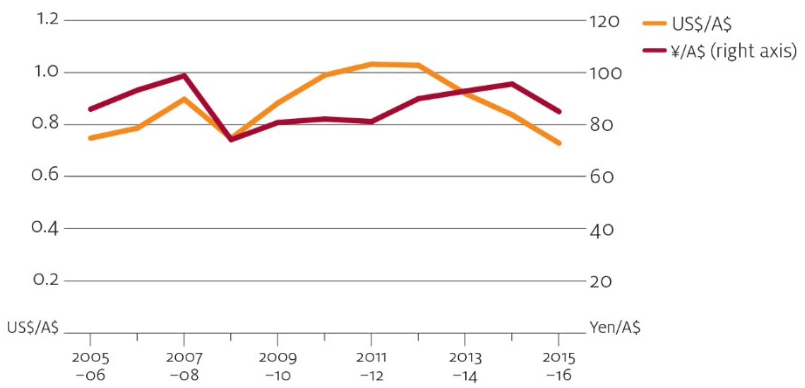
There is evidence of management arrangements to ensure food safety related to contaminants and food safety from the marine environment. No supply chain risks from poor handling are considered. Food standard 4.2.1 requires all seafood business in Australia to identify potential seafood safety hazards and put controls in place that are consistent with the risk.

Data Quality: Not found

External > Market Drivers > Macroeconomic factors > Exchange Rates

A depreciating Australian dollar (or, increasing exchange rate) generally results in producers receiving a higher export price in Australian dollar terms, while an appreciating Australian dollar (or, decreasing exchange rate) results in a lower export price. Domestically, a depreciation of the Australian dollar encourages substitution from imported seafood to domestically produced seafood, as imported products become relatively more expensive. A lower exchange rate also makes Australian exports more competitive in world markets, as exported seafood become relatively cheaper in foreign currency terms.

National export trends are negatively related to exchange rate movements— the Australian dollar declined against the US dollar and Japanese yen from 1990–91 to 2000–01, with exports increasing in volume and value. Exchange rates for the Australian dollar increased against those currencies from 2001–02 to 2015–16. The real export value and volume of Australia's seafood exports decreased between 2005–06 and 2012–13 and then increased between 2012–13 and 2015–16—with a noticeable rise (43 per cent) in volume between 2014–15 and 2015–16.[31]



[31] Mobsby, D and Koduah, A 2017, Australian fisheries and aquaculture statistics 2016, FRDC project 2017-095. ABARES, Canberra, December. CC BY 4.0.

Data Quality: Gold

External > Market Drivers > Consumer Trends > Per person annual apparent consumption of seafood (kg)

Annual apparent consumption is estimated by adding the total edible quantity of seafood supplied domestically—that is, total production plus imported seafood— less exports of seafood. Apparent consumption provides an estimate of the total amount of seafood consumed in Australia assuming zero change in stocks.

The production quantity of Australian fishery and aquaculture products is reported by ABARES on a whole weight basis, whereas trade data are reported on a processed basis. To align the units of measurement between production and trade data, it is necessary to convert production volume to a processed edible equivalent.

Production volumes are adjusted to an edible quantity basis using species-specific conversion rates and excluding species that are known to be predominantly supplied for non-human consumption purposes, such as for aquaculture feed or bait. Imports and exports of seafood are sourced from Australian Bureau of Statistics (ABS) trade data and are reported as edible weight. The apparent consumption per person is calculated as the total apparent consumption divided by the total Australian population in each year. The method applied here is consistent with that used by ABARES to estimate apparent consumption of other agricultural commodities produced in Australia.

The FAO also compiles statistics on apparent consumption of seafood, applying a consistent method across all countries. FAO estimates indicate that annual consumption of seafood in Australia is around 26 kilograms per person in 2013 (FAO 2016[32]). The discrepancy between FAO and ABARES estimates reflects differences in methodological approaches to estimating consumption. Moreover, ABARES estimates seafood consumption on a processed edible basis, whereas the FAO provides its estimates on a whole weight basis.

In Australia, apparent consumption of seafood per person (edible equivalent) decreased, on average, at an annual rate of 0.6 per cent, from 14.6 kilograms in 2005– 06 to 13.8 kilograms per person in 2015–16. Annual apparent consumption is estimated by the Australian Bureau of Agricultural and Resource Economics and Sciences by adding the total edible quantity of seafood supplied domestically—that is, total production plus imported seafood— less exports of seafood[33]

In comparison, global per capita apparent fish consumption increased from an average of 9.9 kg in the 1960s to 14.4 kg in the 1990s and 20.1 kg in 2014, with preliminary estimates for 2015 indicating further growth, exceeding 20 kg (FAO 2016). Australia's per person seafood consumption in 2013 was estimated by the FAO to be 26kg. The differences in estimates are accounted for by varying methods for calculating consumption. ABARES estimates seafood consumption on a processed edible basis, whereas the FAO provides its estimates on a whole weight basis.

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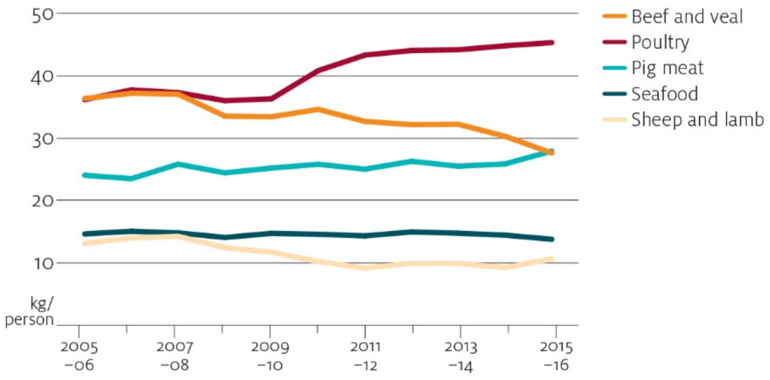
[32] The state of world fisheries and aquaculture 2016—opportunities and challenges, Food and Agriculture Organization of the United Nations, Rome.

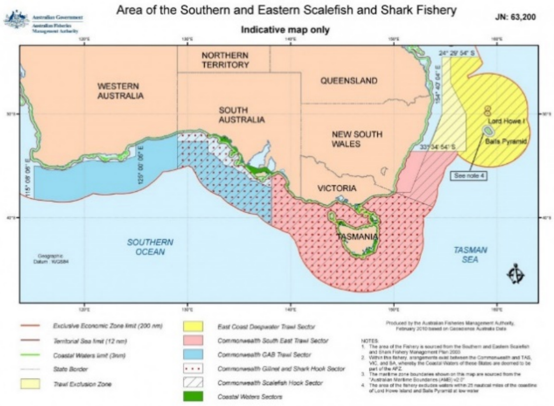
[33] Mobsby, D and Koduah, A 2017, *Australian fisheries and aquaculture statistics 2016*, FRDC 2017-095. ABARES, Canberra, December. CC BY 4.0



Data quality: Gold

Commonwealth Southern and Eastern Scalefish and Shark Fishery

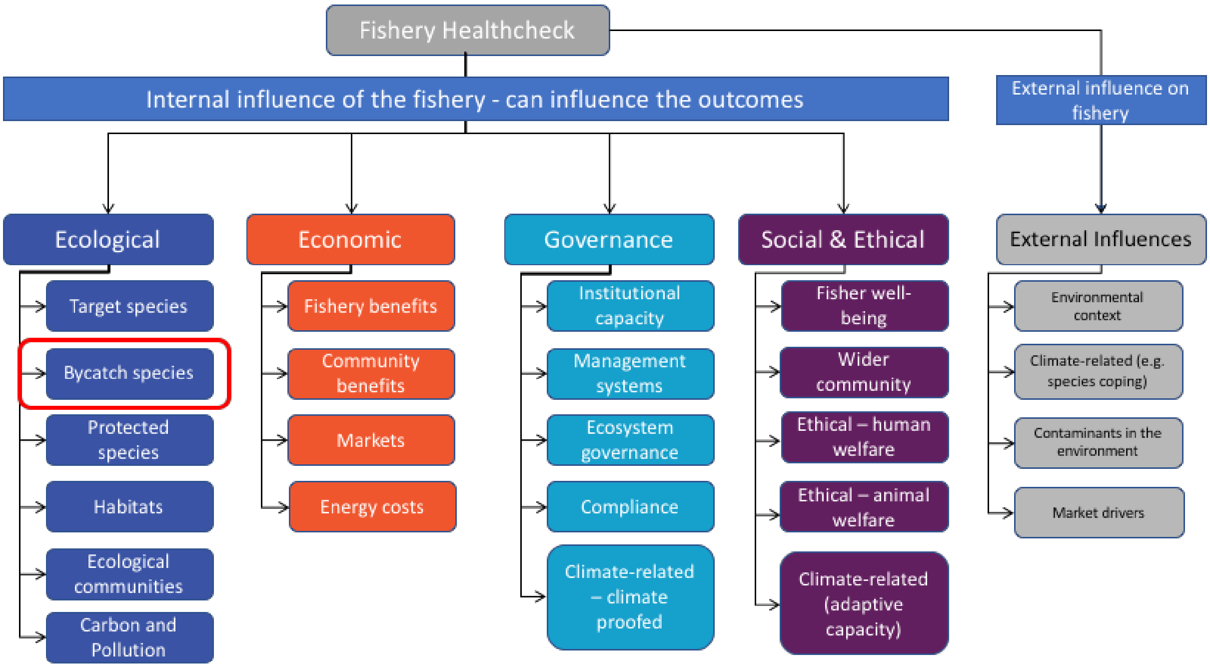
The **Commonwealth Southern and Eastern Scalefish and Shark Fishery** stretches south from Fraser Island in southern Queensland, around Tasmania, to Cape Leeuwin in southern Western Australia. The Southern and Eastern Scalefish and Shark Fishery is a multi-sector, multi-species fishery that covers almost half of the Australian Fishing Zone. AFMA manages this fishery by limiting the catch, restricting how many boats can fish and regulating what gear they can use. The species that are targeted by commercial fishers in the Southern and Eastern Scalefish and Shark Fishery are: Blue grenadier (Macruronus novaezelandiae), Tiger flathead (Neoplatycephalus richardsoni), Silver warehou (Seriolella punctata), Gummy shark (Mustelus antarcticus), Pink ling (Genypterus blacodes). (Source:



http://www.afma.gov.au/fisheries/southern-eastern-scalefish-shark-fishery/).

Case Study Presentation Format

The case study documents are a collection of metrics, organised by the healthcheck structure:



The presentation of metrics will follow the following heading format:

Ecological > Bycatch species > Bycatch composition > Mean Trophic Level

Understand this to be an indicator (**Bycatch composition**) of the **Ecological** Component, **Bycatch species** subcomponent where the (in the figure and heading example above, is being measured by presenting Mean Trophic Level as the metric.

Ecological > Target species > Stock Status > Status of Australian Fish Stocks (SAFS)

Target species in each fishery are the primary focus for this indicator. Status of these species is ideally assessed with the SAFS approach, however this may not cover all target species for each fishery. In that case, we indicate the number of unassessed species. These species could also be assessed by individual states or by alternative methods.

SpeciesName	StockName	StockStatus	Year
Blue Grenadier	Commonwealth Trawl Sector	Sustainable	2016
Blue-eye Trevalla	Eastern Australia	Sustainable	2016
Gummy Shark	Southern Australia	Sustainable	2016
Pink Ling	Eastern	Sustainable	2016
Silver Wahehou			
Tiger Flathead	Southern Australia	Sustainable	2016

Gummy Shark was not in the data provision from SAFS, but information from the SAFS website suggests that it is sustainable

Data Quality: Gold

Ecological > Target Species > Harvest Level > Catch weight

This metric is a proxy for harvest level. The harvested biomass for each species, provides information on the level of the catch. Trends in this metric over time can indicate declining availability of fish, quota restrictions, or changes in market demand. For Australian fisheries, trends are expected to be stable for most species.

The catch of species that are targeted by commercial fishers in the Southern and Eastern Scalefish and Shark Fishery (http://www.afma.gov.au/fisheries/southern-eastern-scalefish-shark-fishery/) are:

Species	2015-16 total allowable catch (tonnes)	2016-17 total allowable catch (tonnes)	2017-18 total allowable catch (tonnes)	2018-19 total allowable catch (tonnes)
Blue grenadier	8796	8810	8765	8810
Flathead	2860	2882	2712	2507
Gummy shark	1836	1836	1774	1763
Pink ling	980	1144	1154	1117
Silver warehou	2417	1209	605	600

The landings from the catch disposal records[34] show the breakdown of catch of these species for recent years.

Fishery	Year	Common Name	Scientific Name	CAAB	Retained Catch (Kg)	Catch (kg) under research catch allowance	Data Source
CTS	2004	Blue Grenadier	Macruronus novaezelandiae	37227001	6391529	50000	CDR
CTS	2004	Gummy Shark	Mustelus antarcticus	37017001	65638	0	CDR
CTS	2004	Pink Ling	Genypterus blacodes	37228002	903577	0	CDR
CTS	2004	Silver Warehou	Seriolella punctata	37445006	3311017	0	CDR
CTS	2004	Tiger Flathead	Platycephalus richardsoni	37296001	3387089	0	CDR
CTS	2005	Blue Grenadier	Macruronus novaezelandiae	37227001	4282775	0	CDR
CTS	2005	Gummy Shark	Mustelus antarcticus	37017001	61060	0	CDR
CTS	2005	Pink Ling	Genypterus blacodes	37228002	756114	0	CDR
CTS	2005	Silver Warehou	Seriolella punctata	37445006	2907578	0	CDR
CTS	2005	Tiger Flathead	Platycephalus richardsoni	37296001	3002098	0	CDR
CTS	2006	Blue Grenadier	Macruronus novaezelandiae	37227001	3613514	100000	CDR

[34] https://data.gov.au/dataset/0cd2ec97-d13c-4b02-8071-fd778fdcdee7/resource/81d3d265-b21a-4b05-b62d-c315beec771e/download/annual-cdr-catch-data-30-05-2018.xlsx

Fishery	Year	Common Name	Scientific Name	CAAB	Retained Catch (Kg)	Catch (kg) under research catch allowance	Data Source
CTS	2006	Gummy Shark	Mustelus antarcticus	37017001	63100	0	CDR
CTS	2006	Pink Ling	Genypterus blacodes	37228002	729709	0	CDR
CTS	2006	Silver Warehou	Seriolella punctata	37445006	2373525	0	CDR
CTS	2006	Tiger Flathead	Platycephalus richardsoni	37296001	2698823	0	CDR
CTS	2007	Blue Grenadier	Macruronus novaezelandiae	37227001	3175626	200000	CDR
CTS	2007	Gummy Shark	Mustelus antarcticus	37017001	68119	0	CDR
CTS	2007	Pink Ling	Genypterus blacodes	37228002	648568	601	CDR
CTS	2007	Silver Warehou	Seriolella punctata	37445006	1999557	4502	CDR
CTS	2007	Tiger Flathead	Platycephalus richardsoni	37296001	2873447	2222	CDR
CTS	2008	Blue Grenadier	Macruronus novaezelandiae	37227001	3930802	228252	CDR
CTS	2008	Gummy Shark	Mustelus antarcticus	37017001	94758	1086	CDR
CTS	2008	Pink Ling	Genypterus blacodes	37228002	706810	5717	CDR
CTS	2008	Silver Warehou	Seriolella punctata	37445006	1522921	24966	CDR

Fishery	Year	Common Name	Scientific Name	CAAB	Retained Catch (Kg)	Catch (kg) under research catch allowance	Data Source
CTS	2008	Tiger Flathead	Platycephalus richardsoni	37296001	3198042	11611	CDR
CTS	2009	Blue Grenadier	Macruronus novaezelandiae	37227001	3259293	200000	CDR
CTS	2009	Gummy Shark	Mustelus antarcticus	37017001	82502	0	CDR
CTS	2009	Pink Ling	Genypterus blacodes	37228002	586491	0	CDR
CTS	2009	Silver Warehou	Seriolella punctata	37445006	1378212	0	CDR
CTS	2009	Tiger Flathead	Platycephalus richardsoni	37296001	2682085	35	CDR
CTS	2010	Blue Grenadier	Macruronus novaezelandiae	37227001	3982900	208235	CDR
CTS	2010	Gummy Shark	Mustelus antarcticus	37017001	80032	333	CDR
CTS	2010	Pink Ling	Genypterus blacodes	37228002	652603	3922	CDR
CTS	2010	Silver Warehou	Seriolella punctata	37445006	1280379	7062	CDR
CTS	2010	Tiger Flathead	Platycephalus richardsoni	37296001	2719863	11235	CDR
CTS	2011	Blue Grenadier	Macruronus novaezelandiae	37227001	4201377	0	CDR
CTS	2011	Gummy Shark	Mustelus antarcticus	37017001	99053	0	CDR

Fishery	Year	Common Name	Scientific Name	CAAB	Retained Catch (Kg)	Catch (kg) under research catch allowance	Data Source
CTS	2011	Pink Ling	Genypterus blacodes	37228002	789544	0	CDR
CTS	2011	Silver Warehou	Seriolella punctata	37445006	1228768	0	CDR
CTS	2011	Tiger Flathead	Platycephalus richardsoni	37296001	2670509	0	CDR
CTS	2012	Blue Grenadier	Macruronus novaezelandiae	37227001	3852255	209452	CDR
CTS	2012	Gummy Shark	Mustelus antarcticus	37017001	106028	269	CDR
CTS	2012	Pink Ling	Genypterus blacodes	37228002	730327	4501	CDR
CTS	2012	Silver Warehou	Seriolella punctata	37445006	841524	6674	CDR
CTS	2012	Tiger Flathead	Platycephalus richardsoni	37296001	3038171	14303	CDR
CTS	2013	Blue Grenadier	Macruronus novaezelandiae	37227001	3821172	0	CDR
CTS	2013	Gummy Shark	Mustelus antarcticus	37017001	102348	0	CDR
CTS	2013	Pink Ling	Genypterus blacodes	37228002	564134	0	CDR
CTS	2013	Silver Warehou	Seriolella punctata	37445006	645534	0	CDR
CTS	2013	Tiger Flathead	Platycephalus richardsoni	37296001	2141727	0	CDR

Fishery	Year	Common Name	Scientific Name	CAAB	Retained Catch (Kg)	Catch (kg) under research catch allowance	Data Source
CTS	2014	Blue Grenadier	Macruronus novaezelandiae	37227001	1257762	11944	CDR
CTS	2014	Gummy Shark	Mustelus antarcticus	37017001	85200	370	CDR
CTS	2014	Pink Ling	Genypterus blacodes	37228002	608179	2839	CDR
CTS	2014	Silver Warehou	Seriolella punctata	37445006	381686	5081	CDR
CTS	2014	Tiger Flathead	Platycephalus richardsoni	37296001	2637870	5649	CDR
CTS	2015	Blue Grenadier	Macruronus novaezelandiae	37227001	1597272	0	CDR
CTS	2015	Gummy Shark	Mustelus antarcticus	37017001	90324	0	CDR
CTS	2015	Pink Ling	Genypterus blacodes	37228002	526180	0	CDR
CTS	2015	Silver Warehou	Seriolella punctata	37445006	361445	0	CDR
CTS	2015	Tiger Flathead	Platycephalus richardsoni	37296001	2894363	0	CDR
CTS	2016	Blue Grenadier	Macruronus novaezelandiae	37227001	1305244	7341	CDR
CTS	2016	Gummy Shark	Mustelus antarcticus	37017001	94132	397	CDR
CTS	2016	Pink Ling	Genypterus blacodes	37228002	555076	2857	CDR

Fishery	Year	Common Name	Scientific Name	CAAB	Retained Catch (Kg)	Catch (kg) under research catch allowance	Data Source
CTS	2016	Silver Warehou	Seriolella punctata	37445006	301583	3231	CDR
CTS	2016	Tiger Flathead	Platycephalus richardsoni	37296001	3007410	9919	CDR
GAB	2004	Blue Grenadier	Macruronus novaezelandiae	37227001	209607	0	CDR
GAB	2004	Gummy Shark	Mustelus antarcticus	37017001	53270	0	CDR
GAB	2004	Pink Ling	Genypterus blacodes	37228002	32350	0	CDR
GAB	2004	Silver Warehou	Seriolella punctata	37445006	11687	0	CDR
GAB	2004	Tiger Flathead	Platycephalus richardsoni	37296001	2638	0	CDR
GAB	2005	Blue Grenadier	Macruronus novaezelandiae	37227001	422592	0	CDR
GAB	2005	Gummy Shark	Mustelus antarcticus	37017001	64619	719	CDR
GAB	2005	Pink Ling	Genypterus blacodes	37228002	48372	0	CDR
GAB	2005	Silver Warehou	Seriolella punctata	37445006	41371	0	CDR
GAB	2005	Tiger Flathead	Platycephalus richardsoni	37296001	18794	0	CDR
GAB	2006	Blue Grenadier	Macruronus novaezelandiae	37227001	142799	0	CDR

Fishery	Year	Common Name	Scientific Name	CAAB	Retained Catch (Kg)	Catch (kg) under research catch allowance	Data Source
GAB	2006	Gummy Shark	Mustelus antarcticus	37017001	59322	391	CDR
GAB	2006	Pink Ling	Genypterus blacodes	37228002	36244	0	CDR
GAB	2006	Silver Warehou	Seriolella punctata	37445006	67910	0	CDR
GAB	2006	Tiger Flathead	Platycephalus richardsoni	37296001	334	0	CDR
GAB	2007	Blue Grenadier	Macruronus novaezelandiae	37227001	84762	0	CDR
GAB	2007	Gummy Shark	Mustelus antarcticus	37017001	54529	450	CDR
GAB	2007	Pink Ling	Genypterus blacodes	37228002	19777	0	CDR
GAB	2007	Silver Warehou	Seriolella punctata	37445006	24612	0	CDR
GAB	2007	Tiger Flathead	Platycephalus richardsoni	37296001	12	0	CDR
GAB	2008	Blue Grenadier	Macruronus novaezelandiae	37227001	3686	0	CDR
GAB	2008	Gummy Shark	Mustelus antarcticus	37017001	35844	476	CDR
GAB	2008	Pink Ling	Genypterus blacodes	37228002	1924	0	CDR
GAB	2008	Silver Warehou	Seriolella punctata	37445006	3370	0	CDR

Fishery	Year	Common Name	Scientific Name	CAAB	Retained Catch (Kg)	Catch (kg) under research catch allowance	Data Source
GAB	2009	Blue Grenadier	Macruronus novaezelandiae	37227001	119	0	CDR
GAB	2009	Gummy Shark	Mustelus antarcticus	37017001	43597	670	CDR
GAB	2009	Pink Ling	Genypterus blacodes	37228002	497	0	CDR
GAB	2009	Silver Warehou	Seriolella punctata	37445006	356	0	CDR
GAB	2010	Blue Grenadier	Macruronus novaezelandiae	37227001	6041	0	CDR
GAB	2010	Gummy Shark	Mustelus antarcticus	37017001	48534	0	CDR
GAB	2010	Pink Ling	Genypterus blacodes	37228002	4986	0	CDR
GAB	2010	Silver Warehou	Seriolella punctata	37445006	306	0	CDR
GAB	2011	Blue Grenadier	Macruronus novaezelandiae	37227001	6871	0	CDR
GAB	2011	Gummy Shark	Mustelus antarcticus	37017001	54851	666	CDR
GAB	2011	Pink Ling	Genypterus blacodes	37228002	4059	0	CDR
GAB	2011	Silver Warehou	Seriolella punctata	37445006	1010	0	CDR
GAB	2012	Blue Grenadier	Macruronus novaezelandiae	37227001	30376	0	CDR

Fishery	Year	Common Name	Scientific Name	CAAB	Retained Catch (Kg)	Catch (kg) under research catch allowance	Data Source
GAB	2012	Gummy Shark	Mustelus antarcticus	37017001	54346	0	CDR
GAB	2012	Pink Ling	Genypterus blacodes	37228002	12195	0	CDR
GAB	2012	Silver Warehou	Seriolella punctata	37445006	1018	0	CDR
GAB	2013	Blue Grenadier	Macruronus novaezelandiae	37227001	19748	0	CDR
GAB	2013	Gummy Shark	Mustelus antarcticus	37017001	54312	0	CDR
GAB	2013	Pink Ling	Genypterus blacodes	37228002	8248	0	CDR
GAB	2013	Silver Warehou	Seriolella punctata	37445006	255	0	CDR
GAB	2014	Blue Grenadier	Macruronus novaezelandiae	37227001	61236	0	CDR
GAB	2014	Gummy Shark	Mustelus antarcticus	37017001	50892	0	CDR
GAB	2014	Pink Ling	Genypterus blacodes	37228002	14774	0	CDR
GAB	2014	Silver Warehou	Seriolella punctata	37445006	789	0	CDR
GAB	2015	Blue Grenadier	Macruronus novaezelandiae	37227001	9033	0	CDR
GAB	2015	Gummy Shark	Mustelus antarcticus	37017001	32404	2900	CDR

Fishery	Year	Common Name	Scientific Name	CAAB	Retained Catch (Kg)	Catch (kg) under research catch allowance	Data Source
GAB	2015	Pink Ling	Genypterus blacodes	37228002	2091	0	CDR
GAB	2015	Silver Warehou	Seriolella punctata	37445006	2267	0	CDR
GAB	2016	Blue Grenadier	Macruronus novaezelandiae	37227001	3141	0	CDR
GAB	2016	Gummy Shark	Mustelus antarcticus	37017001	44989	0	CDR
GAB	2016	Pink Ling	Genypterus blacodes	37228002	4365	0	CDR
GAB	2016	Silver Warehou	Seriolella punctata	37445006	1115	0	CDR
GHAT	2002	Blue Grenadier	Macruronus novaezelandiae	37227001	3817	0	CDR
GHAT	2002	Gummy Shark	Mustelus antarcticus	37017001	1513314	698	CDR
GHAT	2002	Pink Ling	Genypterus blacodes	37228002	522403	3	CDR
GHAT	2002	Silver Warehou	Seriolella punctata	37445006	703	0	CDR
GHAT	2002	Tiger Flathead	Platycephalus richardsoni	37296001	802	7	CDR
GHAT	2003	Blue Grenadier	Macruronus novaezelandiae	37227001	8925	0	CDR
GHAT	2003	Gummy Shark	Mustelus antarcticus	37017001	1570855	864	CDR

Fishery	Year	Common Name	Scientific Name	CAAB	Retained Catch (Kg)	Catch (kg) under research catch allowance	Data Source
GHAT	2003	Pink Ling	Genypterus blacodes	37228002	477475	6	CDR
GHAT	2003	Silver Warehou	Seriolella punctata	37445006	12642	0	CDR
GHAT	2003	Tiger Flathead	Platycephalus richardsoni	37296001	809	2	CDR
GHAT	2004	Blue Grenadier	Macruronus novaezelandiae	37227001	9878	0	CDR
GHAT	2004	Gummy Shark	Mustelus antarcticus	37017001	1619950	395	CDR
GHAT	2004	Pink Ling	Genypterus blacodes	37228002	850448	66	CDR
GHAT	2004	Silver Warehou	Seriolella punctata	37445006	251	0	CDR
GHAT	2004	Tiger Flathead	Platycephalus richardsoni	37296001	858	0	CDR
GHAT	2005	Blue Grenadier	Macruronus novaezelandiae	37227001	10215	0	CDR
GHAT	2005	Gummy Shark	Mustelus antarcticus	37017001	1519202	0	CDR
GHAT	2005	Pink Ling	Genypterus blacodes	37228002	644276	0	CDR
GHAT	2005	Silver Warehou	Seriolella punctata	37445006	139	0	CDR
GHAT	2005	Tiger Flathead	Platycephalus richardsoni	37296001	755	0	CDR

Fishery	Year	Common Name	Scientific Name	CAAB	Retained Catch (Kg)	Catch (kg) under research catch allowance	Data Source
GHAT	2006	Blue Grenadier	Macruronus novaezelandiae	37227001	11442	0	CDR
GHAT	2006	Gummy Shark	Mustelus antarcticus	37017001	1523311	37	CDR
GHAT	2006	Pink Ling	Genypterus blacodes	37228002	456513	0	CDR
GHAT	2006	Silver Warehou	Seriolella punctata	37445006	86	0	CDR
GHAT	2006	Tiger Flathead	Platycephalus richardsoni	37296001	805	0	CDR
GHAT	2007	Blue Grenadier	Macruronus novaezelandiae	37227001	8017	16	CDR
GHAT	2007	Gummy Shark	Mustelus antarcticus	37017001	1544416	10898	CDR
GHAT	2007	Pink Ling	Genypterus blacodes	37228002	339097	154	CDR
GHAT	2007	Silver Warehou	Seriolella punctata	37445006	85	1	CDR
GHAT	2007	Tiger Flathead	Platycephalus richardsoni	37296001	671	45	CDR
GHAT	2008	Blue Grenadier	Macruronus novaezelandiae	37227001	7491	0	CDR
GHAT	2008	Gummy Shark	Mustelus antarcticus	37017001	1735116	25614	CDR
GHAT	2008	Pink Ling	Genypterus blacodes	37228002	443748	35	CDR

Fishery	Year	Common Name	Scientific Name	CAAB	Retained Catch (Kg)	Catch (kg) under research catch allowance	Data Source
GHAT	2008	Silver Warehou	Seriolella punctata	37445006	85	6	CDR
GHAT	2008	Tiger Flathead	Platycephalus richardsoni	37296001	631	45	CDR
GHAT	2009	Blue Grenadier	Macruronus novaezelandiae	37227001	9655	8	CDR
GHAT	2009	Gummy Shark	Mustelus antarcticus	37017001	1520136	0	CDR
GHAT	2009	Pink Ling	Genypterus blacodes	37228002	298193	3056	CDR
GHAT	2009	Silver Warehou	Seriolella punctata	37445006	2	0	CDR
GHAT	2009	Tiger Flathead	Platycephalus richardsoni	37296001	465	0	CDR
GHAT	2010	Blue Grenadier	Macruronus novaezelandiae	37227001	9557	0	CDR
GHAT	2010	Gummy Shark	Mustelus antarcticus	37017001	1408426	1691	CDR
GHAT	2010	Pink Ling	Genypterus blacodes	37228002	388985	0	CDR
GHAT	2010	Silver Warehou	Seriolella punctata	37445006	1441	0	CDR
GHAT	2010	Tiger Flathead	Platycephalus richardsoni	37296001	368	0	CDR
GHAT	2011	Blue Grenadier	Macruronus novaezelandiae	37227001	5919	0	CDR

Fishery	Year	Common Name	Scientific Name	CAAB	Retained Catch (Kg)	Catch (kg) under research catch allowance	Data Source
GHAT	2011	Gummy Shark	Mustelus antarcticus	37017001	1360568	0	CDR
GHAT	2011	Pink Ling	Genypterus blacodes	37228002	429573	0	CDR
GHAT	2011	Silver Warehou	Seriolella punctata	37445006	123	0	CDR
GHAT	2011	Tiger Flathead	Platycephalus richardsoni	37296001	750	0	CDR
GHAT	2012	Blue Grenadier	Macruronus novaezelandiae	37227001	4754	0	CDR
GHAT	2012	Gummy Shark	Mustelus antarcticus	37017001	1288456	0	CDR
GHAT	2012	Pink Ling	Genypterus blacodes	37228002	392646	0	CDR
GHAT	2012	Silver Warehou	Seriolella punctata	37445006	57	0	CDR
GHAT	2012	Tiger Flathead	Platycephalus richardsoni	37296001	1057	0	CDR
GHAT	2013	Blue Grenadier	Macruronus novaezelandiae	37227001	6759	0	CDR
GHAT	2013	Gummy Shark	Mustelus antarcticus	37017001	1314607	0	CDR
GHAT	2013	Pink Ling	Genypterus blacodes	37228002	246255	0	CDR
GHAT	2013	Silver Warehou	Seriolella punctata	37445006	10	0	CDR

Fishery	Year	Common Name	Scientific Name	CAAB	Retained Catch (Kg)	Catch (kg) under research catch allowance	Data Source
GHAT	2013	Tiger Flathead	Platycephalus richardsoni	37296001	435	0	CDR
GHAT	2014	Blue Grenadier	Macruronus novaezelandiae	37227001	7781	0	CDR
GHAT	2014	Gummy Shark	Mustelus antarcticus	37017001	1393945	0	CDR
GHAT	2014	Pink Ling	Genypterus blacodes	37228002	310737	0	CDR
GHAT	2014	Silver Warehou	Seriolella punctata	37445006	12	0	CDR
GHAT	2014	Tiger Flathead	Platycephalus richardsoni	37296001	2690	0	CDR
GHAT	2015	Blue Grenadier	Macruronus novaezelandiae	37227001	8749	0	CDR
GHAT	2015	Gummy Shark	Mustelus antarcticus	37017001	1559284	0	CDR
GHAT	2015	Pink Ling	Genypterus blacodes	37228002	282757	0	CDR
GHAT	2015	Silver Warehou	Seriolella punctata	37445006	34	0	CDR
GHAT	2015	Tiger Flathead	Platycephalus richardsoni	37296001	6225	0	CDR
GHAT	2016	Blue Grenadier	Macruronus novaezelandiae	37227001	6105	0	CDR
GHAT	2016	Gummy Shark	Mustelus antarcticus	37017001	1606805	0	CDR

Fishery	Year	Common Name	Scientific Name	CAAB	Retained Catch (Kg)	Catch (kg) under research catch allowance	Data Source
GHAT	2016	Pink Ling	Genypterus blacodes	37228002	303576	0	CDR
GHAT	2016	Silver Warehou	Seriolella punctata	37445006	25	0	CDR
GHAT	2016	Tiger Flathead	Platycephalus richardsoni	37296001	376	0	CDR

Data quality: Gold

Ecological > Bycatch species > Bycatch composition > Mean Trophic Level

The trophic level is a measure of the position of an organism in a food web, starting at level 1 with primary producers, such as phytoplankton, then moving through the primary consumers at level **2** that eat the primary producers to the secondary consumers at level **3** that eat the primary consumers, and so on. The **bycatch mean trophic level** is an indicator of the mean level of the food chain for bycatch in a fishery.

Recent ERAEF data extraction available:

Otter trawl

	Min trophic level	Max trophic level	Sample size (species)
ERAEF data (2017)	3.25	4.18	278 out of 307 possible

Data Quality: Gold

Ecological > Bycatch species > Bycatch amount > Total weight of bycatch

Bycatch weights for fishery are typically developed by specific projects, and require a range of assumptions due to issues with reporting and retention of bycatch. **Bycatch** estimates typically cover species that are not target species, while **discard** rates may also include undersized individuals of the target species. Kennelly (2018) provides estimates of discard rates, which include both target and bycatch species, and when discard rates are used, that information is noted for each fishery. Animals can be returned to the ocean alive or dead. The intention of this metric is to provide information on animals that are dead on return to the ocean.

Reference:

Kennelly, S.J., 2018. *Developing a National Bycatch Reporting System.* Final FRDC Report, ISBN 978-0-9924930-5-9, March, 2018. 99 pp.

These data are available for the fishery, but the project team has not compiled a summary. A continuation of Kennelly (2018) is underway and will provide these data shortly.

Data Quality: Not organised/analysed

Ecological > Protected species > Capture amount > Captures

The number and diversity of TEP species captured by a fishery in the most recent year, provided as annual numbers.

As a commonwealth managed fishery, interactions are reported quarterly here.

In 2017, the reported number of protected species interactions by quarter is:

QUARTER 1

Southern and Eastern Scalefish and Shark Fishery - Commonwealth Trawl Sector

Gear Type	Common name	Total	Life Status				Interaction type[1]	Comments
			Alive	Dead	Injured	Unknown		
Bottom otter trawl	Albatrosses	**7**	1	5	1		Entangled	-
	Australian fur seal	**26**	3	23			Entangled	-
	Dolphins*	**2**		2			Entangled	-
	Seals	**4**	1	3			Entangled	-
	Shy albatross	**1**		1			Entangled	-
Danish seine	Australian Fur Seal	**2**		2			Entangled	-
	Seals	**1**	1				Entangled	-
	Shy Albatross	**1**		1			Entangled	-
	Total Interactions	**44**	**6**	**37**	**1**			

QUARTER 2

Southern and Eastern Scalefish and Shark Fishery - Commonwealth Trawl Sector

Gear Type	Common name	Total	Life Status				Interaction type[1]	Comments
			Alive	Dead	Injured	Unknown		
Bottom otter trawl	Albatrosses	3		3			Entangled	-
	Australian fur seal	33	6	27			Entangled	-
	Bottlenose dolphin*	1		1			Entangled	-
	Common dolphin*	2		2			Entangled	
	Dolphins*	1		1			Entangled	-
	Seals	1	1				Entangled	-
Danish seine	Australian Fur Seal	4	2	2			Entangled	-
	Seals	2	2				Entangled	-
	Total Interactions	**47**	**11**	**36**				

QUARTER 3

Southern and Eastern Scalefish and Shark Fishery - Commonwealth Trawl Sector

Gear Type	Common name	Total	Life Status				Interaction type[1]	Comments
			Alive	Dead	Injured	Unknown		
Bottom otter trawl	Australian fur seal	20	4	16			Entangled	-
	Seals	3	1	2			Entangled	-
Danish seine	Australian Fur Seal	4	1	3			Entangled	-
	Seals	2	1	1			Entangled	-
	Total Interactions	29	7	22				

QUARTER 4

Southern and Eastern Scalefish and Shark Fishery - Commonwealth Trawl Sector

Gear Type	Common name	Total	Life Status				Interaction type[1]	Comments
			Alive	Dead	Injured	Unknown		
Bottom otter trawl	Albatrosses	10	2	8			Entangled	-
	Australian fur seal	30	9	21			Entangled	-
	Common dolphin*	1		1			Entangled	-
	Dolphins*	1		1			Entangled	-
	Grey Nurse Shark*	1	1				Entangled	-
	New Zealand Fur Seal	1	1				Entangled	-
	Seals	2	2				Entangled	-
	Shy Albatross	1		1			Entangled	-
Danish seine	Australian Fur Seal	5	2	3			Entangled	-
	Seals	1	1				Entangled	-
	Total Interactions	53	18	35	0	0		

QUARTER 1

Southern and Eastern Scalefish and Shark Fishery - Gillnet, Hook & Trap Sector

Gear Type	Common name	Total	Life status				Interaction type[1]	Comments
			Alive	Dead	Injured	Unknown		
Autolongline	Petrels Prions and Shearwaters	**3**		3			Hooked	-
	Porbeagle**	**1**				1	Hooked	-
	Shortfin Mako**	**14**		4		10	Hooked	-
	Shy Albatross	**2**	2				Hooked	-
	White Chinned Petrel	**2**		2			Hooked	-
Gillnet	Albatrosses	**3**	2	1			Entangled	-
	Bottlenose dolphin*	**1**		1			Entangled	-
	Common dolphin*	**2**		2			Entangled	-
	Cormorants	**3**		3			Entangled	-
	Dolphins*	**12**		12			Entangled	-
	Fairy Prion	**1**		1			Entangled	-
	Grey nurse shark*	**2**	1			1	Entangled	-
	Petrels Prions and Shearwaters	**4**		4			Entangled	-
	Red Cormorant	**1**		1			Entangled	-
	Seahorses & pipefishes	**1**	1				Entangled	-
	Seals	**3**		3			Entangled	-
	Shearwaters (mixed)	**7**	6	1			Entangled	-
	Shortfin Mako**	**20**		18		2	Entangled	-
	White Shark*	**9**	7	2			Entangled	-
	Total Interactions	**91**	**19**	**58**		**14**		

QUARTER 2

Southern and Eastern Scalefish and Shark Fishery - Gillnet, Hook & Trap Sector

Gear Type	Common name	Total	Life status				Interaction type[1]	Comments
			Alive	Dead	Injured	Unknown		
Demersal Longline	Albatrosses	1		1			Hooked	-
	Shortfin Mako**	1		1			Hooked	
	White Shark*	1	1				Hooked	
Autolongline	Longfin Mako**	4				4	Hooked	-
	Petrels Prions and Shearwaters	1		1			Hooked	-
	Seals	1		1			Hooked	-
	Shortfin Mako**	1		1			Hooked	-
Gillnet	Albatrosses	1		1			Entangled	-
	Australian fur seal	4	1	3			Entangled	-
	Common dolphin*	6		6			Entangled	-
	Cormorants	8		8			Entangled	-
	Dolphins*	10	1	9			Entangled	-
	Imperial Shag	2		2			Entangled	-
	Petrels Prions and Shearwaters	5	2	3			Entangled	-
	Seahorses & pipefishes	1	1				Entangled	-
	Seals	4		4			Entangled	-
	Shearwaters (mixed)	1		1			Entangled	-
	Shortfin Mako**	38	1	28		9	Entangled	-
	Terns	2	2				Entangled	
	White Shark*	3	2	1			Entangled	-
	Total Interactions	**94**	**11**	**70**		**13**		

QUARTER 3

Southern and Eastern Scalefish and Shark Fishery - Gillnet, Hook & Trap Sector

Gear Type	Common name	Total	Life status				Interaction type[1]	Comments
			Alive	Dead	Injured	Unknown		
Demersal Longline	White Shark*	1	1				Hooked	
Gillnet	Albatrosses	1			1		Entangled	-
	Australian sea lion	1		1			Entangled	-
	Bottlenose dolphin*	3		3			Entangled	-
	Common dolphin*	5		5			Entangled	-
	Cormorants	1		1			Entangled	-
	Dolphins*	10		10			Entangled	-
	Longfin Mako	1		1			Entangled	-
	New Zealand fur seal	1	1				Entangled	-
	Seals	6		6			Entangled	-
	Shearwaters (mixed)	1		1			Entangled	-
	Shortfin Mako	4		3		1	Entangled	-
	Total Interactions	35	2	31	1	1		

QUARTER 4

Southern and Eastern Scalefish and Shark Fishery - Gillnet, Hook & Trap Sector

Gear Type	Common name	Total	Life status				Interaction type[1]	Comments
			Alive	Dead	Injured	Unknown		
Dropline	Shortfin Mako	1		1			Hooked	-
Demersal Auto-Longline	Petrels Prions and Shearwaters	10		10			Hooked	-
	Porbeagle	3		1		2	Hooked	-
	Seals	2	1	1			Hooked	-
	Shortfin Mako	8		5		3	Hooked	-
	White Chinned Petrel	3	1	2			Hooked	-
Demersal Longline	Shortfin Mako	2		2			Hooked	-
	White Shark	2	2				Hooked	-
Gillnet	Australian fur seal	3		3			Entangled	-
	Common dolphin*	7	1	6			Entangled	-
	Cormorants	2		2			Entangled	-
	Dolphins*	11		10	1		Entangled	-
	Petrels Prions and Shearwaters	6	2	4			Entangled	-
	Seals	13		13			Entangled	-
	Shearwaters (mixed)	8		8			Entangled	-
	Short Tailed Shearwater	1		1			Entangled	-
	Shortfin Mako	12	1	9		2	Entangled	-
	White Shark*	2	2				Entangled	-
	Total Interactions	91	9	74	1	7		

The reported number of species interactions as reported by the fishery[35] are:

"In 2017, 179 pinniped interactions were reported in CTS and GHTS logbooks: 53 with Antarctic fur seals, 1 with an Australian sea lion, 2 with New Zealand fur seals, 78 with Australian fur seals and 45 with seals of unknown species. This is an increase from the 136 interactions reported in 2016. In the CTS, 85 per cent of all pinniped interactions in 2017 were reported from bottom-trawling operations; the remainder (15 per cent) were reported from Danish-seine operations. Of the pinniped interactions reported in logbooks in the GHTS in 2017, 92 per cent were reported from gillnet operations.

In 2017, interactions were reported with 67 dolphins in the GHTS, 64 of which were dead; 4 interactions were reported in the CTS—all dolphins were dead. This is an increase from the 37 interactions reported in 2016 and is likely to reflect the introduction of electronic monitoring in the GHTS.

During 2017, 98 seabird interactions were reported in logbooks or by observers in the SESSF: 75 in the GHTS and 23 in the CTS. This is a decrease from143 seabird interactions reported in 2016. Of the 98 interactions, most were with the following groups: 24 were reported as unclassified petrels, prions and shearwaters, 20 of which were dead; 5 were with white-chinned petrels (*Procellaria aequinoctialis*), 4 of which were dead; 4 were with shy albatross (*Thalassarche cauta*), 2 of which were dead; 20 were with unclassified albatrosses, 16 of which were dead; 14 were with cormorants, all of which were dead; 8 were with flesh-footed shearwaters (*Ardenna carneipes*), all of which were dead; and 17 were with unclassified shearwaters, 11 of which were dead.

In 2017, 130 interactions with protected sharks were reported in logbooks: 129 in the GHTS (77 of which were dead) and 1 in the CTS (alive). The most prevalent shark was shortfin mako, with 101 interactions reported, 72 of which were dead. Seventeen white sharks were reported—all in the GHTS; 14 were released alive and 3 were dead. Four porbeagle sharks were reported, of which 1 was dead and 3 were in unknown condition; and 3 grey nurse sharks were reported; 2 were alive and 1 was in an unknown condition.

Two interactions with syngnathids were reported in 2017 in the GHTS; they were released alive."

Species	Interactions
Antarctic fur seal	53
Australian sea lion	1

35 http://data.daff.gov.au/data/warehouse/9aam/fsrXXd9abm_/fsr18d9abm_20180928/08_FishStatus2018SthnEastnScalefishShark_1.0.0.pdf

New Zealand fur seal	2
Australian fur seal	78
Seal	45
Dolphin	67
Petrels/Prions/Shearwaters	24
White chinned petrel	5
Shy albatross	4
Alabatross	20
Cormorants	14
Flesh-footed shearwaters	8
Shearwaters	17
Shortfin mako	101
White shark	17
Porbeagle shark	4
Grey nurse shark	3
Sygnathids	2

Data quality: Gold

Ecological > Protected species > Reporting > Level of monitoring

This indicator is to provide information on the level of coverage for a fishery. Annual measures are preferred.

AFMA uses many methods to monitor the compliance of fishing activities and collect data on fish stocks. Boats in the Southern and Eastern Scalefish and Shark Fishery must carry an AFMA observer when requested by AFMA.
AFMA also has electronic monitoring systems on some fishing boats. These systems have sensors linked to surveillance cameras that record fishing activity. These recordings can then be collected and monitored by AFMA. Electronic monitoring gives fishers a cost effective way to support monitoring and data collection[36].

Data quality: Silver

Ecological > Habitats > Habitat impact > Impact score

The habitat impact is an indicator of the effect the fishing gear has on the habitat. Different gear types have different impacts. See the scoring rubric.

Habitat Impact: Minor

[36] http://www.afma.gov.au/fisheries/southern-eastern-scalefish-shark-fishery/

Three recent ERA reports for the SESSF Danish Seine[37], GAB Otter trawl[38] and south east otter trawl[39] scored habitat impacts at level 1 as shown in the following figures. This assessment is based on fishery impacts as a result of the fishing gear.

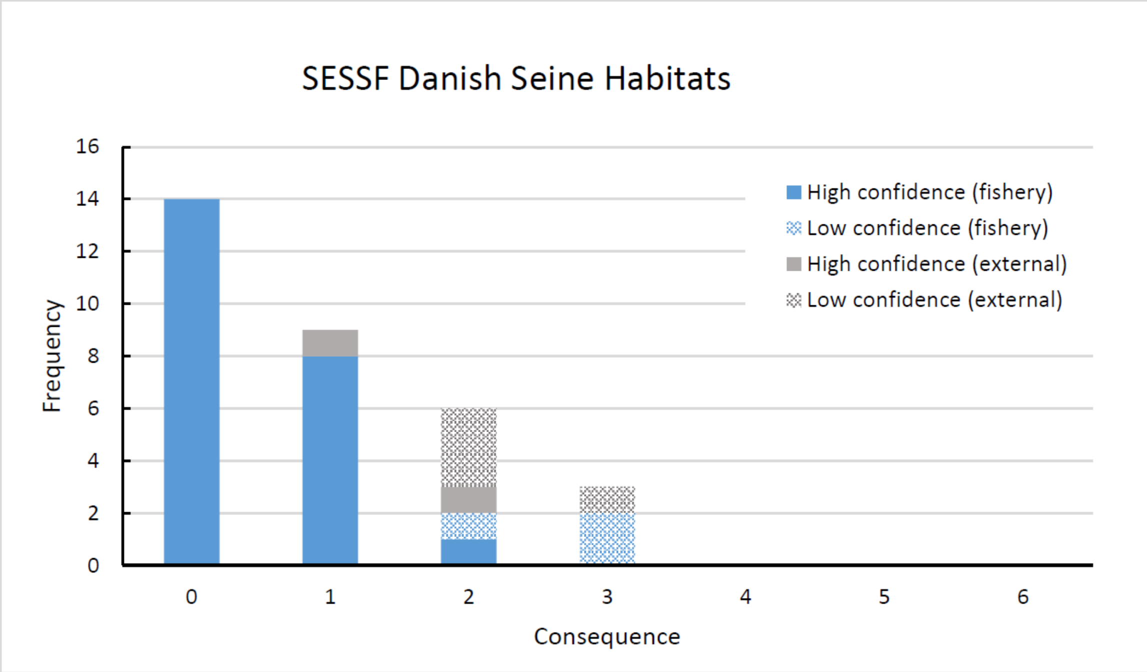


Figure 2.6. Habitats: Frequency of consequence score by high and low confidence.

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[37] Sporcic, M., Bulman, C.M., Fuller, M. (2018). Ecological Risk Assessment for the Effects of Fishing. Report for Southern and Eastern Scalefish and Shark Fishery (Commonwealth Trawl Sector): Danish Seine Sub-fishery 2012- 2016. Report for the Australian Fisheries Management Authority. 214 pp.

[38] Sporcic, M., Bulman, C.M., Fuller, M. (2018). Ecological Risk Assessment for the Effects of Fishing. Report for Southern and Eastern Scalefish and Shark Fishery, Great Australian Bight Sector: Otter trawl sub-fishery 2012- 2016. Report for the Australian Fisheries Management Authority. 204 pp.

[39] Sporcic, M., Bulman, C.M., Fuller, M. (2018). Ecological Risk Assessment for the Effects of Fishing. Report for Southern and Eastern Scalefish and Shark Fishery (Commonwealth Trawl Sector): Otter trawl Sub-fishery 2012- 2016. Report for the Australian Fisheries Management Authority. 294 pp.

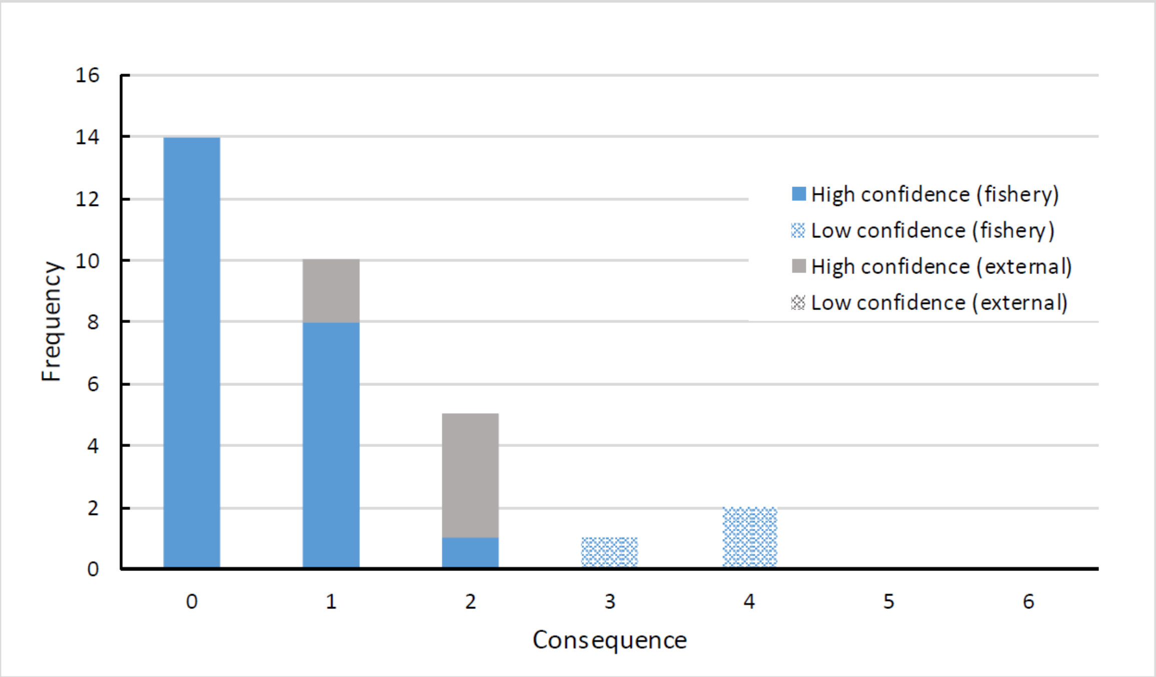

Figure 2.6. Habitat: Frequency of consequence score by high and low confidence.

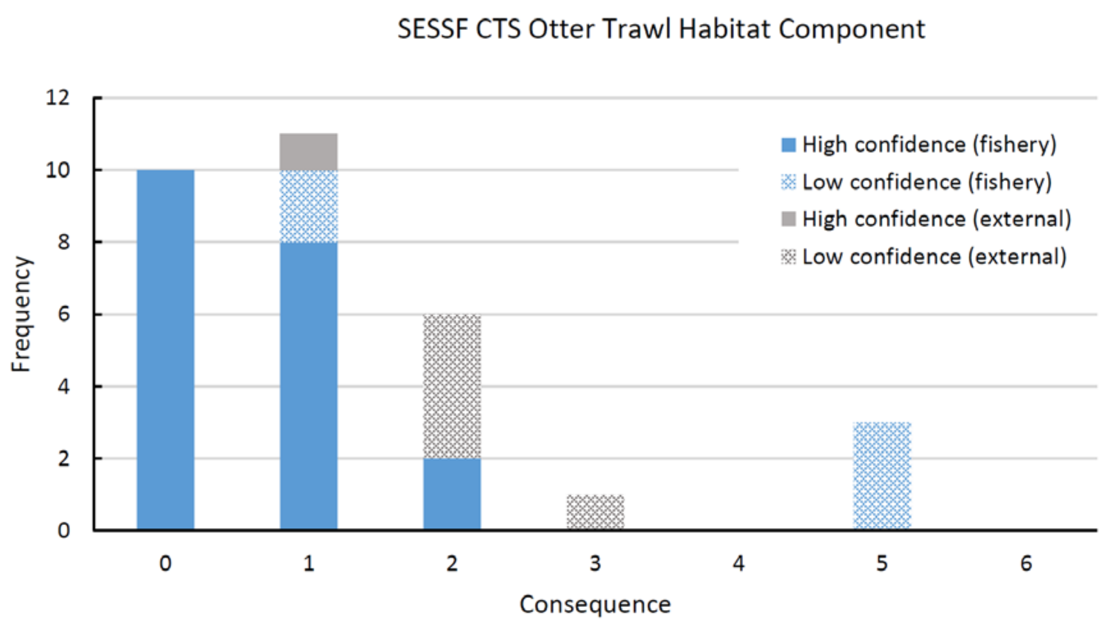

Figure 2.7. Habitat: Frequency of consequence score by high and low confidence.

Data quality: Silver

Ecological > Habitats > Habitat impact > Habitat status

The status of the habitat types is a measure of the condition relative to a pristine state. Fishing may not be responsible for that habitat status, but it is important to note if fishing is taking place in pristine or disturbed habitats.

Habitat status: Moderate

Data quality: Bronze

Ecological > Ecological communities > Ecosystem status > Ecosystem status

This metric reports the ecosystem status in the region of the fishery.

Ecosystem Status: Moderate to Good

The 2016 State of Environment report notes the following [40]

Seabed at depths of 25-250m*: The state is likely* ***poor to good*** *in the South-east and Temperate East marine regions*

Seabed at depths of 250-700m*: Seabed habitats are spatially restricted, with varying impacts as a result of pressures, resulting in varying state and trends. State is* ***poor to very poor*** *but improving in the South-east/Temperate East marine regions*

Seabed at depths of >700m *Habitats …. at 700–1500 m …in the South-east Marine region are* ***poor*** *because of fishing impacts.*

In the South-east Marine Region Pitcher et al. 2015 estimated that gorgonians, bryozoans, *Solenosmilia* spp., sponges, soft corals and some other cnidarians had been reduced by approximately 10–20 per cent, and several other taxa had been reduced by approximately 5–10 per cent at regional scales when trawl effort peaked around 2005. In both regions, bottom habitats are predicted to be recovering since then.

Data Quality: Silver

Ecological > Ecological communities > Ecosystem status > Species diversity

The measure of species diversity as a ratio between fished and unfished states.

Data quality: Not organised/analysed

Ecological > Carbon and Pollution > Macro-plastics > Plastic code of conduct

Macro-plastics are plastics that are visible to the naked eye, such as food containers and wrapping, equipment packaging, and fishing equipment. The metric notes a commitment to a zero waste overboard code of conduct to assess attempts to reduce accidental or intentional introduction of macro-plastics to the ocean. There are stated guidelines detailing Australia's guidelines regarding marine pollution from the Australian Maritime Safety Authority[41]:

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[40] https://soe.environment.gov.au/assessment-summary/marine-environment/state-and-trends-habitats-and-communities

[41] https://www.amsa.gov.au/marine-environment/marine-pollution/pollution-fishing-vessels
https://www.amsa.gov.au/marine-environment/marine-pollution/marpol-and-its-implementation-australia

Pollution of the marine environment by ships, including fishing vessels, is strictly controlled by the International Convention for the Prevention of Pollution from Ships (known as MARPOL).

To minimise pollution, MARPOL prohibits ships from discharging garbage into the sea except in very limited circumstances.

Australian MARPOL regulations apply to Australian fishing vessels wherever they are operating.

Data Quality: Bronze

Ecological > Carbon and Pollution > Carbon footprint > CO_2-equivalents

The emissions of climate forcing gases in kg CO_2-equivalents (CO_2e) per kg live weight fish caught, not including the supply chain after landing.

Data Quality	Gear	Target species	Min (kg CO_2e/kg)	Average (kg CO_2e/kg)	Max (kg CO_2e/kg)	Reference	Description
Gold							
Silver	Otter trawl	Blue grenadier, tiger flathead		2.1		ABARES 2018	SESSF trawl sector, 2014/15, assume diesel, refrigerants not included.
Bronze	Bottom trawl	Finfish	1.0	1.5	1.8	Parker and Tyedmers 2015	Oceania region, year not specified, assume diesel.

Economic > Fishery Benefits > Net Economic Returns > Economic Rent

Net Economic Returns (NER) is equal to fishing revenue less fishing costs and measures the economic profit that is derived from fishing activity, it is measured by the Commonwealth as Net Economic Returns and by some States as Economic Rent.

Data Quality	Indicator	Year	Amount	Reference	Note
Gold	Net economic returns	2016-2017	$4,236,151	Bath, A, Mobsby, D & Koduah, A (2018) Australian fisheries economic indicators report 2017: financial and economic performance of the Southern and Eastern Scalefish and Shark Fishery, ABARES, Canberra, April CC BY 4.0 Supporting data tables	Commonwealth Trawl Sector Includes management costs

Gold	Net economic returns	2015-2016	$3,483,041	Bath, A, Mobsby, D & Koduah, A (2018) Australian fisheries economic indicators report 2017: financial and economic performance of the Southern and Eastern Scalefish and Shark Fishery, ABARES, Canberra, April CC BY 4.0 Supporting data tables	Commonwealth Trawl Sector Includes management costs
Gold	Net economic returns	2014-2015	$174,793	Bath, A, Mobsby, D & Koduah, A (2018) Australian fisheries economic indicators report 2017: financial and economic performance of the Southern and Eastern Scalefish and Shark Fishery, ABARES, Canberra, April CC BY 4.0 Supporting data tables	Commonwealth Trawl Sector Includes management costs
Gold	Net economic returns	2013-2014	-$1,109,712	Bath, A, Mobsby, D & Koduah, A (2018) Australian fisheries economic indicators report 2017: financial and economic performance of the Southern and Eastern Scalefish and Shark Fishery, ABARES, Canberra, April CC BY 4.0 Supporting data tables	Commonwealth Trawl Sector Includes management costs
Gold	Net economic returns	2012-2013	$3,957,761	Bath, A, Mobsby, D & Koduah, A (2018) Australian fisheries economic indicators report 2017: financial and economic performance of the Southern and Eastern Scalefish and Shark Fishery, ABARES, Canberra, April CC BY 4.0 Supporting data tables	Commonwealth Trawl Sector Includes management costs

Gold	Net economic returns	2011-2012	$4,097,764	Bath, A, Mobsby, D & Koduah, A (2018) Australian fisheries economic indicators report 2017: financial and economic performance of the Southern and Eastern Scalefish and Shark Fishery, ABARES, Canberra, April CC BY 4.0 Supporting data tables	Commonwealth Trawl Sector Includes management costs
Gold	Net economic returns	2010-2011	$6,663,319	Bath, A, Mobsby, D & Koduah, A (2018) Australian fisheries economic indicators report 2017: financial and economic performance of the Southern and Eastern Scalefish and Shark Fishery, ABARES, Canberra, April CC BY 4.0 Supporting data tables	Commonwealth Trawl Sector Includes management costs
Gold	Net economic returns	2009-2010	$2,368,879	Bath, A, Mobsby, D & Koduah, A (2018) Australian fisheries economic indicators report 2017: financial and economic performance of the Southern and Eastern Scalefish and Shark Fishery, ABARES, Canberra, April CC BY 4.0 Supporting data tables	Commonwealth Trawl Sector Includes management costs
Gold	Net economic returns	2008-2009	$3,839,848	Bath, A, Mobsby, D & Koduah, A (2018) Australian fisheries economic indicators report 2017: financial and economic performance of the Southern and Eastern Scalefish and Shark Fishery, ABARES, Canberra, April CC BY 4.0 Supporting data tables	Commonwealth Trawl Sector Includes management costs

Economic > Fishery Benefits > Gross Value of Production > Gross Value of Production

GVP calculated as the volume of catch multiplied by the average per unit beach price (AUD$).

Data Quality	Species/Fishery	Year	Amount	Reference	Note/Comment
Gold	CTS	2016-2017	$47.1 million	Bath, A, Mobsby, D & Koduah A (2018)) Australian fisheries economic indicators report 2017: Financial and economic performance of the Southern and Eastern Scalefish and Shark Fishery, ABARES, Canberra, April. CC BY 4.0. Supporting data tables	Nominal
Gold	CTS	2015-2016	$42.8 million	Bath, A, Mobsby, D & Koduah A (2018)) Australian fisheries economic indicators report 2017: Financial and economic performance of the Southern and Eastern Scalefish and Shark Fishery, ABARES, Canberra, April. CC BY 4.0. Supporting data tables	Nominal
Gold	CTS	2014-2015	$38.4 million	Bath, A, Mobsby, D & Koduah A (2018)) Australian fisheries economic indicators report 2017: Financial and economic performance of the Southern and Eastern Scalefish and Shark Fishery, ABARES, Canberra, April. CC BY 4.0. Supporting data tables	Nominal
Gold	CTS	2013-2014	$40.1 million	Bath, A, Mobsby, D & Koduah A (2018)) Australian fisheries economic indicators report 2017: Financial and economic performance of the Southern and Eastern Scalefish and Shark Fishery, ABARES, Canberra, April. CC BY 4.0. Supporting data tables	Nominal
Gold	CTS	2012-2013	$56.3 million	Bath, A, Mobsby, D & Koduah A (2018)) Australian fisheries economic indicators report 2017: Financial and economic performance of the Southern and Eastern Scalefish and Shark Fishery, ABARES,	Nominal

				Canberra, April. CC BY 4.0. Supporting data tables	
Gold	CTS	2011-2012	$50.6 million	Bath, A, Mobsby, D & Koduah A (2018)) Australian fisheries economic indicators report 2017: Financial and economic performance of the Southern and Eastern Scalefish and Shark Fishery, ABARES, Canberra, April. CC BY 4.0. Supporting data tables	Nominal
Gold	CTS	2010-2011	$48.6 million	Bath, A, Mobsby, D & Koduah A (2018)) Australian fisheries economic indicators report 2017: Financial and economic performance of the Southern and Eastern Scalefish and Shark Fishery, ABARES, Canberra, April. CC BY 4.0. Supporting data tables	Nominal
Gold	CTS	2009-2010	$55.7 million	Bath, A, Mobsby, D & Koduah A (2018)) Australian fisheries economic indicators report 2017: Financial and economic performance of the Southern and Eastern Scalefish and Shark Fishery, ABARES, Canberra, April. CC BY 4.0. Supporting data tables	Nominal
Gold	CTS	2008-2009	$55.9 million	Bath, A, Mobsby, D & Koduah A (2018)) Australian fisheries economic indicators report 2017: Financial and economic performance of the Southern and Eastern Scalefish and Shark Fishery, ABARES, Canberra, April. CC BY 4.0. Supporting data tables	Nominal
Gold	GHT	2016-2017	$25.3 million	Bath, A, Mobsby, D & Koduah A (2018)) Australian fisheries economic indicators report 2017: Financial and economic performance of the Southern and Eastern Scalefish and Shark Fishery, ABARES, Canberra, April. CC BY 4.0. Supporting data tables	Nominal
Gold	GHT	2015-2016	$22.4 million	Bath, A, Mobsby, D & Koduah A (2018)) Australian fisheries economic indicators report 2017: Financial and economic	Nominal

				performance of the Southern and Eastern Scalefish and Shark Fishery, ABARES, Canberra, April. CC BY 4.0. Supporting data tables	
Gold	GHT	2014-2015	$20.9 million	Bath, A, Mobsby, D & Koduah A (2018)) Australian fisheries economic indicators report 2017: Financial and economic performance of the Southern and Eastern Scalefish and Shark Fishery, ABARES, Canberra, April. CC BY 4.0. Supporting data tables	Nominal
Gold	GHT	2013-2014	$20.4 million	Bath, A, Mobsby, D & Koduah A (2018)) Australian fisheries economic indicators report 2017: Financial and economic performance of the Southern and Eastern Scalefish and Shark Fishery, ABARES, Canberra, April. CC BY 4.0. Supporting data tables	Nominal
Gold	GHT	2012-2013	$22 million	Bath, A, Mobsby, D & Koduah A (2018)) Australian fisheries economic indicators report 2017: Financial and economic performance of the Southern and Eastern Scalefish and Shark Fishery, ABARES, Canberra, April. CC BY 4.0. Supporting data tables	Nominal
Gold	GHT	2011-2012	$20.9 million	Bath, A, Mobsby, D & Koduah A (2018)) Australian fisheries economic indicators report 2017: Financial and economic performance of the Southern and Eastern Scalefish and Shark Fishery, ABARES, Canberra, April. CC BY 4.0. Supporting data tables	Nominal
Gold	GHT	2010-2011	$23.8 million	Bath, A, Mobsby, D & Koduah A (2018)) Australian fisheries economic indicators report 2017: Financial and economic performance of the Southern and Eastern Scalefish and Shark Fishery, ABARES, Canberra, April. CC BY 4.0. Supporting data tables	Nominal

Gold	GHT	2009-2010	$24.6 million	Bath, A, Mobsby, D & Koduah A (2018)) Australian fisheries economic indicators report 2017: Financial and economic performance of the Southern and Eastern Scalefish and Shark Fishery, ABARES, Canberra, April. CC BY 4.0. Supporting data tables	Nominal
Gold	GHT	2008-2009	$30.6 million	Bath, A, Mobsby, D & Koduah A (2018)) Australian fisheries economic indicators report 2017: Financial and economic performance of the Southern and Eastern Scalefish and Shark Fishery, ABARES, Canberra, April. CC BY 4.0. Supporting data tables	Nominal

Economic > Fishery Benefits > Profitability > Financial Performance

Economic health of a fishery can be measured by the financial performance of the operators in the fleet. Fleet wide averages or distributions of levels of profitability indicate the extent to which the fishery is generating economic benefits for fishers.

Data Quality	Indicator used	Year	Amount	Reference	Note
					See SESSFIcome.xlsx
Gold	Profit at full equity	2014-2015	$153,631 RSE (31)	Bath, A, Mobsby, D & Koduah, A (2018) Australian fisheries economic indicators report 2017: financial and economic performance of the Southern and Eastern Scalefish and Shark Fishery, ABARES, Canberra, April. CC BY 4.0 Supporting data tables	CTS Nominal average vessel level RSE are relative standard errors. An RSE will be higher for estimates closer to zero. A guide to interpreting RSEs is included in Appendix A of the main report
Gold	Profit at full equity	2013-2014	$131,041 RSE (37	Bath, A, Mobsby, D & Koduah, A (2018) Australian fisheries economic indicators report 2017: financial and economic performance of the Southern and Eastern	CTS Nominal average vessel level RSE are relative standard errors. An RSE will be higher for estimates closer to zero. A guide to

				Scalefish and Shark Fishery, ABARES, Canberra, April. CC BY 4.0 Supporting data tables	interpreting RSEs is included in Appendix A of the main report
Gold	Profit at full equity	2012-2013	$205,283 RSE (26)	Bath, A, Mobsby, D & Koduah, A (2018) Australian fisheries economic indicators report 2017: financial and economic performance of the Southern and Eastern Scalefish and Shark Fishery, ABARES, Canberra, April. CC BY 4.0 Supporting data tables	CTS Nominal average vessel level RSE are relative standard errors. An RSE will be higher for estimates closer to zero. A guide to interpreting RSEs is included in Appendix A of the main report
Gold	Profit at full equity	2011-2012	$197,850 RSE (31)	Bath, A, Mobsby, D & Koduah, A (2018) Australian fisheries economic indicators report 2017: financial and economic performance of the Southern and Eastern Scalefish and Shark Fishery, ABARES, Canberra, April. CC BY 4.0 Supporting data tables	CTS Nominal average vessel level RSE are relative standard errors. An RSE will be higher for estimates closer to zero. A guide to interpreting RSEs is included in Appendix A of the main report
Gold	Profit at full equity	2010-2011	$162,513 RSE (23)	Bath, A, Mobsby, D & Koduah, A (2018) Australian fisheries economic indicators report 2017: financial and economic performance of the Southern and Eastern Scalefish and Shark Fishery, ABARES, Canberra, April. CC BY 4.0 Supporting data tables	CTS Nominal average vessel level RSE are relative standard errors. An RSE will be higher for estimates closer to zero. A guide to interpreting RSEs is included in Appendix A of the main report
Gold	Profit at full equity	2009-2010	$165,142 RSE (20)	Bath, A, Mobsby, D & Koduah, A (2018) Australian fisheries economic indicators report 2017: financial and economic performance of the	CTS Nominal average vessel level RSE are relative standard errors. An RSE will be higher for estimates closer to

				Southern and Eastern Scalefish and Shark Fishery, ABARES, Canberra, April. CC BY 4.0 Supporting data tables	zero. A guide to interpreting RSEs is included in Appendix A of the main report
Gold	Profit at full equity	2008-2009	$242,128 RSE (31)	Bath, A, Mobsby, D & Koduah, A (2018) Australian fisheries economic indicators report 2017: financial and economic performance of the Southern and Eastern Scalefish and Shark Fishery, ABARES, Canberra, April. CC BY 4.0 Supporting data tables	CTS Nominal average vessel level RSE are relative standard errors. An RSE will be higher for estimates closer to zero. A guide to interpreting RSEs is included in Appendix A of the main report
Gold	Profit at full equity	2007-2008	$219,850 RSE (28)	Bath, A, Mobsby, D & Koduah, A (2018) Australian fisheries economic indicators report 2017: financial and economic performance of the Southern and Eastern Scalefish and Shark Fishery, ABARES, Canberra, April. CC BY 4.0 Supporting data tables	CTS Nominal average vessel level RSE are relative standard errors. An RSE will be higher for estimates closer to zero. A guide to interpreting RSEs is included in Appendix A of the main report

Economic > Fishery Benefits > Latency > Underutilised Effort

Latency is fishery concessions that are not being fully utilised by fishers, for example, often the annual total allowable catch is left partially or largely uncaught for a fishery. Latency may appear as effort or uncaught TAC or inactive licences.

Data Quality	Indicator used	Year	Amount	Reference	Note
Gold	Uncaught TAC	2014-2015	83% of TAC	Bath, A, Mobsby, D & Koduah A (2018) Australian fisheries economic indicators report 2017: financial and economic performance of the Southern and Eastern Scalefish and Shark Fishery,	Blue Grenadier (CTS)

				ABARES, Canberra, April. CC BY 4.0	
Gold	Uncaught TAC	2014-2015	2% of TAC	Bath, A, Mobsby, D & Koduah A (2018) Australian fisheries economic indicators report 2017: financial and economic performance of the Southern and Eastern Scalefish and Shark Fishery, ABARES, Canberra, April. CC BY 4.0	Eastern school whiting (CTS)
Gold	Uncaught TAC	2014-2015	2% of TAC	Bath, A, Mobsby, D & Koduah A (2018) Australian fisheries economic indicators report 2017: financial and economic performance of the Southern and Eastern Scalefish and Shark Fishery, ABARES, Canberra, April. CC BY 4.0	Flathead (CTS)
Gold	Uncaught TAC	2014-2015	2% of TAC	Bath, A, Mobsby, D & Koduah A (2018) Australian fisheries economic indicators report 2017: financial and economic performance of the Southern and Eastern Scalefish and Shark Fishery, ABARES, Canberra, April. CC BY 4.0	Pink ling (CTS and GHTS)
Gold	Uncaught TAC	2015	21 % of TAC	Bath, A, Mobsby, D & Koduah A (2018) Australian fisheries economic indicators report 2017: financial and economic performance of the Southern and Eastern Scalefish and Shark Fishery, ABARES, Canberra, April. CC BY 4.0	GHTS fishery
Gold	Uncaught TAC	2013	33% of TAC	Bath, A, Mobsby, D & Koduah A (2018) Australian fisheries economic indicators report 2017: financial and economic performance of the Southern and Eastern Scalefish and Shark Fishery,	GHTS fishery

				ABARES, Canberra, April. CC BY 4.0	
Gold	Uncaught TAC	2008	7% of TAC	Bath, A, Mobsby, D & Koduah A (2018) Australian fisheries economic indicators report 2017: financial and economic performance of the Southern and Eastern Scalefish and Shark Fishery, ABARES, Canberra, April. CC BY 4.0	Gummy shark (GHTS)

Economic > Community benefits > Value to community > GDP or GSP value

A fisheries contribution to Gross Domestic Production (GDP)/Gross State Product (GSP) is the total economic value that it generates directly, plus the indirect contribution made to other industries, which is also measured in value-add terms.

Data Quality: Not found

Economic > Community benefits > Wealth Spread > Distribution of fishing firm size

The spread of profits to owners and crew members indicates how widely benefits of fishing are distributed across the fishing community. A wide spread of benefits may be important to some fishery stakeholders. A narrow spread may not indicate a lack of distribution of benefits in the case where all participating businesses are the same size, or if other mechanisms are present to capture and distribute benefits such as high levels of employment of crew. The number of large business versus small business, classified by turnover (direct measure) or catch volume (proxy) may provide an indirect indicator: i.e. are economic returns from commercial fishing gained by one or two large businesses or a spread over many smaller businesses? **Data Quality:** Not released

Economic > Markets > Fish distribution > Fish receivers

One way of measuring benefits from a fishery is by assessing the flow of seafood through the supply chain. In many fishery jurisdictions, the first step in the supply chain is via licensed fish receivers who are allowed to receive fish for sale. They can also trade fish with other receivers. In some jurisdictions, commercial fishers must sell their catch to a receiver (although they can sell small amounts on wharves). While this restricts fishers' options for landing their catch, it means that fish can be tracked, reduces illegal fish trading and ensures that the Quota Management Systems (QMS) work effectively by ensuring catches do not exceed the total allowable catch or quota amounts for individual species. Receivers of fish may be fish processors, wholesalers or retailers.

In some jurisdictions, the fishers and fish receivers are integrated, such that they are effectively the same “business”. In Commonwealth fisheries, the total number of fish receivers per year may differ to the sum of the fish receivers per fishery because some receivers operate in more than one fishery.

Fish taken in the SESSF can only be landed or disposed of to holders of a Commonwealth Fish Receiver Permit (FRP). The FRP holder must verify the species and weight of all fish received and sign the **blue copy** of the Catch Disposal Record (CDR) immediately after the fish are received (within 50m of unload area unless the FRP holder has an 'exempt' certification). A CDR must be completed for each consignment of fish sent to each different receiver and all fish landed must be recorded on the CDR. After completing a CDR: the **white** copy (filled in by the permit holder or authorised agent) must be sent to AFMA within 3 calendar days of unloading. Data obtained from AFMA for this demonstration phased of the project for major sub-fisheries in the SESSF are:

	number of active fish receivers								
Fishery	2009	2010	2011	2012	2013	2014	2015	2016	2017
CTS	42	40	45	41	39	40	47	36	41
ECDW	2		3	1	1				
GHAT	83	91	101	87	78	88	88	73	85

Data Quality: Gold

Economic > Markets > Volatility in market price > Price volatility

Price volatility is the mean beach price for the target species (top one or five depending on price) over the given period (most recent ten years). The level of volatility is the standard deviation in mean price over this period.

Data Quality	Species/Fishery	Year/Time period	Amount	Reference	Note
Silver	SESSF- CTS	2007-08 to 2016-17	$0.4/kg	Bath, A, Mobsby, D & Koduah, A 2018, Australian fisheries economic indicators report 2017: financial and economic performance of the Southern and Eastern Scalefish and Shark Fishery, ABARES, Canberra, April. CC BY 4.0 Supporting data tables	Standard deviation in mean beach price 2007-2016
Silver	SESSF - GHT	2007-08 to 2016-17	$0.33/kg	Bath, A, Mobsby, D & Koduah, A 2018, Australian fisheries economic indicators report 2017: financial and economic performance of the Southern and Eastern Scalefish and Shark Fishery, ABARES, Canberra, April. CC BY 4.0 Supporting data tables	Standard deviation in mean beach price 2007-2016

Economics > Energy costs > Energy Use > Fuel use per kg of fish harvested

Fuel use varies over time and between stocks and are best collected from industry on a yearly basis. Estimates for different fisheries should be compared with caution, and in particular comparing energy use between fisheries with different data quality which is not recommended (different data availability, may be e.g. old or not fisheries-specific). Estimates are provided for all levels of data quality if available and are given in L per kg live-weight.

Data Quality	Gear	Target species	Min (L/kg)	Average (L/kg)	Max (L/kg)	Reference	Description
Gold	Otter trawl	Blue grenadier, tiger flathead		0.8		ABARES 2018	SESSF trawl sector, 2014/15
Silver	Otter trawl	Blue grenadier, tiger flathead		0.9		Parker et al 2015	Southeast finfish (CW), average 2008-2011
Bronze	Bottom trawl	Finfish	0.4	0.5	0.7	Parker and Tyedmers 2015	Oceania region

Economic > Energy costs > Fossil fuel subsidies > Fuel subsidies directed to the fishery

Fossil fuel subsidies (fuel rebates) illustrate to which extent the fuel cost is reduced in the fishery, measured in AUD/kg live weight fish. Note that this form of tax exemption for fisheries is in Australia motivated from the sector not using roads (i.e. costs embedded in fuel price for road construction and maintenance), and are not formally reported as fuel subsidies in Australia.

Data Quality	Gear	Target species	Subsidy (AUD/kg)	Reference	Description
Gold	Otter trawl	Blue grenadier, tiger flathead	0.31	ABARES 2018	Fuel use from SESSF trawl sector, 2014/15
Silver	Otter trawl	Blue grenadier, tiger flathead	0.36	Parker et al 2015	Fuel use from Southeast finfish trawl fishery (CW), average 2008-2011
Bronze	All SA	All SA	0.10	Total tax claims per total landings in SA	Assuming SA (closest), 2015-16 (2016-17 also available), state level figures on landings are preliminary for 2015-16

Governance > Ecosystem governance > Bycatch mitigation > Description of the bycatch mitigation measures

Bycatch measures can be spatial (e.g. area closure), temporal (time closure, e.g. night setting only) or technical (bycatch reduction devices, hook size). This indicator describes the measures that are in place for a fishery – but not the rates of compliance. For example, spatial closures for different gear types are shown here for AFMA fisheries http://www.afma.gov.au/sustainability-environment/fishing-closures/.

Bycatch and Discarding Workplans are developed in consultation with industry and research partners to find practical and affordable solutions to minimising bycatch and the discarding of target species. These fishery specific workplans focus on 'high risk' bycatch and threatened, endangered and protected species identified though the ecological risk assessment process and in accordance with the AFMA Bycatch Strategy: Mitigating protected species interactions and general bycatch 2017-2022.

There are Bycatch and Discard work plans for[42]:

Commonwealth Trawl Sector
Great Australian Bight Trawl Sector
Gillnet Hook and Trap sectors

Data Quality: Gold

Governance > Ecosystem governance > Protected species mitigation > Description of the protected species mitigation measures

TEP mitigation measures can be spatial (e.g. area closure), temporal (time closure, e.g. night setting only) or technical (bycatch reduction devices, hook size). This indicator describes the measures that are in place for a fishery – but not the rates of compliance.

The SESSF has management strategies developed by AFMA in consultation with the Department of the Environment and Energy and other stakeholders for:

Australian sea lions
Dolphins
Seabirds
Management strategies for the Australian Sea Lion include:

closures around each of the known Australian Sea Lion breeding colonies;
increased observer coverage and adaptive management zones;
depending on the area fished a vessel must have and AFMA approved electronic monitoring system operating at all times. [43]
Management strategies for Dolphins include completion of the Dolphin mitigation plan before fishing with gillnets.

Seabird mitigation measures include:

For automatic longline sector
An AFMA approved Seabird Management Plan must be on the vessel at all times
Tori lines must be deployed when setting
A bird excluder device must be deployed during the haul
Set at night only for remainder of trip if a seabird mortality occurs
Set at night only for the remainder of a TAP season if interaction rates exceeds 0.01 seabirds per 1000 hooks
All baits must be non-frozen

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[42] http://www.afma.gov.au/sustainability-environment/bycatch-discarding/bycatch-discard-workplans/
[43] https://www.afma.gov.au/sites/g/files/net5531/f/uploads/2018/04/SESSF-Management-Arrangements-Booklet-2018-FINAL.pdf

Offal must not be discharged while setting or hauling
For Demersal longline sector
Offal must not be discharged with setting or hauling
For Trawl fisheries (one of the following measures)
Bird baffers
Water sprayers
Pinkies with zero offal discharge

Data Quality: Gold

Governance > Management system > Harvest strategy > Scope of the harvest strategy

Assessment can be based on scoring presence of the following: a harvest strategy designed to achieve management objectives; harvest control rules and tools; collection of relevant information to support the harvest strategy; and, assessment of stock status or the presence of the following key elements: Defined operational objectives for the fishery; Indicators of fishery performance related to the objectives; Reference points for performance indicators; A statement defining acceptable levels of risk to meeting objectives; A monitoring strategy to collect relevant data to assess fishery performance; A process for conducting assessment of fishery performance relative to objectives; and; Decision rules that control the intensity of fishing activity and/or catch.

A tiered HSF has been applied in the SESSF since 2005[44]. The framework has evolved since its introduction, particularly after the release of the Commonwealth Fisheries Harvest Strategy Policy (HSP; DAFF 2007). The current SESSF HSF applies to all sectors and each stock under quota, and is assigned to one of five 'tiers' for assessment purposes under the HSF (AFMA 2014; Haddon et al. 2015). The assessment tiers have been developed to accommodate different levels of data quantity, quality or knowledge about stocks. Tier 1 assessments are the highest quality and use a fitted statistical catch-at-age model with high-quality data. Tier 2 are the same but with low-quality data. Tier 3 rely on analysis of catch curves, tier 4 on catch-per-unit-effort data and tier 5 on catch-only, model-assisted data-poor stock assessments. Although described in the HSF, tier 2 assessments are not currently applied in the SESSF.

Data Quality: Gold

Governance > Management system > Management plans > Scope of management plan

Management plans can be assessed by evaluating the presence of minimum requirements, as follows: a description of the fishery, especially its current status and any established user rights: the management objectives; how these objectives are to be achieved; how the plan is to be reviewed and/or appealed, as well as the consultation process for review and appeal.

The Southern and Eastern Scalefish and Shark Fishery is managed under the Southern and Eastern Scalefish and Shark Fishery Management Plan 2003[45] which contains the following minimum requirements:

Area of the fishery

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[44] http://www.agriculture.gov.au/abares/research-topics/fisheries/fishery-status/scalefish-shark-fishery#83-harvest-strategy-performance
[45] https://www.legislation.gov.au/Details/F2014C01078

Objectives (Act s 17 (5))
Measures by which objectives attained
Performance criteria for assessing measures to achieve objectives
Statutory fishing rights and fishing permits

Data Quality: Gold

Governance > Institutional capacity > Accountability of decision making bodies > Level of Accountability

Accountability of Decision-making bodies. Performance of a fisheries management agency is based on the degree to which decision-making processes are consultative, the basis for decisions are fully explained, and information about decision making is publicly available. The assessment applied the three tiers of Principle 3.2.2 (d) 'Decision-making process' of the MSC Fisheries Standard v2.0 (2014) to determine whether the level of accountability was low, medium or high.

High level of accountability. This is demonstrated by the availability of a management plan, assessment report and harvest strategy, and of decision-making procedures and outcomes online.

Data Quality: Silver

Governance > Institutional capacity > Uncertainty management > Extent of incorporation of uncertainty in management of the targeted stock

This metric reports on the explicit incorporation of uncertainties in decision support processes used to inform and make appropriate choices of management actions. We recognise three levels of uncertainty: Low level of incorporation of uncertainty; Medium level of incorporation of uncertainty; High level of incorporation of uncertainty. These are based on: Major sources of uncertainty are identified; Assessment takes uncertainty into account; Frequency of monitoring of indicators is high; Monitoring of more than one indicator to support management decisions; Assessment evaluates stock status relative to reference points in a probabilistic way; Robustness of assessments are tested, Alternative hypotheses and assessment approaches are rigorously explored.

Medium level of incorporation of uncertainty in management of the targeted stock, noting that this is a multi species multi gear fishery and the extent of incorporation of uncertainty varies across species.	The assessment applied Principle 1.2.4 (c & d) 'Assessment of stock status: Uncertainty in the Assessment' of the MSC Fisheries Standard v2.0 (2014) to assess extent of incorporation of uncertainty in management of the targeted stock.

Data Quality: Silver

Governance > Compliance > Compliance regime > Level of Compliance

Level of compliance with rules and regulations controlling catch can be assessed by audits that measure the agreement between 1) logbook and observer records; 2) catch disposal records submitted by fishers and fish receivers. It might also be assessed by counting the annual number of breaches/observed offences or enforcement actions, preferably scaled to the level of enforcement effort (e.g. $). This indicator can be scored on the basis of the presence of key monitoring, control and surveillance elements and capacities.

Catch taken in the SESSF can be verified using the catch disposal records. Data are taken from two different sources (receivers and permit holders) and then verified by AFMA. Holders of a Commonwealth Fish Receiver Permit (FRP) verify the species and weight of all fish received and sign the **blue copy** of the Catch Disposal Record (CDR) immediately after the fish are received (within 50m of unload area unless the FRP holder has an 'exempt' certification). A CDR must be completed for each consignment of fish sent to each different receiver and all fish landed in the ETBF must be recorded on the CDR. After completing a CDR: the **white** copy (filled in by the permit holder or authorised agent) must be sent to AFMA within 3 calendar days of unloading.

Data Quality: Gold

Governance > Compliance > Surveillance > Surveillance Effort

Regulatory controls include logs and catch reporting, on-board observer programs, vessel inspections, vessel monitoring systems, and visual or electronic surveillance using radar or satellite by boat or by air. Higher degrees of surveillance, or coverage using multiple methods, provide greater levels of certainty in estimates of effort, fishing mortality, bycatch and discard levels, and interactions with protected/listed species. Report on the surveillance carried out on the fishery, as reported by the compliance branch responsible for the fishery

Surveillance effort score: undefined
AFMA uses many methods to monitor the SESSF. These are on-board observers, satellite tracking and electronic monitoring.

On-board observers - One of the main monitoring methods used by AFMA is on-board scientific observers. Observers are people employed by AFMA to go out on boats and independently record catch, effort and biological information of each fishing trip. They take samples from fish, such as the otoliths or ear bones, and these are used later to determine the age of the fish caught. Observers also record the length, weight and sex of a sample of the fish caught during a trip and report on the other wildlife that may be seen, the weather conditions, the composition of commercial catch fate of species that are caught as bycatch. Boats in the Southern and Eastern Scalefish and Shark Fishery must carry an AFMA observer when requested by AFMA.

Satellite tracking - A satellite monitoring system called a Vessel Monitoring System, or VMS for short, is fitted on all concession holders boats. This system helps AFMA to monitor vessel position, course and speed. The system regularly transmits the information to a database at AFMA.

Electronic monitoring - AFMA has electronic monitoring systems on some fishing boats. These systems have sensors linked to surveillance cameras that record fishing activity. These recordings can then be collected and monitored by AFMA. Electronic monitoring gives fishers a cost effective way to support monitoring and data collection.[46]

Data Quality: Bronze

Governance > Adaptive capacity > Governance arrangements > Climate change recognition

Governance arrangements relevant to the fishery consider the impact of climate change on the fishery, as evidenced by documentation, policies and plans that describe how management is

[46] http://www.afma.gov.au/fisheries/southern-eastern-scalefish-shark-fishery/

addressing climate change impacts. Does the fishery management plan, harvest strategy or research activity suggest that climate change is recognised, and integrated into management planning?

The influence of the environment on the distribution and abundance of target species in this fishery have been documented in published literature, and species sensitivity assessments completed[47].

Impacts of climate change have been recognised by AFMA and the fishery. Fishery-specific plans are being developed under the AFMA –led project "Adaptation of Commonwealth Fisheries Management to Climate Change (FRDC 2016-059)". This project will conclude in June 2019.

The National Harvest Strategy also recognizes that "*Variability in ocean conditions, due to natural variability, climate change or other factors, can affect the productivity of stocks. Fisheries should seek to account for that variability when developing and implementing harvest strategies*"[48]. The Guidelines for the Harvest Strategy provide explicit approaches for fisheries[49].
Data quality: Silver

Governance > Adaptive capacity > Coping strategies > Climate responses

The fishery has initiated coping strategies (directed) to reduce the impacts of climate change. Evidence of strategies that have been specifically implemented for the fishery might include codes of practice, restocking programs, early warning systems, and so on. The coping strategies may be for long-term change or for extreme events. A description of the climate change responses that have been implemented or explored in research or application are provided.

The SESSF and the species targeted in this fishery have been studied with respect to climate change in a number of projects over the last 10 years. The influence of the environment on the distribution of target species in this fishery have been documented in published literature, and species sensitivity assessments completed[50]. The impact of changing reference points in stock assessments was explored for one species, Jackass Morwong[51], however, changes have not been formally included for the target species in the fishery.

Data quality: Silver

Social and Ethical > Fishers wellbeing > Fisher satisfaction > Satisfaction scores

If available, fishery specific surveys of well-being or satisfaction, with interpretation required for the types of questions and sample. When surveys are not available other sources of data may need to include broader surveys (e.g. not fishery specific) or discussions with industry representatives, managers or fishers about the industry and their opinion of general fisher-wellbeing (note this will be subjective).

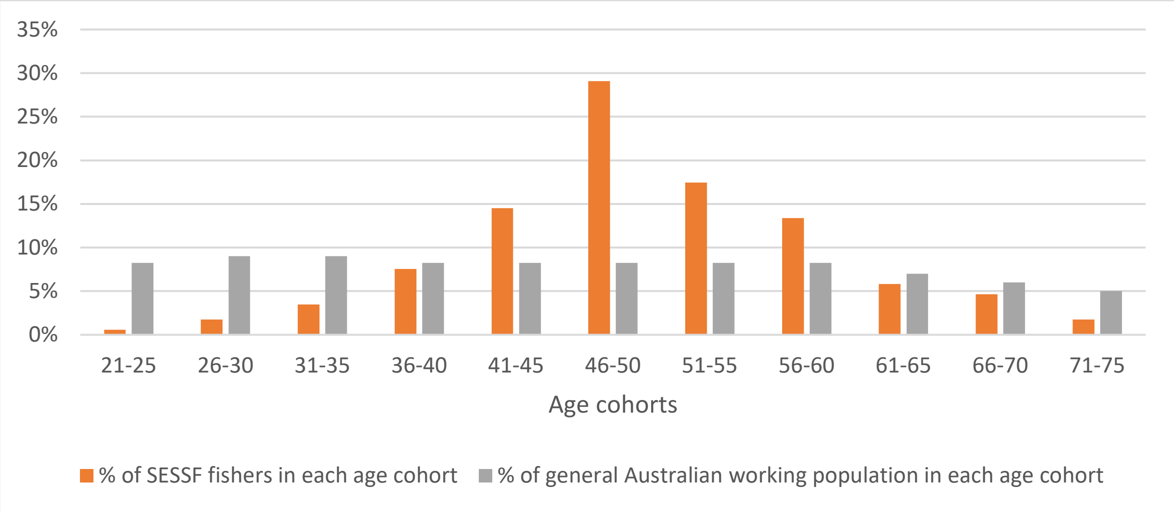
Data Quality: Not found

[47] www.frdc.com.au/Archived-Reports/FRDC%20Projects/2016-139-DLD.PDF
[48] Department of Agriculture and Water Resources 2018, *Commonwealth Fisheries Harvest Strategy Policy*, Canberra, June. CC BY 4.0.
[49] Department of Agriculture and Water Resources 2018, *Guidelines for the Implementation of the Commonwealth Fisheries Harvest Strategy Policy*, Canberra, June. CC BY 4.0.
[50] www.frdc.com.au/Archived-Reports/FRDC%20Projects/2016-139-DLD.PDF
[51] Wayte, S. (2013). Management implications of including a climate-induced recruitment shift in the stock assessment for jackass morwong (Nemadactylus macropterus) in south-eastern Australia. Fisheries Research **142**: 47–55 http://dx.doi.org/10.1016/j.fishres.2012.1007.1009.

Social and Ethical > Fishers wellbeing > Age Structure > Proportion of fishers in standard age cohorts

Proportion of fishers in standard age cohorts that were involved in the fishery at any point in the previous 5 years. If the fishery is not attractive or difficult to enter, the age distribution will be skewed to older ages.

The majority of fishers who were participating in the SESSF in 2016 were aged 46-50 years and older[52].



Data Quality: Gold

Social and Ethical > Wider community > Community satisfaction with fishery > Community feedback

Evidence of processes in place to gather direct engagement with the community (diversely represented) to listen and respond to feedback. This may be through a range of means including formal and informal processes and may not be appropriate to all fisheries in the same way. In some cases Marine Stewardship Council accreditation may demonstrate some evidence of community engagement.

Community feedback: Medium.

From discussions with the manager, there is no community conflict in this fishery but this may reflect a lack of awareness rather than endorsement. Based on general FRDC community perception surveys, satisfaction with Australian fisheries is rated at 42%.

Data quality: Bronze.

Social and Ethical > Wider Community > Level of local employment > Percentage of local employment

[52] Australian Bureau of Statistics (31010DO001_201606 Australian Demographic Statistics, Jun 2016) and Australian Fisheries Management Agency data records.

The communities surrounding and supporting fisheries benefit from those fisheries when the majority of employees (direct and indirect) associated with the fishery activity are local. Can be reported as direct, indirect and downstream levels. **Data Quality:** Not found

Social and Ethical > Ethical - Human welfare > Protections in place > Legislation exists

Although all workers are automatically operating under legislation according to their state or territory to a safe work place, the extent to which there is awareness of the relevant Acts, and use of these if required, is highly variable and may be different for each business or individual operation within each fishery. See http://workplaceohs.com.au/legislation for a list of state acts and regulations.

Protections in Place: Medium

The SESSF is a commonwealth fishery located off the coast of all states except the Northern Territory. It operates under Commonwealth regulations (administered by Comcare) – WHS Act 2011 and WHS Regulations 2011. State level requirements may also apply.

Data Quality: Gold

Social and Ethical > Ethical > Human welfare > Levels of compliance

Levels of compliance (or violations of) with Workplace Health and Safety. If references to Workplace Health and Safety exist in relation to the specific fishery, determine whether these are voluntary or recorded in anyway. If they are recorded, note the level of compliance. As they are likely to be voluntary, there will not likely be a record of compliance, but this may become more readily available in the future. **Data Quality:** Not found

Social and Ethical > Ethical-animal welfare > Animal welfare protections > Protections in place

At this early stage of development of animal welfare, any type of mention of animal welfare exists, it is probably the most appropriate. As this develops in to the future, assessments as to the level of engagement may become more relevant.

The SESSF follows AFMA's ethical bycatch handling guidelines.

Data Quality: Silver

Social and Ethical > Ethical-animal welfare > Level of Compliance > Levels of compliance or violations of animal welfare

If there are any references to animal welfare protections or guidelines in fishery management plans and if reports exist, the indicator reports on the level of compliance or violations with welfare provisions.

Data Quality: Not found.

Social and Ethical > Climate-related > Access to information > Availability of information

This indicator describes available information that will help participants in the fishery adapt to changes. The assumption behind this indicator is that good information availability and flow will help fishers to adapt.

Availability of information: High
AFMA maintains a website for this fishery.

Data Quality: Gold.

Social and Ethical > Climate-related > Access to networks > Level of membership of industry association

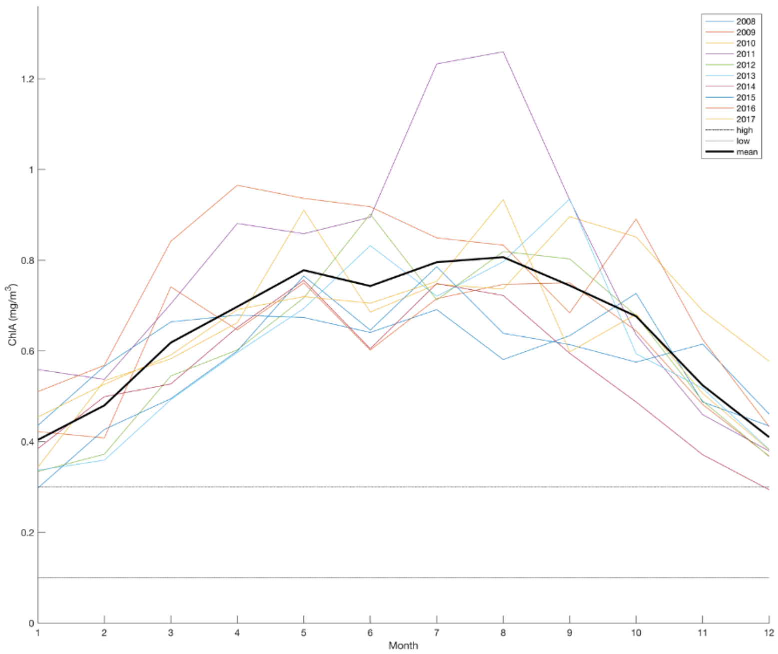
This metric assesses the presence or absence of a dedicated social media or social network group for the fishery. The fishery may still have a strong social network without a social media presence.

Network in place: Yes
AFMA is active on Facebook.

Data Quality: Bronze

External > Environmental Context > Productivity > Mean chlorophyll

A measure of environmental productivity is the biomass of phytoplankton, which in oceanic waters can be approximated by chlorophyll a concentration, as estimated from satellite (MODIS, oceandata.sci.gsfc.nasa.gov). Monthly chlorophyll values for a representative area of the fishery are shown with the mean productivity shown in solid black and references levels of low chlorophyll at 0.1 mg $m^{-3}$and high chlorophyll levels at 0.3 mg m^{-3}. This indicator shows the mean chlorophyll by month for the years 2008-2017. These data provide information on the relative environmental productivity in the fishery area. Missing data for some months can be due to ice cover. Variability in chlorophyll a concentration between years can indicate high environmental variability, while similar seasonal patterns indicate relative environmental stability.



Data Quality: Gold

External > Environmental Context > Environmental character > Description of the ecosystems

This metric provides a qualitative description of the ecosystem(s) in which the fishery occurs. The goal is to provide a general overview of these environments. The knowledge about which ecosystems are encountered during fishing activity is the indicator (rather than the response of the ecosystems to fishing).

Marine ecosystems are defined for the purposes of this indicator as the composition of plants, animals, and the marine environment (water masses, geomorphology). Types of marine ecosystems include estuaries, the sea floor, the mesopelagic zone, the pelagic zone, the inter-tidal zones, coral reefs, lagoons, and mangroves. A pelagic zone ecosystem for example, is defined by physical, chemical and biological features of the marine water column of the open ocean[53].

Description of the ecosystems: High

The Southern and Eastern Scalefish and Shark Fishery is a multi-sector, multi-species fishery that covers almost half of the Australian Fishing Zone. A range of ecosystems, from shallow sandy bottom, to rocky reef, and the edge of the continental shelf are covered[54].

Data Quality: Gold

External > Climate related > Susceptibility of target species > Impacts on target species

Climate change directly affects the distribution, abundance and phenology of individual species. These changes then affect the fisheries that harvest these species, and can be a strong external influence on the fishery. These impacts can be positive (e.g. increased abundance), or negative (e.g. movements further from fishing ports), and to long-term warming, or short-term extreme events such as marine heatwaves.

Sensitivity of some of the target species to climate change has been assessed[55]. Species in this fishery have sensitivities ranging from low to high.

Common name	Species	Fishery	Score	Sensitivity
Blue grenadier	Macruronus novaezelandiae	Southern and Eastern Scalefish and Shark Fishery (Commonwealth Trawl Sector)	6.25	HIGH

[53] Game, E. T., H. S. Grantham, A. J. Hobday, R. L. Pressey, A. T. Lombard, L. E. Beckley, K. Gjerde, R. H. Bustamante, H. P. Possingham and A. J. Richardson (2009). Pelagic protected areas: the missing dimension in ocean conservation. Trends in Ecology and Evolution **24**(7): 360-369 doi:310.1016/j.tree.2009.1001.1011.

[54] https://www.afma.gov.au/fisheries/southern-eastern-scalefish-shark-fishery

[55] Fulton EA, Hobday AJ, Pethybridge H, Blanchard J, Bulman C, Butler I, Cheung W, Gorton B, Hutton T, Lozano- Montes H, Matear R, Pecl G, Villanueva C, Zhang X (2018). *Decadal scale projection of changes in Australian fisheries stocks under climate change.* CSIRO Report to FRDC. FRDC Project No: 2016/139 – ONLINE.

Blue grenadier	Macruronus novaezelandiae	Southern and Eastern Scalefish and Shark Fishery (Great Australian Bight Trawl Sector)	6.25	HIGH
Tiger flathead	Platycephalus richardsoni	Southern and Eastern Scalefish and Shark Fishery (Commonwealth Trawl Sector)	5.25	MODERATE
Tiger flathead	Platycephalus richardsoni	Southern and Eastern Scalefish and Shark Fishery (Gillnet Hook and Trap Sector)	5.25	MODERATE
Gummy shark	Mustelus antarcticus	Southern and Eastern Scalefish and Shark Fishery (Gillnet Hook and Trap Sector)	6	MODERATELY HIGH
Australian sardine	Sardinops sagax	Southern and Eastern Scalefish and Shark Fishery (Commonwealth Trawl Sector)	5	LOW
Jack mackerel	Trachurus declivis	Southern and Eastern Scalefish and Shark Fishery (Commonwealth Trawl Sector)	5.75	MODERATELY HIGH
Jack mackerel	Trachurus declivis	Southern and Eastern Scalefish and Shark Fishery (Great Australian Bight Trawl Sector)	5.75	MODERATELY HIGH
Blue mackerel	Scomber australasicus	Southern and Eastern Scalefish and Shark Fishery (Commonwealth Trawl Sector)	5	LOW
Blue mackerel	Scomber australasicus	Southern and Eastern Scalefish and Shark Fishery (Great Australian Bight Trawl Sector)	5	LOW
Southern calamari	Sepioteuthis australis	Southern and Eastern Scalefish and Shark Fishery (Commonwealth Trawl Sector)	6	MODERATELY HIGH
Yellowtail kingfish	Seriola lalandi	Southern and Eastern Scalefish and Shark Fishery (Commonwealth Trawl Sector)	5.5	MODERATE
Yellowtail kingfish	Seriola lalandi	Southern and Eastern Scalefish and Shark Fishery (Gillnet Hook and Trap Sector)	5.5	MODERATE

Data Quality: Silver

External > Climate related > Susceptibility of key habitats > Habitat Impacts

Habitat impact: High

Studies showing changes to habitats have been published, and changes in the productivity of fishery habitats have been postulated[56].

Data Quality: Silver

External > Contaminants in the environment > Detection system for seafood contaminants > Risk of contaminants

Potential risk for contamination from the marine environment combined with monitoring arrangements to be able to address risks needed to ensure food safety. Contaminants include those with maximum levels set for by Food Standards Code Australia: metal contaminants, non-metal contaminants, natural toxicants, and average and maximum levels of mercury in fish. Contaminants from poor handling after landing are not assessed but may be indirectly addressed.

Rubric for risk level:

Low risk	Medium risk	High risk
There are no documented levels of contaminants from the marine environment causing risk/diet restrictions to any consumer group in the fishery.	There may be seasonal/area/species/size-based risks of contaminants for some species.	Permanent diet restrictions of species caught to vulnerable consumers such as children or pregnant women.

Risk of Contaminants: High

No specific monitoring arrangements found for marine contaminants on the fishery webpage: http://www.afma.gov.au/fisheries/southern-eastern-scalefish-shark-fishery/. High potential risk, several large pelagics (e.g. sharks, tunas) have high levels of mercury which cause diet restrictions to women and children.

Data Quality: Silver

External > Contaminants in the environment > Management arrangements to ensure food safety related to contaminants > Evidence for arrangements

There is evidence of management arrangements to ensure food safety related to contaminants and food safety from the marine environment. No supply chain risks from poor handling are considered. Food standard 4.2.1 requires all seafood business in Australia to identify potential seafood safety hazards and put controls in place that are consistent with the risk.

Data Quality: Not found

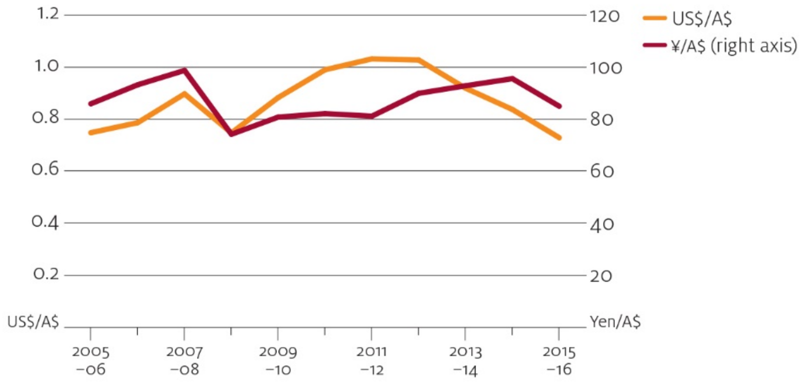
External > Market Drivers > Macroeconomic factors > Exchange Rates

A depreciating Australian dollar (or, increasing exchange rate) generally results in producers receiving a higher export price in Australian dollar terms, while an appreciating Australian dollar (or,

[56] Wayte, S. (2013). Management implications of including a climate-induced recruitment shift in the stock assessment for jackass morwong (Nemadactylus macropterus) in south-eastern Australia. Fisheries Research **142**: 47–55 http://dx.doi.org/10.1016/j.fishres.2012.1007.1009.

decreasing exchange rate) results in a lower export price. Domestically, a depreciation of the Australian dollar encourages substitution from imported seafood to domestically produced seafood, as imported products become relatively more expensive. A lower exchange rate also makes Australian exports more competitive in world markets, as exported seafood become relatively cheaper in foreign currency terms.

National export trends are negatively related to exchange rate movements— the Australian dollar declined against the US dollar and Japanese yen from 1990–91 to 2000–01, with exports increasing in volume and value. Exchange rates for the Australian dollar increased against those currencies from 2001–02 to 2015–16. The real export value and volume of Australia's seafood exports decreased between 2005–06 and 2012–13 and then increased between 2012–13 and 2015–16—with a noticeable rise (43 per cent) in volume between 2014–15 and 2015–16.[57]



Data Quality: Gold

External > Market Drivers > Consumer Trends > Per person annual apparent consumption of seafood (kg)

Annual apparent consumption is estimated by adding the total edible quantity of seafood supplied domestically—that is, total production plus imported seafood— less exports of seafood. Apparent consumption provides an estimate of the total amount of seafood consumed in Australia assuming zero change in stocks.

The production quantity of Australian fishery and aquaculture products is reported by ABARES on a whole weight basis, whereas trade data are reported on a processed basis. To align the units of measurement between production and trade data, it is necessary to convert production volume to a processed edible equivalent.

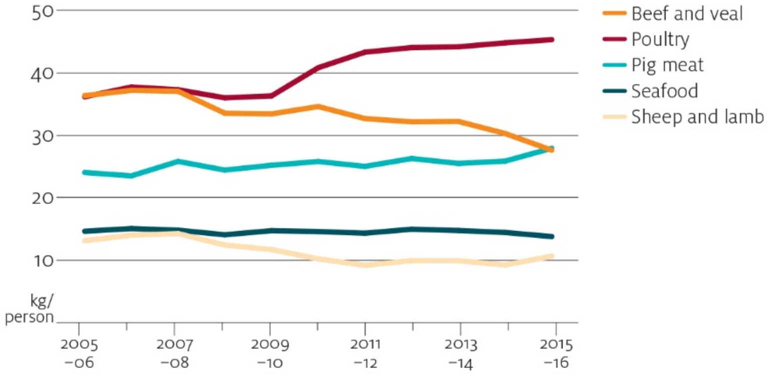
Production volumes are adjusted to an edible quantity basis using species-specific conversion rates and excluding species that are known to be predominantly supplied for non-human consumption purposes, such as for aquaculture feed or bait. Imports and exports of seafood are sourced from Australian Bureau of Statistics (ABS) trade data and are reported as edible weight. The apparent consumption per person is calculated as the total apparent consumption divided by the total Australian population in each year. The method applied here is consistent with that used by ABARES to estimate apparent consumption of other agricultural commodities produced in Australia.

[57] Mobsby, D and Koduah, A 2017, Australian fisheries and aquaculture statistics 2016, FRDC project 2017-095. ABARES, Canberra, December. CC BY 4.0.

The FAO also compiles statistics on apparent consumption of seafood, applying a consistent method across all countries. FAO estimates indicate that annual consumption of seafood in Australia is around 26 kilograms per person in 2013 (FAO 2016[58]). The discrepancy between FAO and ABARES estimates reflects differences in methodological approaches to estimating consumption. Moreover, ABARES estimates seafood consumption on a processed edible basis, whereas the FAO provides its estimates on a whole weight basis.

In Australia, apparent consumption of seafood per person (edible equivalent) decreased, on average, at an annual rate of 0.6 per cent, from 14.6 kilograms in 2005– 06 to 13.8 kilograms per person in 2015–16. Annual apparent consumption is estimated by the Australian Bureau of Agricultural and Resource Economics and Sciences by adding the total edible quantity of seafood supplied domestically—that is, total production plus imported seafood— less exports of seafood[59]

In comparison, global per capita apparent fish consumption increased from an average of 9.9 kg in the 1960s to 14.4 kg in the 1990s and 20.1 kg in 2014, with preliminary estimates for 2015 indicating further growth, exceeding 20 kg (FAO 2016). Australia's per person seafood consumption in 2013 was estimated by the FAO to be 26kg. The differences in estimates are accounted for by varying methods for calculating consumption. ABARES estimates seafood consumption on a processed edible basis, whereas the FAO provides its estimates on a whole weight basis.



Data quality: Gold

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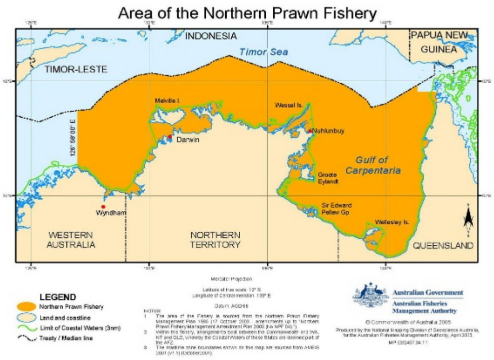
[58] The state of world fisheries and aquaculture 2016—opportunities and challenges, Food and Agriculture Organization of the United Nations, Rome.

[59] Mobsby, D and Koduah, A 2017, *Australian fisheries and aquaculture statistics 2016*, FRDC 2017-095. ABARES, Canberra, December. CC BY 4.0

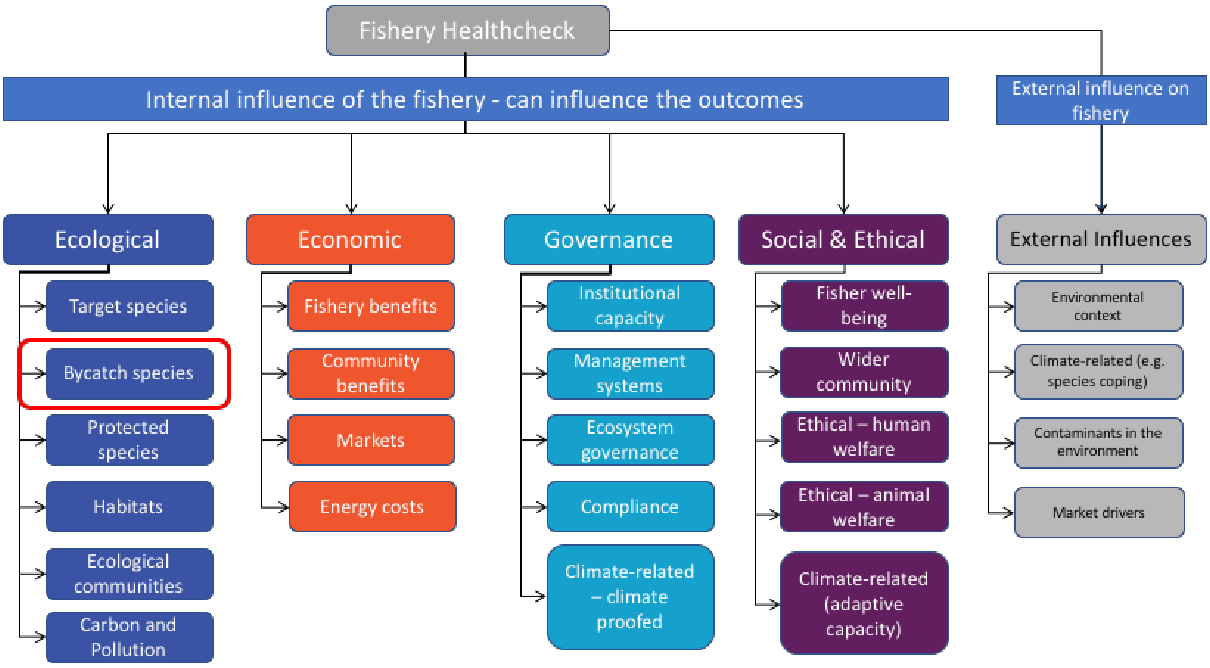
Commonwealth Northern Prawn Fishery

The **Commonwealth Northern Prawn Fishery** extends from Cape York in Queensland to Cape Londonderry in Western Australia and is the Commonwealth's most valuable fishery, with a commercial value of $100m annually. The fishery has a mature management framework and is Marine Stewardship Council and EPBC Act certified 'There is a management plan and fully transferable statutory fishing rights based on boat access and the allowable net size (TAE management). A harvest strategy, observer program, independent monitoring program and data collection program supports stock assessment. There are closed seasons and permanent closures to protect juveniles and recruitment. A Management Advisory Committee and Resource Assessment Group with stakeholder expertise provides policy and scientific advice to the AFMA Commission. This is a single sector fishery, single gear type trawl fishery and multi-species fishery, with sub-fisheries targeting white banana, tiger, endeavour and red-legged banana prawns. Catch is exported and sold on the domestic market. The NPF stock assessment is a bio-economic model based on tiger and endeavour prawns to pursue maximum economic yield and a trigger limit to manage optimum season length. The peak industry body participates in functions and management activities through a co-management arrangement. (Source: Fisheries Guidelines Project).



Case Study Presentation Format

The case study documents are a collection of metrics, organised by the healthcheck structure:



The presentation of metrics will follow the following heading format:

Ecological > Bycatch species > Bycatch composition > Mean Trophic Level

Understand this to be an indicator (**Bycatch composition**) of the **Ecological** Component, **Bycatch species** subcomponent where the (in the figure and heading example above, is being measured by presenting Mean Trophic Level as the metric.

Ecological > Target species > Stock Status > Status of Australian Fish Stocks (SAFS)

Target species in each fishery are the primary focus for this indicator. Status of these species is ideally assessed with the SAFS approach, however this may not cover all target species for each fishery. In that case, we indicate the number of unassessed species. These species could also be assessed by individual states or by alternative methods.

SpeciesName	StockName	StockStatus	Year
Banana Prawn	Northern Prawn Fishery	Sustainable	2016
Blue Endeavour Prawn	Northern Prawn Fishery (Blue Endeavour Prawn)	Sustainable	2016
Brown Tiger Prawn	Northern Prawn Fishery (Brown Tiger Prawn)	Sustainable	2016
Grooved Tiger Prawn	Northern Prawn Fishery (Grooved Tiger Prawn)	Sustainable	2016

MORETON BAY BUGS	Northern Prawn Fishery	Sustainable	2016
Red Endeavour Prawn	Northern Prawn Fishery (Red Endeavour Prawn)	Undefined	2016

Data Quality: Gold

Ecological > Target Species > Harvest Level > Catch weight

This metric is a proxy for harvest level. The harvested biomass for each species, provides information on the level of the catch. Trends in this metric over time can indicate declining availability of fish, quota restrictions, or changes in market demand. For Australian fisheries, trends are expected to be stable for most species.

The catch of species that are targeted by commercial fishers in the Northern Prawn Fishery (http://www.afma.gov.au/fisheries/northern-prawn-fishery/) are:

Banana prawns (*Fenneropenaeus merguiensis*, *F. indicus*)

Tiger prawns (*Penaeus esculentus*, *P. semisulcatus*)

Endeavour prawns (*Metapenaeus endeavouri*, *M. ensis*)

The recent catch history is:

Species	2013	2014	2015	2016	2017
Banana prawns	3050	6245	3931	2904	5069
Tiger prawns	2215	1688	3168	2158	1087
Endeavour prawns	508	677	554	374	382

Data quality: Gold

Ecological > Bycatch species > Bycatch composition > Mean Trophic Level

The trophic level is a measure of the position of an organism in a food web, starting at level 1 with primary producers, such as phytoplankton, then moving through the primary consumers at level **2** that eat the primary producers to the secondary consumers at level **3** that eat the primary consumers, and so on. The **bycatch mean trophic level** is an indicator of the mean level of the food chain for bycatch in a fishery. **Data Quality:** Not organised/analysed.

Ecological > Bycatch species > Bycatch amount > Total weight of bycatch

Bycatch weights for fishery are typically developed by specific projects, and require a range of assumptions due to issues with reporting and retention of bycatch. **Bycatch** estimates typically cover species that are not target species, while **discard** rates may also include undersized individuals of the target species. Kennelly (2018) provides estimates of discard rates, which include both target and bycatch species, and when discard rates are used, that information is noted for each fishery. Animals can be returned to the ocean alive or dead. The intention of this metric is to provide information on animals that are dead on return to the ocean.

Reference:

Kennelly, S.J., 2018. *Developing a National Bycatch Reporting System.* Final FRDC Report, ISBN 978-0-9924930-5-9, March, 2018. 99 pp.

These data are available for the fishery, but the project team has not compiled a summary. A continuation of Kennelly (2018) is underway and will provide these data shortly.

Data Quality: Not organised/analysed

Ecological > Protected species > Capture amount > Captures

The number and diversity of TEP species captured by a fishery in the most recent year, provided as annual numbers.

As a commonwealth managed fishery, interactions are reported quarterly here.

In 2017, the reported number of protected species interactions by quarter is:

QUARTER 1

No protected species interaction occurred.

QUARTER 2

Northern Prawn Fishery

Gear Type	Common name	Total	Life status				Interaction type[1]	Comments
			Alive	Dead	Injured	Unknown		
Prawn Trawl	Freshwater Sawfish	**24**	24				Netted	
	Green Sawfish	**7**	7				Netted	-
	Green Turtle	**3**	3				Netted	-
	Narrow Sawfish	**18**	11	7			Netted	-
	Sawfishes	**150**	68	82			Netted	-
	Seahorses & pipefishes	**3**	1	2			Netted	-
	Seasnakes	**1351**	1015	334	2		Netted	-
	Turtles	**9**	9				Netted	-
	Total interactions	**1565**	**1138**	**425**	**2**			

QUARTER 3

Northern Prawn Fishery

Gear Type	Common name	Total	Life status				Interaction type[1]	Comments
			Alive	Dead	Injured	Unknown		
Prawn Trawl	Dwarf Sawfish	2	2				Netted	-
	Flatback Turtle	3	1			2	Netted	-
	Freshwater Sawfish	1					Netted	-
	Green Sawfish	9	7	2			Netted	-
	Green Turtle	3	3				Netted	-
	Hawksbill Turtle	1	1				Netted	-
	Loggerhead Turtle	2	2				Netted	-
	Narrow Sawfish	56	49	7			Netted	-
	Pacific (Olive) Ridely Turtle	3	3				Netted	-
	Sawfishes	125	90	35			Netted	-
	Seahorses & pipefishes	43	23	20			Netted	-
	Seasnakes	3955	3079	872		4	Netted	-
	Terns	1	1				Landed on vessel	-
	Turtles	19	18	1			Netted	-
	Total interactions	4223	3280	937		6		

QUARTER 4

Northern Prawn Fishery

Gear Type	Common name	Total	Life status				Interaction type[1]	Comments
			Alive	Dead	Injured	Unknown		
Prawn Trawl	Flatback Turtle	1	1				Netted	-
	Freshwater Sawfish	4	4				Netted	-
	Green Sawfish	5	5				Netted	-
	Green Turtle	3	3				Netted	-
	Leatherback Turtle	1	1				Netted	-
	Narrow Sawfish	52	39	13			Netted	-
	Pacific (Olive) Ridley Turtle	3	3				Netted	-
	Sawfishes	53	43	10			Netted	-
	Seahorses & Pipefishes	3	1	1		1	Netted	-
	Seasnakes	3745	2731	973		41	Netted	-
	Turtles	12	12				Netted	-
	Total Interactions	3882	2843	997	0	42		

The ABARES fishery status report for this fishery[60] state

"In the NPF in the 2017 calendar year, 63 turtle interactions were reported, and all but 3 of these turtles were released alive; 506 sawfish were caught, of which 350 were released alive and the remainder were dead; and 9,051 sea snakes were caught, of which 6,825 were released alive, 2 were injured, 45 had an unknown life status and the remainder were dead. Reports also indicate that 49 seahorses or pipefish were caught—23 were dead, 25 were released alive and 1 was released in an unknown condition."

Data quality: Gold

Ecological > Protected species > Reporting > Level of monitoring

This indicator is to provide information on the level of coverage for a fishery. Annual measures are preferred.

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60 http://data.daff.gov.au/data/warehouse/9aam/fsrXXd9abm_/fsr18d9abm_20180928/05_FishStatus2018NthnPrawn_1.0.0.pdf

AFMA uses many methods to monitor the compliance of fishing activities and collect data on fish stocks. The method used in the Northern Prawn Fishery is on-board observers. Boats in the Northern Prawn fishery must carry an AFMA observer when requested by AFMA[61].

Observer coverage in the Northern Prawn Fishery						
Observer	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**
Crew member observers	962 days	1083 days	843 days	1058 days	893 days	1169 days
Scientific observers	167 days	168 days	117 days	159 days	103 days	152 days

Data quality: Silver

Ecological > Habitats > Habitat impact > Impact score

The habitat impact is an indicator of the effect the fishing gear has on the habitat. Different gear types have different impacts. See the scoring rubric.

Habitat Impact: Moderate

Northern Prawn habitats were assessed at level 2[62], with gold standard data, but it is more than 5 years old, so data quality is downgraded to bronze.

PSA (productivity and susceptibility) risk categories for the habitat component.

Risk Category	High	Medium	Low	Total
Total Habitats	0	81	76	157

Data quality: Bronze

Ecological > Habitats > Habitat impact > Habitat status

The status of the habitat types is a measure of the condition relative to a pristine state. Fishing may not be responsible for that habitat status, but it is important to note if fishing is taking place in pristine or disturbed habitats.

Habitat status: Moderate

Data quality: Bronze

Ecological > Ecological communities > Ecosystem status > Ecosystem status

This metric reports the ecosystem status in the region of the fishery.

Ecosystem Status: Good, but declining in some regions

Ongoing assessments of ecosystem impact have been undertaken as part of fisheries assessments, scientific surveys and resulted in MSC certification for the fishery (re-certified in 2018). At the coast,

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[61] http://www.afma.gov.au/fisheries/northern-prawn-fishery/

[62] Griffiths, S., Kenyon, R., Bulman, C., Dowdney, J., Williams, A., Sporcic, M. and Fuller, M. (2007) Ecological Risk Assessment for the Effects of Fishing: Report for the Northern Prawn Fishery. Report for the Australian Fisheries Management Authority, Canberra. Available from http://www.afma.gov.au/sustainability-environment/ecological-risk-management-strategies/

recent mangrove dieoffs covering almost 1/3 of the distribution in the Gulf of Carpentaria[63], have reduced ecosystem function and will take many years to recover.

Data Quality: Gold

Ecological > Ecological communities > Ecosystem status > Species diversity

The measure of species diversity as a ratio between fished and unfished states.

Data quality: Not organised/analysed

Ecological > Carbon and Pollution > Macro-plastics > Plastic code of conduct

Macro-plastics are plastics that are visible to the naked eye, such as food containers and wrapping, equipment packaging, and fishing equipment. The metric notes a commitment to a zero waste overboard code of conduct to assess attempts to reduce accidental or intentional introduction of macro-plastics to the ocean. There are stated guidelines detailing Australia's guidelines regarding marine pollution from the Australian Maritime Safety Authority[64]:

Pollution of the marine environment by ships, including fishing vessels, is strictly controlled by the International Convention for the Prevention of Pollution from Ships (known as MARPOL).

To minimise pollution, MARPOL prohibits ships from discharging garbage into the sea except in very limited circumstances.

Australian MARPOL regulations apply to Australian fishing vessels wherever they are operating.

Data Quality: Bronze

Ecological > Carbon and Pollution > Carbon footprint > CO_2-equivalents

The emissions of climate forcing gases in kg CO_2-equivalents (CO_2e) per kg live weight fish caught, not including the supply chain after landing.

Data Quality	Gear	Target species	Min (kg CO_2e/kg)	Average (kg CO_2e/kg)	Max (kg CO_2e/kg)	Reference	Description
Gold							
Silver	Bottom trawl	Banana prawn		4.2		Farmery et al 2015	Northern prawn (CW), 2009-

[63] Duke, N. C., Kovacs, J. M., Griffiths, A. D., Preece, L., Hill, D. J. E., Van Oosterzee, P., … Burrows, D. (2017). Large-scale dieback of mangroves in Australia's Gulf of Carpentaria: A severe ecosystem response, coincidental with an unusually extreme weather event. *Marine and Freshwater Research*, *68*(10), 1816–1829. https://doi.org/10.1071/MF16322

[64] https://www.amsa.gov.au/marine-environment/marine-pollution/pollution-fishing-vessels
https://www.amsa.gov.au/marine-environment/marine-pollution/marpol-and-its-implementation-australia

							2011, includes emissions from fishing and spotter planes, not refrigerants.
Silver	Bottom trawl	Tiger prawn		32		Farmery et al 2015	Northern prawn (CW), 2009-2011, includes emissions from fishing and spotter planes, not refrigerants.
Bronze	Bottom trawl	Crustaceans	3.2	11.2	29.6	Parker and Tyedmers 2015	Oceania region, year not specified, assuming diesel, refrigerants not included.

Economic > Fishery Benefits > Net Economic Returns > Economic Rent

Net Economic Returns (NER) is equal to fishing revenue less fishing costs and measures the economic profit that is derived from fishing activity, it is measured by the Commonwealth as Net Economic Returns and by some States as Economic Rent.

Data Quality	Indicator	Year	Amount	Reference	Note
Gold	Net economic returns	2014-2015	$12,267,108	Bath, A & Green, R (2016) Australian fisheries economic indicators report 2015: financial and economic performance of the Northern Prawn Fishery, Australian Bureau of Agricultural and Research Economics and Sciences, Canberra, December. CC BY 3.0 Supporting data tables	Preliminary Includes management costs
Gold	Net economic returns	2013-2014	$12,249,989	Bath, A & Green, R (2016) Australian fisheries economic indicators report 2015: financial and economic performance of the Northern Prawn Fishery, Australian Bureau of Agricultural and	Includes management costs

				Research Economics and Sciences, Canberra, December. CC BY 3.0 Supporting data tables	
Gold	Net economic returns	2012-2013	$5,126,173	Bath, A & Green, R (2016) Australian fisheries economic indicators report 2015: financial and economic performance of the Northern Prawn Fishery, Australian Bureau of Agricultural and Research Economics and Sciences, Canberra, December. CC BY 3.0 Supporting data tables	Includes management costs
Gold	Net economic returns	2011-2012	-$3,749,327	Bath, A & Green, R (2016) Australian fisheries economic indicators report 2015: financial and economic performance of the Northern Prawn Fishery, Australian Bureau of Agricultural and Research Economics and Sciences, Canberra, December. CC BY 3.0 Supporting data tables	Includes management costs
Gold	Net economic returns	2010-2011	$5,849,042	Bath, A & Green, R (2016) Australian fisheries economic indicators report 2015: financial and economic performance of the Northern Prawn Fishery, Australian Bureau of Agricultural and Research Economics and Sciences, Canberra, December. CC BY 3.0 Supporting data tables	Includes management costs
Gold	Net economic returns	2009-2010	$13,158,252	Bath, A & Green, R (2016) Australian fisheries economic indicators report 2015: financial and economic performance of the Northern Prawn Fishery, Australian Bureau of	Includes management costs

				Agricultural and Research Economics and Sciences, Canberra, December. CC BY 3.0 Supporting data tables	
Gold	Net economic returns	2008-2009	$5,533,744	Bath, A & Green, R (2016) Australian fisheries economic indicators report 2015: financial and economic performance of the Northern Prawn Fishery, Australian Bureau of Agricultural and Research Economics and Sciences, Canberra, December. CC BY 3.0 Supporting data tables	Includes management costs

Economic > Fishery Benefits > Gross Value of Production > Gross Value of Production

GVP calculated as the volume of catch multiplied by the average per unit beach price (AUD$).

Data Quality	**Species/Fishery**	**Year**	**Amount**	**Reference**	**Note/Comment**
Gold	Northern Prawn	2014-2015	$106.8 million	Bath, A & Green, R (2016) Australian fisheries economic indicators report 2015: financial and economic performance of the Northern Prawn Fishery, Australian Bureau of Agricultural and Research Economics and Sciences, Canberra, December. CC BY 3.0. Supporting data tables	(2014-2015 dollars)
Gold	Northern Prawn	2013-2014	$117.2 million	Bath, A & Green, R (2016) Australian fisheries economic indicators report 2015: financial and economic performance of the Northern Prawn Fishery, Australian Bureau of Agricultural and Research Economics and Sciences, Canberra, December. CC BY 3.0. Supporting data tables	(2014-2015 dollars)
Gold	Northern Prawn	2012-2013	$74.2 million	Bath, A & Green, R (2016) Australian fisheries economic indicators report 2015:	(2014-2015 dollars)

				financial and economic performance of the Northern Prawn Fishery, Australian Bureau of Agricultural and Research Economics and Sciences, Canberra, December. CC BY 3.0. Supporting data tables	
Gold	Northern Prawn	2011-2012	$69.1 million	Bath, A & Green, R (2016) Australian fisheries economic indicators report 2015: financial and economic performance of the Northern Prawn Fishery, Australian Bureau of Agricultural and Research Economics and Sciences, Canberra, December. CC BY 3.0. Supporting data tables	(2014-2015 dollars)
Gold	Northern Prawn	2010-2011	$103.7 million	Bath, A & Green, R (2016) Australian fisheries economic indicators report 2015: financial and economic performance of the Northern Prawn Fishery, Australian Bureau of Agricultural and Research Economics and Sciences, Canberra, December. CC BY 3.0. Supporting data tables	(2014-2015 dollars)
Gold	Northern Prawn	2009-2010	$100.1 million	Bath, A & Green, R (2016) Australian fisheries economic indicators report 2015: financial and economic performance of the Northern Prawn Fishery, Australian Bureau of Agricultural and Research Economics and Sciences, Canberra, December. CC BY 3.0. Supporting data tables	(2014-2015 dollars)
Gold	Northern Prawn	2008-2009	$85.3 million	Bath, A & Green, R (2016) Australian fisheries economic indicators report 2015: financial and economic performance of the Northern Prawn Fishery, Australian Bureau of Agricultural and Research Economics and Sciences, Canberra,	(2014-2015 dollars)

				December. CC BY 3.0. Supporting data tables	

Economic > Fishery Benefits > Profitability > Financial Performance

Economic health of a fishery can be measured by the financial performance of the operators in the fleet. Fleet wide averages or distributions of levels of profitability indicate the extent to which the fishery is generating economic benefits for fishers.

Data Quality	Indicator used	Year	Amount	Reference	Note
Gold	Profit at full equity	2013-2014	\$389,502 RSE (13)	Bath, A & Green, R (2016) Australian fisheries economic indicators report 2015: financial and economic performance of the Northern Prawn Fishery, ABARES, Canberra, December. CC BY 3.0 Supporting data tables	Vessel level average (2014-15 dollars) RSE are relative standard errors. An RSE will be higher for estimates closer to zero. A guide to interpreting RSEs is included in Appendix B of the main report.
Gold	Profit at full equity	2012-2013	\$249,763 RSE (24)	Bath, A & Green, R (2016) Australian fisheries economic indicators report 2015: financial and economic performance of the Northern Prawn Fishery, ABARES, Canberra, December. CC BY 3.0 Supporting data tables	Vessel level average (2014-15 dollars) RSE are relative standard errors. An RSE will be higher for estimates closer to zero. A guide to interpreting RSEs is included in Appendix B of the main report.
Gold	Profit at full equity	2011-2012	\$98,161 RSE (28)	Bath, A & Green, R (2016) Australian fisheries economic indicators report 2015: financial and economic performance of the Northern Prawn Fishery, ABARES, Canberra, December. CC BY 3.0 Supporting data tables	Vessel level average (2014-15 dollars) RSE are relative standard errors. An RSE will be higher for estimates closer to zero. A guide to interpreting RSEs is included in Appendix B of the main report.
Gold	Profit at full equity	2010-2011	\$344,769 RSE (12)	Bath, A & Green, R (2016) Australian fisheries economic indicators report 2015: financial and economic	Vessel level average (2014-15 dollars) RSE are relative standard errors. An RSE will be higher

				performance of the Northern Prawn Fishery, ABARES, Canberra, December. CC BY 3.0 Supporting data tables	for estimates closer to zero. A guide to interpreting RSEs is included in Appendix B of the main report.
Gold	Profit at full equity	2009-2010	$322,825 RSE (-12)	Bath, A & Green, R (2016) Australian fisheries economic indicators report 2015: financial and economic performance of the Northern Prawn Fishery, ABARES, Canberra, December. CC BY 3.0 Supporting data tables	Vessel level average (2014-15 dollars) RSE are relative standard errors. An RSE will be higher for estimates closer to zero. A guide to interpreting RSEs is included in Appendix B of the main report.
Gold	Profit at full equity	2008-2009	$242,420 RSE (-20)	Bath, A & Green, R (2016) Australian fisheries economic indicators report 2015: financial and economic performance of the Northern Prawn Fishery, ABARES, Canberra, December. CC BY 3.0 Supporting data tables	Vessel level average (2014-15 dollars) RSE are relative standard errors. An RSE will be higher for estimates closer to zero. A guide to interpreting RSEs is included in Appendix B of the main report.

Economic > Fishery Benefits > Latency > Underutilised Effort

Latency is fishery concessions that are not being fully utilised by fishers, for example, often the annual total allowable catch is left partially or largely uncaught for a fishery. Latency may appear as effort or uncaught TAC or inactive licences.

Data Quality	Indicator used	Year	Amount	Reference	Note
Bronze	Fishing right latency in fishing season	2015-2016	low unused effort	Patterson, H, Noriega R, Georgeson, L, Larcombe, J and Curtotti, R (2017) Fishery status reports 2017, Australian Bureau of Agricultural and Resource Economics and Sciences, Canberra. CC BY 4.0	

Economic > Community benefits > Value to community > GDP or GSP value

A fisheries contribution to Gross Domestic Production (GDP)/Gross State Product (GSP) is the total economic value that it generates directly, plus the indirect contribution made to other industries, which is also measured in value-add terms.

Data Quality: Not found

Economic > Community benefits > Wealth Spread > Distribution of fishing firm size

The spread of profits to owners and crew members indicates how widely benefits of fishing are distributed across the fishing community. A wide spread of benefits may be important to some fishery stakeholders. A narrow spread may not indicate a lack of distribution of benefits in the case where all participating businesses are the same size, or if other mechanisms are present to capture and distribute benefits such as high levels of employment of crew. The number of large business versus small business, classified by turnover (direct measure) or catch volume (proxy) may provide an indirect indicator: i.e. are economic returns from commercial fishing gained by one or two large businesses or a spread over many smaller businesses? **Data Quality:** Not released

Economic > Markets > Fish distribution > Fish receivers

One way of measuring benefits from a fishery is by assessing the flow of seafood through the supply chain. In many fishery jurisdictions, the first step in the supply chain is via licensed fish receivers who are allowed to receive fish for sale. They can also trade fish with other receivers. In some jurisdictions, commercial fishers must sell their catch to a receiver (although they can sell small amounts on wharves). While this restricts fishers' options for landing their catch, it means that fish can be tracked, reduces illegal fish trading and ensures that the Quota Management Systems (QMS) work effectively by ensuring catches do not exceed the total allowable catch or quota amounts for individual species. Receivers of fish may be fish processors, wholesalers or retailers.

In some jurisdictions, the fishers and fish receivers are integrated, such that they are effectively the same "business". In Commonwealth fisheries, the total number of fish receivers per year may differ to the sum of the fish receivers per fishery because some receivers operate in more than one fishery.

Data obtained from AFMA for this demonstration phase of the project does not provide this for the NPF, as it seems not to be used for prawn fisheries.

Data Quality: Not applicable

Economic > Markets > Volatility in market price > Price volatility

Price volatility is the mean beach price for the target species (top one or five depending on price) over the given period (most recent ten years). The level of volatility is the standard deviation in mean price over this period.

Data Quality	Species/Fishery	Year/Time period	Amount	Reference	Note
Silver	Northern Prawn	2007-08 to 2016-17	$1.48/kg	Bath, A & Green, R (2016) Australian fisheries economic indicators report 2015: financial and economic performance of	

				the Northern Prawn Fishery, Australian Bureau of Agricultural and Research Economics and Sciences, Canberra, December. CC BY 3.0. Supporting data tables	

Economics > Energy costs > Energy Use > Fuel use per kg of fish harvested

Fuel use varies over time and between stocks and are best collected from industry on a yearly basis. Estimates for different fisheries should be compared with caution, and in particular comparing energy use between fisheries with different data quality which is not recommended (different data availability, may be e.g. old or not fisheries-specific). Estimates are provided for all levels of data quality if available and are given in L per kg live-weight.

Data Quality	Gear	Target species	Min (L/kg)	Average (L/kg)	Max (L/kg)	Reference	Description
Gold							
Silver	Bottom trawl	Banana prawn		1.3		Farmery et al 2015	Northern prawn (CW), 2009-2011
Silver	Bottom trawl	Tiger prawn		9.9		Farmery et al 2015	Northern prawn (CW), 2009-2011
Bronze	Bottom trawl	Crustaceans	1.2	4.1	10.9	Parker and Tyedmers 2015	Oceania region

Economic > Energy costs > Fossil fuel subsidies > Fuel subsidies directed to the fishery

Fossil fuel subsidies (fuel rebates) illustrate to which extent the fuel cost is reduced in the fishery, measured in AUD/kg live weight fish. Note that this form of tax exemption for fisheries is in Australia motivated from the sector not using roads (i.e. costs embedded in fuel price for road construction and maintenance), and are not formally reported as fuel subsidies in Australia.

Data Quality	Gear	Target species	Subsidy (AUD/kg)	Reference	Description
Gold					
Silver	Bottom trawl	Banana prawn	0.52	Farmery et al 2015	Fuel use from Northern prawn fishery (CW), 2009-2011
Silver	Bottom trawl	Tiger prawn	3.96	Farmery et al 2015	Fuel use from Northern prawn fishery (CW), 2009-2011
Bronze	All NT	All NT	0.13	Total tax claims per total landings in NT	Assuming NT (closest), 2015-16 (2016-17 also available), state level figures on landings are preliminary for 2015-16

Governance > Ecosystem governance > Bycatch mitigation > Description of the bycatch mitigation measures

Bycatch measures can be spatial (e.g. area closure), temporal (time closure, e.g. night setting only) or technical (bycatch reduction devices, hook size). This indicator describes the measures that are in place for a fishery – but not the rates of compliance. For example, spatial closures for different gear types are shown here for AFMA fisheries http://www.afma.gov.au/sustainability-environment/fishing-closures/.

The use of TEDs and BRDs is known to reduce the volume of bycatch taken in fisheries. Since they were introduced in 2000, TEDs have proven most successful in the reduction of large bycatch species. The prevention of large animals from entering the codend greatly enhances their chance of survival, reduces damage to the prawns and sorting time, and minimises the risk to deck crew from being bitten, stung or injured. BRDs have also been mandated for the fishery to reduce the volume of fish bycatch. In combination with TEDs they have resulted in an overall 50% reduction in bycatch since 1998.
An extensive system of spatial and temporal closures has been implemented in the NPF since the 1980s. Apart from managing target species in the fishery, the spatial and temporal management regime in the NPF significantly reduced the area and time available for fishing generally, thereby protecting critical habitats and providing sanctuary for a number of vulnerable species. Protecting the diversity of complex seagrass beds, reef communities and the epibenthos that they support, has significantly reduced the footprint of the fishery and its impact on the ecology of the area.[65]

Data Quality: Gold

Governance > Ecosystem governance > Protected species mitigation > Description of the protected species mitigation measures

TEP mitigation measures can be spatial (e.g. area closure), temporal (time closure, e.g. night setting only) or technical (bycatch reduction devices, hook size). This indicator describes the measures that are in place for a fishery – but not the rates of compliance.

It is compulsory that all nets rigged for fishing in the NPF are fitted with bycatch reduction devices (BRD) and turtle excluder devices (TEDs) or modified TEDs for the entire fishing year. Effectively used TEDs eliminate nearly all catch of adult turtles and other large animals.[66]

Data Quality: Gold

Governance > Management system > Harvest strategy > Scope of the harvest strategy

Assessment can be based on scoring presence of the following: a harvest strategy designed to achieve management objectives; harvest control rules and tools; collection of relevant information to support the harvest strategy; and, assessment of stock status or the presence of the following key elements: Defined operational objectives for the fishery; Indicators of fishery performance related to the objectives; Reference points for performance indicators; A statement defining acceptable levels of risk to meeting objectives; A monitoring strategy to collect relevant data to assess fishery

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[65] http://www.afma.gov.au/wp-content/uploads/2014/11/NPF-Bycatch-and-Discard-Workplan-Nov2014.pdf
[66] https://www.afma.gov.au/sites/g/files/net5531/f/uploads/2017/03/Final-NPF-Directions-and-Closures-2017.pdf

performance; A process for conducting assessment of fishery performance relative to objectives; and; Decision rules that control the intensity of fishing activity and/or catch.

The NPF is managed through a series of input controls, including limited entry to the fishery, individual transferable effort units, gear restrictions, bycatch restrictions, and a system of seasonal and spatial closures. The fishery has two seasons: a 6–12-week predominantly banana prawn season starting in April, and a longer tiger prawn season, running from August to November. Two distinct components of the NPF harvest strategy are used to manage the two seasons of the fishery, because only a few tiger prawns are landed in the first season. Both operate within the management system of input controls (Dichmont et al. 2012), and use season length controls that are informed by the real-time monitoring of catch and catch rates. The harvest strategies have been subjected to management strategy evaluation testing (Buckworth et al. 2013[67]; Dichmont et al. 2006[68]), to assess their performance against the objectives of the Commonwealth Fisheries Harvest Strategy Policy (HSP; DAFF 2007).[69]

Data Quality: Gold

Governance > Management system > Management plans > Scope of management plan

Management plans can be assessed by evaluating the presence of minimum requirements, as follows: a description of the fishery, especially its current status and any established user rights: the management objectives; how these objectives are to be achieved; how the plan is to be reviewed and/or appealed, as well as the consultation process for review and appeal.

The Northern Prawn Fishery is managed under the Northern Prawn Fishery Management Plan 1995[70] which contains the following minimum requirements:

Area of the fishery
Objectives (Act s 17 (5))
Measures by which objectives attained
Performance criteria for assessing measures to achieve objectives
Statutory fishing rights and fishing permit

Data Quality: Gold

Governance > Institutional capacity > Accountability of decision making bodies > Level of Accountability

Accountability of Decision-making bodies. Performance of a fisheries management agency is based on the degree to which decision-making processes are consultative, the basis for decisions are fully explained, and information about decision making is publicly available. The assessment applied the

[67] Buckworth, RC, Ellis, N, Zhou, S, Pascoe, S, Deng, R A, Hill, FG & O'Brien, M (2013) Comparison of TAC and current management for the white banana prawn fishery of the Northern Prawn Fishery, final report for project RR2012/0812 to AFMA, CSIRO, Canberra
[68] Dichmont, CM, Deng, A, Punt, A, Venables, W & Haddon, M 2006, 'Management strategies for short lived species: the case of Australia's Northern Prawn Fishery. 2. Choosing appropriate management strategies using input controls', Fisheries Research, vol. 82, pp. 221–34.
[69] Patterson, H, Noriega R, Georgeson, L, Larcombe, J and Curtotti, R (2017) Fishery status reports 2017, Australian Bureau of Agricultural and Resource Economics and Sciences, Canberra. CC BY 4.0.
[70] https://www.legislation.gov.au/Series/F2005B02455

three tiers of Principle 3.2.2 (d) 'Decision-making process' of the MSC Fisheries Standard v2.0 (2014) to determine whether the level of accountability was low, medium or high.

High level of accountability. This is demonstrated by the availability of a management plan, assessment report and harvest strategy, and of decision-making procedures and outcomes online. The fishery has achieved and maintained MSC certification since 2012, and this includes assessment of Principle 3 and 3.2.2 at the highest level.

Data Quality: Silver

Governance > Institutional capacity > Uncertainty management > Extent of incorporation of uncertainty in management of the targeted stock

This metric reports on the explicit incorporation of uncertainties in decision support processes used to inform and make appropriate choices of management actions. We recognise three levels of uncertainty: Low level of incorporation of uncertainty; Medium level of incorporation of uncertainty; High level of incorporation of uncertainty. These are based on: Major sources of uncertainty are identified; Assessment takes uncertainty into account; Frequency of monitoring of indicators is high; Monitoring of more than one indicator to support management decisions; Assessment evaluates stock status relative to reference points in a probabilistic way; Robustness of assessments are tested, Alternative hypotheses and assessment approaches are rigorously explored.

High level of incorporation of uncertainty in management of the targeted stock.	MSC Certification by MRAG (2018). The fishery has achieved and maintained MSC certification since 2012, and this includes assessment of Principle 1.2.4 at the highest level.

Data Quality: Gold

Governance > Compliance > Compliance regime > Level of Compliance

Level of compliance with rules and regulations controlling catch can be assessed by audits that measure the agreement between 1) logbook and observer records; 2) catch disposal records submitted by fishers and fish receivers. It might also be assessed by counting the annual number of breaches/observed offences or enforcement actions, preferably scaled to the level of enforcement effort (e.g. $). This indicator can be scored on the basis of the presence of key monitoring, control and surveillance elements and capacities. **Data Quality:** Not found

Governance > Compliance > Surveillance > Surveillance Effort

Regulatory controls include logs and catch reporting, on-board observer programs, vessel inspections, vessel monitoring systems, and visual or electronic surveillance using radar or satellite by boat or by air. Higher degrees of surveillance, or coverage using multiple methods, provide greater levels of certainty in estimates of effort, fishing mortality, bycatch and discard levels, and interactions with protected/listed species. Report on the surveillance carried out on the fishery, as reported by the compliance branch responsible for the fishery

Surveillance effort score: undefined
AFMA uses two main methods to monitor the Northern Prawn Fishery. These are on-board observers and satellite tracking.

On-board observers - One of the main monitoring methods used by AFMA is on-board scientific observers. These observers are people employed by AFMA to go out on boats and independently record the catch, effort and biological information of each fishing trip. They take samples from the catch for scientific analysis.

Observers also record the length, weight and sex of target species caught during a trip and report on the other wildlife, the weather conditions, the composition of commercial catch and the fate of species caught as bycatch.

Boats in the fishery must carry an AFMA observer when requested by AFMA.

Observer coverage in the Northern Prawn Fishery						
Observer	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**
Crew member observers	962 days	1083 days	843 days	1058 days	893 days	1169 days
Scientific observers	167 days	168 days	117 days	159 days	103 days	152 days

Satellite tracking - A satellite monitoring system called a Vessel Monitoring System (VMS), is fitted to each boat. This system helps AFMA to monitor vessel position, course and speed. The tracking unit regularly transmits the information through a communications satellite to a land earth station. This information is sent by secure internet connection to a database at AFMA.[71]

Data Quality: Gold

Governance > Adaptive capacity > Governance arrangements > Climate change recognition

Governance arrangements relevant to the fishery consider the impact of climate change on the fishery, as evidenced by documentation, policies and plans that describe how management is addressing climate change impacts. Does the fishery management plan, harvest strategy or research activity suggest that climate change is recognised, and integrated into management planning?

The influence of the environment on the distribution and abundance of target species in this fishery have been documented in published literature, and species sensitivity assessments completed[72].

Impacts of climate change have been recognised by AFMA and the fishery. Fishery-specific plans are being developed under the AFMA –led project "Adaptation of Commonwealth Fisheries Management to Climate Change (FRDC 2016-059)". This project will conclude in June 2019.

The National Harvest Strategy also recognizes that "*Variability in ocean conditions, due to natural variability, climate change or other factors, can affect the productivity of stocks. Fisheries should seek to account for that variability when developing and implementing harvest strategies*"[73]. The Guidelines for the Harvest Strategy provide explicit approaches for fisheries[74].
Data quality: Silver

Governance > Adaptive capacity > Coping strategies > Climate responses

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[71] http://www.afma.gov.au/fisheries/northern-prawn-fishery/

[72] www.frdc.com.au/Archived-Reports/FRDC%20Projects/2016-139-DLD.PDF

[73] Department of Agriculture and Water Resources 2018, *Commonwealth Fisheries Harvest Strategy Policy*, Canberra, June. CC BY 4.0.

[74] Department of Agriculture and Water Resources 2018, *Guidelines for the Implementation of the Commonwealth Fisheries Harvest Strategy Policy*, Canberra, June. CC BY 4.0.

The fishery has initiated coping strategies (directed) to reduce the impacts of climate change. Evidence of strategies that have been specifically implemented for the fishery might include codes of practice, restocking programs, early warning systems, and so on. The coping strategies may be for long-term change or for extreme events. A description of the climate change responses that have been implemented or explored in research or application are provided.

The species targeted in this fishery have been studied with respect to climate change in a number of projects. The influence of the environment on the distribution of target species in this fishery have been documented in published literature, and species sensitivity assessments completed[75].

Data quality: Silver

Social and Ethical > Fishers wellbeing > Fisher satisfaction > Satisfaction scores

If available, fishery specific surveys of well-being or satisfaction, with interpretation required for the types of questions and sample. When surveys are not available other sources of data may need to include broader surveys (e.g. not fishery specific) or discussions with industry representatives, managers or fishers about the industry and their opinion of general fisher-wellbeing (note this will be subjective).

Data Quality: Not found

Social and Ethical > Fishers wellbeing > Age Structure > Proportion of fishers in standard age cohorts

Proportion of fishers in standard age cohorts that were involved in the fishery at any point in the previous 5 years. If the fishery is not attractive or difficult to enter, the age distribution will be skewed to older ages.

In 2013/14, the average age of skippers in the fishery was 43, and the average skipper had 26 years fishing experience and 20 of those years had been spent working in the Northern Prawn Fishery[76].

Data Quality: Gold

Social and Ethical > Wider community > Community satisfaction with fishery > Community feedback

Evidence of processes in place to gather direct engagement with the community (diversely represented) to listen and respond to feedback. This may be through a range of means including formal and informal processes and may not be appropriate to all fisheries in the same way. In some cases Marine Stewardship Council accreditation may demonstrate some evidence of community engagement.

Community feedback: Medium.

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[75] www.frdc.com.au/Archived-Reports/FRDC%20Projects/2016-139-DLD.PDF

[76] Bath, A & Green, R 2016, Australian fisheries economic indicators report 2015: financial and economic performance of the Northern Prawn Fishery, ABARES, Canberra, December. CC BY 3.0.

This fishery has Marine Stewardship Council certification. It has a management advisory committee, which could oversee a feedback process. Based on general FRDC community perception surveys, satisfaction with Australian fisheries is rated at 42%.

Data quality: Bronze.

Social and Ethical > Wider Community > Level of local employment > Percentage of local employment

The communities surrounding and supporting fisheries benefit from those fisheries when the majority of employees (direct and indirect) associated with the fishery activity are local. Can be reported as direct, indirect and downstream levels. **Data Quality:** Not found

Social and Ethical > Ethical - Human welfare > Protections in place > Legislation exists

Although all workers are automatically operating under legislation according to their state or territory to a safe work place, the extent to which there is awareness of the relevant Acts, and use of these if required, is highly variable and may be different for each business or individual operation within each fishery. See http://workplaceohs.com.au/legislation for a list of state acts and regulations.

Protections in Place: Medium

The Northern Prawn fishery is a commonwealth fishery located off the coast of Western Australia, the Northern Territory and North Queensland. It operates under Commonwealth regulations (administered by Comcare) – WHS Act 2011 and WHS Regulations 2011. State level requirements may also apply.

Data Quality: Gold

Social and Ethical > Ethical > Human welfare > Levels of compliance

Levels of compliance (or violations of) with Workplace Health and Safety. If references to Workplace Health and Safety exist in relation to the specific fishery, determine whether these are voluntary or recorded in anyway. If they are recorded, note the level of compliance. As they are likely to be voluntary, there will not likely be a record of compliance, but this may become more readily available in the future. **Data Quality:** Not found

Social and Ethical > Ethical-animal welfare > Animal welfare protections > Protections in place

At this early stage of development of animal welfare, any type of mention of animal welfare exists, it is probably the most appropriate. As this develops in to the future, assessments as to the level of engagement may become more relevant.

In line with food safety plans, trawler crews and shore-based processing staff are trained in the requirements and responsibilities in catching and processing the product, using ISO 9002, although it is not clear how much of this relates to animal welfare.

(AFMA http://npfindustry.com.au/Publications/R&D%20Plan%202001-2006.pdf)

Data Quality: Bronze

Social and Ethical > Ethical-animal welfare > Level of Compliance > Levels of compliance or violations of animal welfare

If there are any references to animal welfare protections or guidelines in fishery management plans and if reports exist, the indicator reports on the level of compliance or violations with welfare provisions.

Data Quality: Not found.

Social and Ethical > Climate-related > Access to information > Availability of information

This indicator describes available information that will help participants in the fishery adapt to changes. The assumption behind this indicator is that good information availability and flow will help fishers to adapt.

Availability of information: High
AFMA maintains a website for this fishery.

Data Quality: Gold.

Social and Ethical > Climate-related > Access to networks > Level of membership of industry association

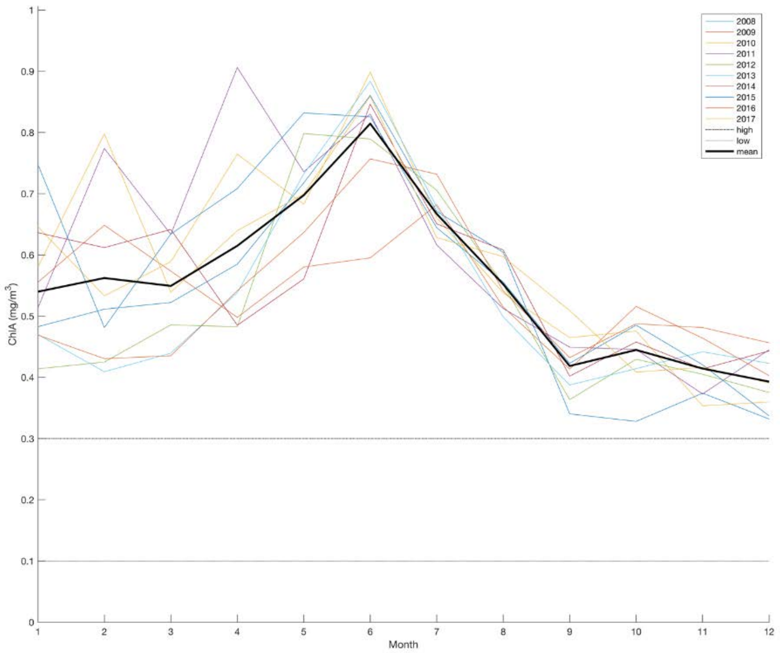
This metric assesses the presence or absence of a dedicated social media or social network group for the fishery. The fishery may still have a strong social network without a social media presence.

Network in place: Yes
AFMA is active on Facebook.

Data Quality: Bronze

External > Environmental Context > Productivity > Mean chlorophyll

A measure of environmental productivity is the biomass of phytoplankton, which in oceanic waters can be approximated by chlorophyll a concentration, as estimated from satellite (MODIS, oceandata.sci.gsfc.nasa.gov). Monthly chlorophyll values for a representative area of the fishery are shown with the mean productivity shown in solid black and references levels of low chlorophyll at 0.1 mg $m^{-3}$and high chlorophyll levels at 0.3 mg m^{-3}. This indicator shows the mean chlorophyll by month for the years 2008-2017. These data provide information on the relative environmental productivity in the fishery area. Missing data for some months can be due to ice cover. Variability in chlorophyll a concentration between years can indicate high environmental variability, while similar seasonal patterns indicate relative environmental stability.



Data Quality: Gold

External > Environmental Context > Environmental character > Description of the ecosystems

This metric provides a qualitative description of the ecosystem(s) in which the fishery occurs. The goal is to provide a general overview of these environments. The knowledge about which ecosystems are encountered during fishing activity is the indicator (rather than the response of the ecosystems to fishing).

Marine ecosystems are defined for the purposes of this indicator as the composition of plants, animals, and the marine environment (water masses, geomorphology). Types of marine ecosystems include estuaries, the sea floor, the mesopelagic zone, the pelagic zone, the inter-tidal zones, coral reefs, lagoons, and mangroves. A pelagic zone ecosystem for example, is defined by physical, chemical and biological features of the marine water column of the open ocean[77].

Description of the ecosystems: High

The Northern Prawn Fishery (NPF) extends from Joseph Bonaparte Gulf across the top end to the Gulf of Carpentaria. White banana prawn (*Fenneropenaeus merguiensis*) is mainly caught during the day on the eastern side of the Gulf of Carpentaria, whereas red-legged banana prawn (*F. indicus*) is mainly caught in Joseph Bonaparte Gulf. White banana prawns form dense aggregations ('boils') that can be located using spotter planes, which direct the trawlers to the aggregations. The highest catches are taken offshore from mangrove forests, which are the juvenile nursery areas. Tiger prawns (*Penaeus esculentus* and *P. semisulcatus*) catches come from the southern and western Gulf of

[77] Game, E. T., H. S. Grantham, A. J. Hobday, R. L. Pressey, A. T. Lombard, L. E. Beckley, K. Gjerde, R. H. Bustamante, H. P. Possingham and A. J. Richardson (2009). Pelagic protected areas: the missing dimension in ocean conservation. Trends in Ecology and Evolution **24**(7): 360-369 doi:310.1016/j.tree.2009.1001.1011.

Carpentaria, and along the Arnhem Land coast. Tiger prawn fishing grounds may be close to those of banana prawns, but the highest catches come from areas near coastal seagrass beds, the nursery habitat for tiger prawns[78].

Data Quality: Gold

External > Climate related > Susceptibility of target species > Impacts on target species

Climate change directly affects the distribution, abundance and phenology of individual species. These changes then affect the fisheries that harvest these species, and can be a strong external influence on the fishery. These impacts can be positive (e.g. increased abundance), or negative (e.g. movements further from fishing ports), and to long-term warming, or short-term extreme events such as marine heatwaves.

Sensitivity of some of the target species to climate change has been assessed[79]. Species in this fishery have a sensitivity of moderately high.

Common name	Species	Fishery	Score	Sensitivity
Brown tiger prawn	Penaeus esculentus	Northern Prawn Fishery	6	MODERATELY HIGH
Banana prawn	Penaeus merguiensis	Northern Prawn Fishery	6	MODERATELY HIGH
Grooved tiger prawn	Penaeus semisulcatus	Northern Prawn Fishery	6	MODERATELY HIGH

Data Quality: Silver

External > Climate related > Susceptibility of key habitats > Habitat Impacts

Habitat impact: Moderate

Changes in rainfall have been implicated in the changing quality of juvenile prawn habitats. Offshore, impacts have not been reported.

Data Quality: Silver

External > Contaminants in the environment > Detection system for seafood contaminants > Risk of contaminants

Potential risk for contamination from the marine environment combined with monitoring arrangements to be able to address risks needed to ensure food safety. Contaminants include those with maximum levels set for by Food Standards Code Australia: metal contaminants, non-metal

[78] http://www.agriculture.gov.au/abares/Pages/northern-prawn-fishery.aspx#51-description-of-the-fishery

[79] Fulton EA, Hobday AJ, Pethybridge H, Blanchard J, Bulman C, Butler I, Cheung W, Gorton B, Hutton T, Lozano- Montes H, Matear R, Pecl G, Villanueva C, Zhang X (2018). *Decadal scale projection of changes in Australian fisheries stocks under climate change.* CSIRO Report to FRDC. FRDC Project No: 2016/139 – ONLINE.

contaminants, natural toxicants, and average and maximum levels of mercury in fish. Contaminants from poor handling after landing are not assessed but may be indirectly addressed.

Rubric for risk level:

Low risk	Medium risk	High risk
There are no documented levels of contaminants from the marine environment causing risk/diet restrictions to any consumer group in the fishery.	There may be seasonal/area/species/size-based risks of contaminants for some species.	Permanent diet restrictions of species caught to vulnerable consumers such as children or pregnant women.

Risk of Contaminants: Low

No specific monitoring arrangements found for marine contaminants on the fishery webpage: http://www.afma.gov.au/fisheries/northern-prawn-fishery/, but targeted species have low potential risk for contamination from the marine environment.

Data Quality: Silver

External > Contaminants in the environment > Management arrangements to ensure food safety related to contaminants > Evidence for arrangements

There is evidence of management arrangements to ensure food safety related to contaminants and food safety from the marine environment. No supply chain risks from poor handling are considered. Food standard 4.2.1 requires all seafood business in Australia to identify potential seafood safety hazards and put controls in place that are consistent with the risk.

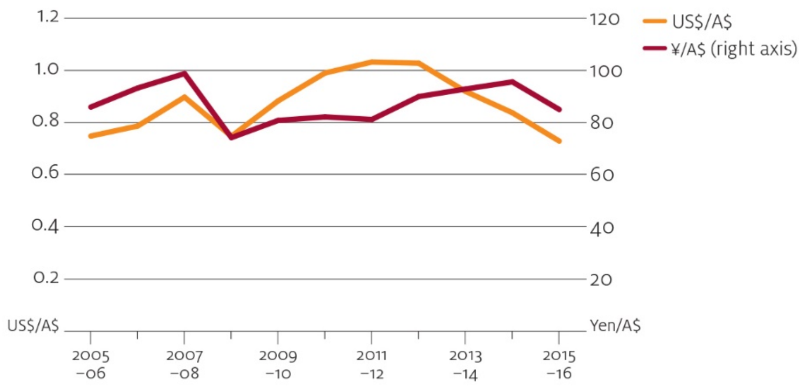
Data Quality	
GOLD	Food safety risks with prawns consumed in Australia have been assessed. http://www.afma.gov.au/wp-content/uploads/2010/06/npf_code.pdf
SILVER	There is an industry code of practice. http://australianwildprawns.com.au/wp-content/uploads/2017/02/2009-787-Food-safety-risks-for-prawns.pdf
BRONZE	

External > Market Drivers > Macroeconomic factors > Exchange Rates

A depreciating Australian dollar (or, increasing exchange rate) generally results in producers receiving a higher export price in Australian dollar terms, while an appreciating Australian dollar (or, decreasing exchange rate) results in a lower export price. Domestically, a depreciation of the Australian dollar encourages substitution from imported seafood to domestically produced seafood, as imported products become relatively more expensive. A lower exchange rate also makes Australian exports more competitive in world markets, as exported seafood become relatively cheaper in foreign currency terms.

National export trends are negatively related to exchange rate movements— the Australian dollar declined against the US dollar and Japanese yen from 1990–91 to 2000–01, with exports increasing in volume and value. Exchange rates for the Australian dollar increased against those currencies from

2001–02 to 2015–16. The real export value and volume of Australia's seafood exports decreased between 2005–06 and 2012–13 and then increased between 2012–13 and 2015–16—with a noticeable rise (43 per cent) in volume between 2014–15 and 2015–16.[80]



Data Quality: Gold

External > Market Drivers > Consumer Trends > Per person annual apparent consumption of seafood (kg)

Annual apparent consumption is estimated by adding the total edible quantity of seafood supplied domestically—that is, total production plus imported seafood— less exports of seafood. Apparent consumption provides an estimate of the total amount of seafood consumed in Australia assuming zero change in stocks.

The production quantity of Australian fishery and aquaculture products is reported by ABARES on a whole weight basis, whereas trade data are reported on a processed basis. To align the units of measurement between production and trade data, it is necessary to convert production volume to a processed edible equivalent.

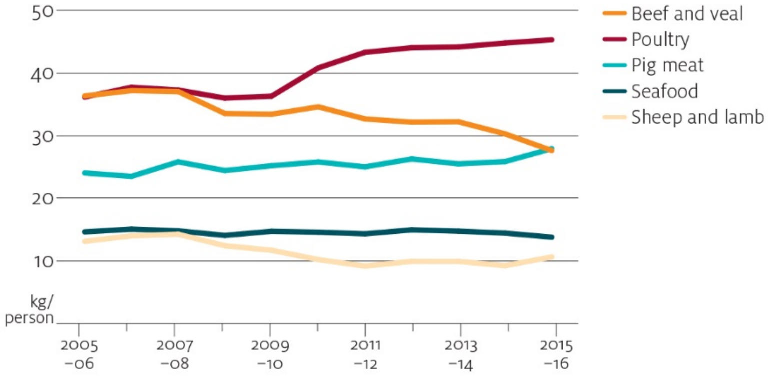
Production volumes are adjusted to an edible quantity basis using species-specific conversion rates and excluding species that are known to be predominantly supplied for non-human consumption purposes, such as for aquaculture feed or bait. Imports and exports of seafood are sourced from Australian Bureau of Statistics (ABS) trade data and are reported as edible weight. The apparent consumption per person is calculated as the total apparent consumption divided by the total Australian population in each year. The method applied here is consistent with that used by ABARES to estimate apparent consumption of other agricultural commodities produced in Australia.

The FAO also compiles statistics on apparent consumption of seafood, applying a consistent method across all countries. FAO estimates indicate that annual consumption of seafood in Australia is around 26 kilograms per person in 2013 (FAO 2016[81]). The discrepancy between FAO and ABARES estimates reflects differences in methodological approaches to estimating consumption. Moreover, ABARES estimates seafood consumption on a processed edible basis, whereas the FAO provides its estimates on a whole weight basis.

[80] Mobsby, D and Koduah, A 2017, Australian fisheries and aquaculture statistics 2016, FRDC project 2017-095. ABARES, Canberra, December. CC BY 4.0.
[81] The state of world fisheries and aquaculture 2016—opportunities and challenges, Food and Agriculture Organization of the United Nations, Rome.

In Australia, apparent consumption of seafood per person (edible equivalent) decreased, on average, at an annual rate of 0.6 per cent, from 14.6 kilograms in 2005– 06 to 13.8 kilograms per person in 2015–16. Annual apparent consumption is estimated by the Australian Bureau of Agricultural and Resource Economics and Sciences by adding the total edible quantity of seafood supplied domestically—that is, total production plus imported seafood— less exports of seafood[82]

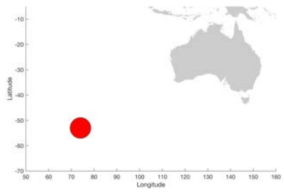
In comparison, global per capita apparent fish consumption increased from an average of 9.9 kg in the 1960s to 14.4 kg in the 1990s and 20.1 kg in 2014, with preliminary estimates for 2015 indicating further growth, exceeding 20 kg (FAO 2016). Australia's per person seafood consumption in 2013 was estimated by the FAO to be 26kg. The differences in estimates are accounted for by varying methods for calculating consumption. ABARES estimates seafood consumption on a processed edible basis, whereas the FAO provides its estimates on a whole weight basis.



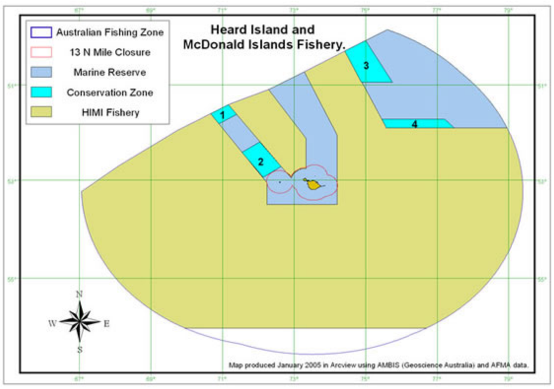
Data quality: Gold

[82] Mobsby, D and Koduah, A 2017, *Australian fisheries and aquaculture statistics 2016*, FRDC 2017-095. ABARES, Canberra, December. CC BY 4.0

Commonwealth Heard Island and McDonald Islands Fishery

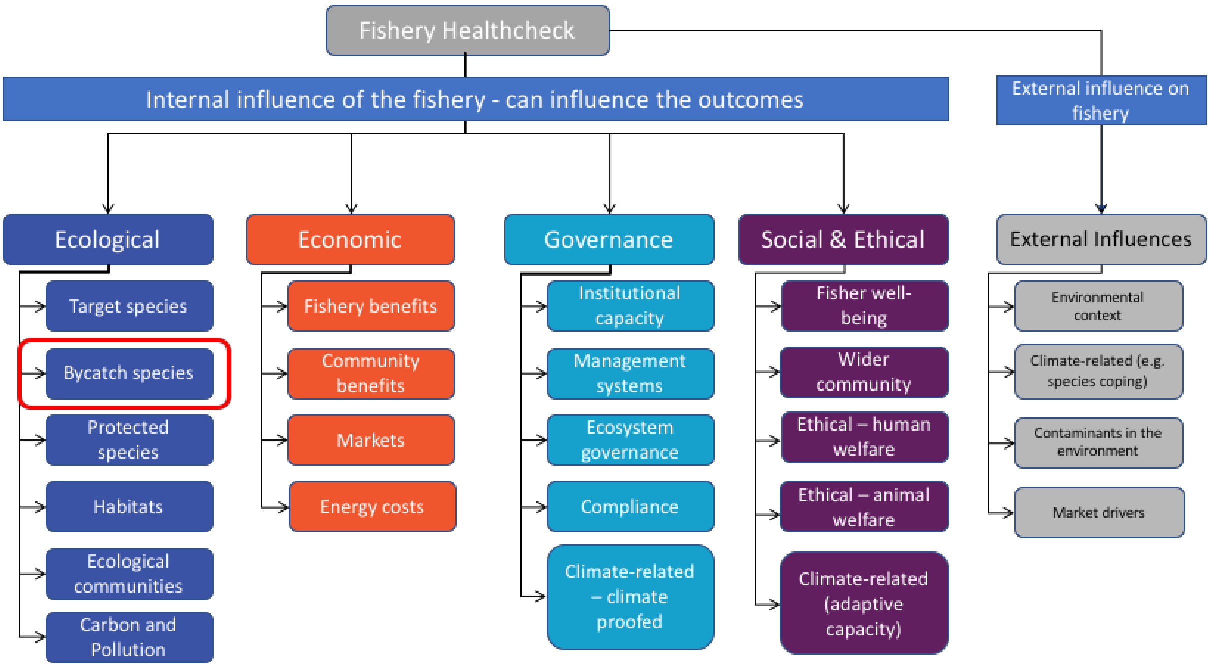


The Commonwealth Heard Island and McDonald Islands Fishery is managed by limiting the catch of fish, restricting how many boats can fish and regulating what gear they can use. Several species are caught in the Antarctic Fisheries but the species targeted by commercial fishers are: [Patagonian toothfish](#) (*Dissostichus eleginoides*) and [Mackerel icefish](#) (*Champsocephalus gunnari*). Patagonian toothfish and mackerel icefish are also caught by other countries. Australia's catch of these species is part of the total catch internationally. In the Heard Island and McDonald Islands Fishery, fishers mainly use longline fishing gear (demersal or bottom longline) to catch Patagonian toothfish and trawl gear (demersal or bottom trawl) for mackerel icefish. The Australian external territory of the Heard Island and McDonald Islands is in the southern Indian Ocean within the area covered by the Convention for the Conservation of Antarctic Marine Living Resources. Source: http://www.afma.gov.au/fisheries/heard-island-mcdonald-island-fishery/



Case Study Presentation Format

The case study documents are a collection of metrics, organised by the healthcheck structure:



The presentation of metrics will follow the following heading format:

Ecological > Bycatch species > Bycatch composition > Mean Trophic Level

Understand this to be an indicator (**Bycatch composition**) of the **Ecological** Component, **Bycatch species** subcomponent where the (in the figure and heading example above, is being measured by presenting Mean Trophic Level as the metric.

Ecological > Target species > Stock Status > Status of Australian Fish Stocks (SAFS)

Target species in each fishery are the primary focus for this indicator. Status of these species is ideally assessed with the SAFS approach, however this may not cover all target species for each fishery. In that case, we indicate the number of unassessed species. These species could also be assessed by individual states or by alternative methods.

SpeciesName	StockName	StockStatus	Year
Mackerel Icefish	Heard Island and McDonald Islands	Sustainable	2016
Patagonian Toothfish	Heard Island and McDonald Islands	Sustainable	2016

Data Quality: Gold

Ecological > Target Species > Harvest Level > Catch weight

This metric is a proxy for harvest level. The harvested biomass for each species, provides information on the level of the catch. Trends in this metric over time can indicate declining availability of fish, quota restrictions, or changes in market demand. For Australian fisheries, trends are expected to be stable for most species.

Several species are caught in the Antarctic Fisheries (http://www.afma.gov.au/fisheries/heard-island-mcdonald-island-fishery/) but the species targeted by commercial fishers are:

Patagonian toothfish (*Dissostichus eleginoides*)

Mackerel icefish (*Champsocephalus gunnari*)

Species	2015-16 total allowable catch (tonnes)	2016-17 total allowable catch (tonnes)	2017-18 total allowable catch (tonnes)
Patagonian toothfish	3405	3405	3525
Mackerel icefish	482	561	526
Grey rockcod	80	80	80
Unicorn icefish	150	1663	1663
Skates and rays	120	120	120
Macrourids (all species)	360	–	-
Macrourids (Macrourus caml & M. whitsoni)	–	409	409
Macrourids (M. halotrachys & M. crainatus)	–	360	360
Other deepwater species	50	50	50

The landings from the catch disposal records[83] show the breakdown of catch of these species for recent years.

[83] https://data.gov.au/dataset/0cd2ec97-d13c-4b02-8071-fd778fdcdee7/resource/81d3d265-b21a-4b05-b62d-c315beec771e/download/annual-cdr-catch-data-30-05-2018.xlsx

Fishery	Year	Common Name	Scientific Name	CAAB	Retained Catch (Kg)	Catch (kg) under research catch allowance	Data Source
HIMI	2002	Mackerel Icefish	Champsocephalus gunnari	37407791	547013	0	CDR
HIMI	2002	Patagonian Toothfish	Dissostichus eleginoides	37404792	2695996	0	CDR
HIMI	2002	Unicorn icefish	Channichthys rhinoceratus	37407792	73	0	CDR
HIMI	2003	Mackerel Icefish	Champsocephalus gunnari	37407791	2345110	0	CDR
HIMI	2003	Patagonian Toothfish	Dissostichus eleginoides	37404792	3107709	0	CDR
HIMI	2003	Unicorn icefish	Channichthys rhinoceratus	37407792	228	0	CDR
HIMI	2004	Mackerel Icefish	Champsocephalus gunnari	37407791	78233	0	CDR
HIMI	2004	Patagonian Toothfish	Dissostichus eleginoides	37404792	2598422	0	CDR
HIMI	2004	Unicorn icefish	Channichthys rhinoceratus	37407792	11987	0	CDR
HIMI	2004	Whiptails	Macrouridae & Bathygadidae - undifferentiated	37232000	1116	0	CDR
HIMI	2005	Mackerel Icefish	Champsocephalus gunnari	37407791	1851137	0	CDR
HIMI	2005	Patagonian Toothfish	Dissostichus eleginoides	37404792	2745067	0	CDR
HIMI	2006	Mackerel Icefish	Champsocephalus gunnari	37407791	659882	0	CDR

Fishery	Year	Common Name	Scientific Name	CAAB	Retained Catch (Kg)	Catch (kg) under research catch allowance	Data Source
HIMI	2006	Patagonian Toothfish	Dissostichus eleginoides	37404792	2528205	0	CDR
HIMI	2006	Unicorn icefish	Channichthys rhinoceratus	37407792	30006	0	CDR
HIMI	2007	Mackerel Icefish	Champsocephalus gunnari	37407791	837	0	CDR
HIMI	2007	Patagonian Toothfish	Dissostichus eleginoides	37404792	2411901	0	CDR
HIMI	2007	Unicorn icefish	Channichthys rhinoceratus	37407792	425	0	CDR
HIMI	2008	Mackerel Icefish	Champsocephalus gunnari	37407791	206242	0	CDR
HIMI	2008	Patagonian Toothfish	Dissostichus eleginoides	37404792	2445753	0	CDR
HIMI	2008	Unicorn icefish	Channichthys rhinoceratus	37407792	157	0	CDR
HIMI	2009	Mackerel Icefish	Champsocephalus gunnari	37407791	94393	0	CDR
HIMI	2009	Patagonian Toothfish	Dissostichus eleginoides	37404792	2476361	0	CDR
HIMI	2010	Mackerel Icefish	Champsocephalus gunnari	37407791	361854	0	CDR
HIMI	2010	Patagonian Toothfish	Dissostichus eleginoides	37404792	2514556	0	CDR
HIMI	2010	Unicorn icefish	Channichthys rhinoceratus	37407792	70041	0	CDR

Fishery	Year	Common Name	Scientific Name	CAAB	Retained Catch (Kg)	Catch (kg) under research catch allowance	Data Source
HIMI	2011	Mackerel Icefish	Champsocephalus gunnari	37407791	500	0	CDR
HIMI	2011	Patagonian Toothfish	Dissostichus eleginoides	37404792	2565145	0	CDR
HIMI	2012	Mackerel Icefish	Champsocephalus gunnari	37407791	4689	0	CDR
HIMI	2012	Patagonian Toothfish	Dissostichus eleginoides	37404792	2719607	0	CDR
HIMI	2013	Mackerel Icefish	Champsocephalus gunnari	37407791	678226	0	CDR
HIMI	2013	Patagonian Toothfish	Dissostichus eleginoides	37404792	2718426	0	CDR
HIMI	2014	Mackerel Icefish	Champsocephalus gunnari	37407791	1075571	0	CDR
HIMI	2014	Patagonian Toothfish	Dissostichus eleginoides	37404792	2846506	0	CDR
HIMI	2015	Mackerel Icefish	Champsocephalus gunnari	37407791	8150	0	CDR
HIMI	2015	Patagonian Toothfish	Dissostichus eleginoides	37404792	4176721	0	CDR
HIMI	2016	Mackerel Icefish	Champsocephalus gunnari	37407791	490653	0	CDR
HIMI	2016	Patagonian Toothfish	Dissostichus eleginoides	37404792	2798924	0	CDR

Data quality: Gold

Ecological > Bycatch species > Bycatch composition > Mean Trophic Level

The trophic level is a measure of the position of an organism in a food web, starting at level 1 with primary producers, such as phytoplankton, then moving through the primary consumers at level **2** that eat the primary producers to the secondary consumers at level **3** that eat the primary consumers, and so on. The **bycatch mean trophic level** is an indicator of the mean level of the food chain for bycatch in a fishery.

Demersal longline: AFMA requires that no offal or bycatch is to be discarded in the area of the fishery to avoid possible provisioning effects, however, skates and rays must be released or returned to the sea soon after capture. The following species are listed as bycatch in the 2017 ERA report, and we queried the ERAEF database to obtain estimates for this list.

Bulman, C.M., Sporcic, M., Pethybridge, H. & Hobday, A. (2017) Ecological Risk Assessment for Effects of Fishing. Report for the Demersal Longline Sub-fishery of the Heard Island and McDonald Islands Fishery. CSIRO/AFMA, Hobart)

Bulman et al 2017. Table 2.1. Bycatch species (BC) in the HIMI demersal longline sub-fishery

TAXA	FAMILY NAME	SCIENTIFIC NAME	COMMON NAME	CAAB CODE
Chondrichthyan	Rajidae	Rajiformes	Rays, stingrays, mantas nei	37031000
Chondrichthyan	Rajidae	*Bathyraja irrasa*	Kerguelen sandpaper skate	37031000
Chondrichthyan	Rajidae	*Bathyraja caeluronigricans*		37031000
Chondrichthyan	Rajidae	*Bathyraja murrayi*	Murray's skate	37031048
Chondrichthyan	Rajidae	*Bathyraja eatonii*	Eaton's skate	37031750
Chondrichthyan	Rajidae	*Raja georgiana*	Antarctic starry skate	37031753
Chondrichthyan	Squalidae	*Etmopterus lucifer*	Blackbelly lanternshark	37020005
Chondrichthyan	Squalidae	*Etmopterus granulosus*	Southern lanternshark(Lucifer)	37020021
Chondrichthyan	Squalidae	*Somniosus pacificus*	Pacific sleeper shark	37020036
Teleost	Muraenolepididae	*Muraenolepis spp*	Moray cods nei	37223901
Teleost	Muraenolepididae	*Muraenolepis microps*	Smalleye moray cod	
Teleost	Moridae	*Antimora rostrata*	Blue antimora	37224008
Teleost	Moridae	*Lepidion* spp	Lepidion codlings nei	37224901
Teleost	Nototheniidae	*Notothenia kempi*	Striped-eyed rockcod	37404000
Teleost	Nototheniidae	*Notothenia squamifrons*	Grey rockcod	37404793
Teleost	Nototheniidae	*Notothenia rossii*	Marbled rockcod	
Teleost	Nototheniidae	*Trematomus* spp	Trematomus nei	37404909
Teleost	Channichthyidae	*Channichthyidae*	Crocodile icefishes nei	37407000
Teleost		*Rhacochilus toxotes*	Rubberlip seaperch	not in area
Invertebrate		Porifera	Porifera - undifferentiated	10000000
Invertebrate		Invertebrata	Aquatic invertebrates nei	11000000
Invertebrate		Gorgoniidae	Gorgonians	11186000
Invertebrate		Scleractinia	Hard corals, madrepores nei	11290000
Invertebrate		Actiniaria	Sea anemones	14410000

Invertebrate	Octopodidae	Octopuses, etc. nei	23659921
Invertebrate	Asteroidea	Starfishes nei	25102000
Invertebrate	Ophiuroidea	Basket, brittle, snake stars	25160000
Invertebrate	Euryalida	Basket stars	25170000
Invertebrate	Lithodidae	King crabs, stone crabs nei	28836000
Invertebrate	Paralomis aculeata	Red stone crab	28836902
Invertebrate	Pennatulacea	Sea pens	
Invertebrate	Echinoidea	Sea urchins, etc. nei	
Invertebrate	Holothuroidea	Sea cucumbers nei	
Invertebrate	Crustacea	Freshwater crustaceans nei	
Invertebrate	Echinodermata	Echinoderms	
Invertebrate	Ascidiacea	Sea squirts nei	
Invertebrate	Cnidaria	Cnidarians nei	
Invertebrate	Solenocera pectinata	Comb shrimp	
Invertebrate	Gastropoda	Gastropods nei	
Invertebrate	Loliginidae, Ommastrephidae	Various squids nei	

	Min trophic level	Max trophic level	Sample size (species)
ERAEF database extraction for the longline sub-fishery (2017)	3.58	4.48	7 species

Data Quality: Silver

(data list incomplete in ERAEF database, need updated fishbase search)

Ecological > Bycatch species > Bycatch amount > Total weight of bycatch

Bycatch weights for fishery are typically developed by specific projects, and require a range of assumptions due to issues with reporting and retention of bycatch. **Bycatch** estimates typically cover species that are not target species, while **discard** rates may also include undersized individuals of the target species. Kennelly (2018) provides estimates of discard rates, which include both target and bycatch species, and when discard rates are used, that information is noted for each fishery. Animals can be returned to the ocean alive or dead. The intention of this metric is to provide information on animals that are dead on return to the ocean.

Reference:

Kennelly, S.J., 2018. *Developing a National Bycatch Reporting System.* Final FRDC Report, ISBN 978-0-9924930-5-9, March, 2018. 99 pp.

Bycatch ranges between 6 and 13% of the total catch[84] (or up to 26% if elasmobranchs cut-off longlines before landing are included), primarily comprising rattails Macrourus sp., skates Rajidae,

[84] https://www.ccamlr.org/en/document/publications/fishery-report-2017-dissostichus-eleginoides-heard-island-australian-eez

unicorn icefish Channichthys rhinoceratus, and grey rockcod Lepidonotothen squamifrons, all of which have bycatch limits that have never been exceeded. The following tables are from that report showing bycatch for the major taxa.

Table 2: Catch history for by-catch (macrourids and rajids), including catch limits and number of rajids released alive, in Division 58.5.2. Catch limits are for all targeted fishing in Division 58.5.2 (see CM 33-03 for details). From 1997 to 2015, all macrourids were reported as a single taxon for the purpose of by-catch limits. (Source: fine-scale data.)

Season	*Macrourus caml* and *M. whitsoni*				*Macrourus holotrachys* and *M. carinatus*				Rajids				
	Catch limit (tonnes)	Reported catch (tonnes)			Catch limit (tonnes)	Reported catch (tonnes)			Catch limit (tonnes)	Reported catch (tonnes)			Number released
		Longline	Trawl	Total		Longline	Trawl	Total		Longline	Trawl	Total	
1997	-	0	<1	<1					-	0	2	2	-
1998	-	0	<1	<1					120	0	3	3	-
1999	-	0	1	1					-	0	2	2	-
2000	-	0	4	4					-	0	6	6	-
2001	-	0	1	1					50	0	4	4	-
2002	50	0	3	4					50	0	3	3	-
2003	465	3	1	4					120	7	7	14	-
2004	360	42	3	46					120	62	11	73	155
2005	360	72	2	74					120	71	3	74	8412
2006	360	26	<1	27					120	17	12	29	3814
2007	360	61	5	66					120	8	10	18	7886
2008	360	81	5	86					120	13	8	21	9799
2009	360	110	2	112					120	15	9	24	10738
2010	360	100	3	103					120	11	6	17	19319
2011	360	147	4	151					120	11	3	14	7164
2012	360	89	3	92					120	7	3	9	8484
2013	360	154	3	157					120	13	11	24	13135
2014	360	175	1	176					120	16	<1	16	25251
2015	360	288	4	292					120	19	5	24	32515
2016	409	79	1	80	360	220	0	220	120	20	29	50	32201
2017	409	104	<1	105	360	237	0	237	120	34	8	42	43109

Table 3: Catch history for by-catch (*Channichthys rhinoceratus*, *Lepidonotothen squamifrons*) and other species in Division 58.5.2. Catch limits are for the whole fishery (see CM 33-02 for details). Data from the 2017 fishing season is incomplete. (Source: fine-scale data.)

Season	*Channichthys rhinoceratus*				*Lepidonotothen squamifrons*				Other species			
	Catch limit (tonnes)	Reported catch (tonnes)			Catch limit (tonnes)	Reported catch (tonnes)			Catch limit (tonnes)	Reported catch (tonnes)		
		Longline	Trawl	Total		Longline	Trawl	Total		Longline	Trawl	Total
2004	150	0	1	1	80	0	0	0	50	3	16	19
2005	150	0	2	2	80	0	<1	<1	50	3	9	12
2006	150	0	3	3	80	0	0	0	50	3	7	12
2007	150	0	12	12	80	0	0	0	50	1	4	5
2008	150	0	29	29	80	0	<1	<1	50	2	18	21
2009	150	0	46	46	80	0	<1	<1	50	9	17	26
2010	150	0	26	26	80	0	<1	<1	50	6	16	22
2011	150	0	23	23	80	0	1	1	50	11	6	18
2012	150	0	42	42	80	0	0	0	50	7	5	12
2013	150	0	25	25	80	0	2	2	50	9	27	35
2014	150	0	<1	<1	80	0	5	5	50	12	17	30
2015	150	0	12	12	80	0	3	3	50	36	7	43
2016	1663	0	128	128	80	<1	3	3	50	21	24	45
2017	1663	0	18	18	80	<1	2	2	50	30	28	58

Data Quality: Gold

Ecological > Protected species > Capture amount > Captures

The number and diversity of TEP species captured by a fishery in the most recent year, provided as annual numbers.

As a commonwealth managed fishery, interactions are reported quarterly here.

In 2017, the reported number of protected species interactions by quarter is:

QUARTER 1

No protected species interaction occurred.

QUARTER 2

Heard Island and McDonald Island Fishery

Gear Type	Common name	Total	Alive	Dead	Injured	Unknown	Interaction type[1]	Comments
Longline	White Chinned Petrel	1		1			Hooked	-
	Grey Petrel	1		1			Hooked	-
	Southern Elephant Seal	2		2			Entangled	Both females
	Total interactions	**4**		**4**				

QUARTER 3

Heard Island and McDonald Island Fishery

Gear Type	Common name	Total	Life Status: Alive	Dead	Injured	Unknown	Interaction type[1]	Comments
Longline	Southern Giant Petrel	1		1			Collision[2]	Did not interact with fishing gear
	Southern Elephant Seal	2		1			Hooked	-
				1			Entangled	-
	Seal	2		1			Hooked	-
				1			Entangled	-
	Total Interactions	5		5				

QUARTER 4

Heard Island and McDonald Islands Fishery

Gear Type	Common name	Total	Life status: Alive	Dead	Injured	Unknown	Interaction type[1]	Comments
Longline	Southern Giant Petrel	1		1			Collision	Not a fishing gear interaction
	Southern Elephant Seal	1		1			Hooked	-
	Total Interactions	2		1	0	9		

Data quality: Gold

Ecological > Protected species > Reporting > Level of monitoring

This indicator is to provide information on the level of coverage for a fishery. Annual measures are preferred.

AFMA uses different methods to monitor fishing activities in the Heard Island and McDonald Islands Fishery. One of the main monitoring methods used by AFMA is on-board scientific observers. These observers are people employed by AFMA to go out on boats and independently record the catch, effort and biological information of each fishing trip. Boats in the Heard Island and McDonald Islands Fishery must carry an AFMA observer at all times[85].

Data quality: Gold

Ecological > Habitats > Habitat impact > Impact score

[85] http://www.afma.gov.au/fisheries/heard-island-mcdonald-island-fishery/

The habitat impact is an indicator of the effect the fishing gear has on the habitat. Different gear types have different impacts. See the scoring rubric.

Three gear types are used in the HIMI fishery. The most recent ERAEF assessment was in 2018.

Midwater Trawl

Habitat Impact: Negligible **(Pelagic habitats).**

The impact on pelagic habitat was assessed using the most recent SICA[86]. The use of this fishing method has declined over the past decade, to only 5 shots in 2013/14 (vs 100 shots per year 2002-2005)

Figure 2.5.Habitats (pelagic): Frequency of consequence score by high and low confidence (not including activities impacting benthic habitats).

Data quality: Silver

Demersal Longline

Habitat Impact: Minor **(Pelagic habitats),** Minor **(Benthic habitats)**

Two pelagic habitats were assessed in most recent ERAEF[87].

[86] Sporcic, M., Pethybridge, H., Bulman, C.M., Hobday, A., Fuller, M. (2018). Ecological Risk Assessment for the Effects of Fishing Final report for Heard Island and McDonald Islands Fishery: midwater trawl sub-fishery 2010/11 to 2014/15. Report for the Australian Fisheries Management Authority. 116 pp.
[87] Bulman, C.M., Sporcic, M., Pethybridge, H. & Hobday, A. (2017) Ecological Risk Assessment for Effects of Fishing. Report for the Demersal Longline Sub-fishery of the Heard Island and McDonald Islands Fishery. 2010/11-2015/16. CSIRO/AFMA, Hobart)

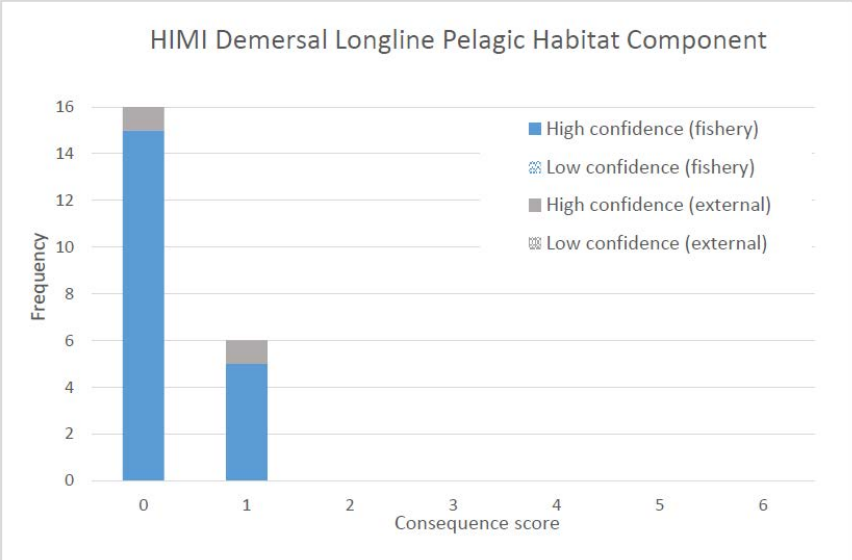


Figure 2.5 Habitats (pelagic only): Frequency of consequence score differentiated between high and low confidence

Benthic habitat impacts were assessed by Welsford et al[88]. in a dedicated study. They showed that the majority of benthic invertebrates at HIMI are predicted to live in depths shallower than 1000 m. This contrasts with the fishing footprint of the longline, which, while it has been able to attain commercially viable catch rates over a wider area than trawling, primarily fishes at depths >1000 m where the abundance of most vulnerable taxa is low. Hence, with the exception of the few taxa for which the deeper slopes are an important habitat such as euryalids and stalked barnacles, as well as the smaller amount of area disturbed by each longline event relative to most trawls, longline effort does not contribute greatly to the total amount of benthic taxa killed or damaged.

Data quality: Silver (pelagic)

Data quality: Gold (benthic)

<u>Demersal Trawl</u>

Habitat Impact: Minor **(Pelagic habitats),** Minor **(Benthic habitats)**

One pelagic habitat was assessed in most recent ERAEF[89]. The risks to pelagic habitats from the fishery gear was assessed as minor or negligible.

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[88] Welsford, D., Ewing, G.P., Constable, A.J., Hibberd, T., Kilpatrick, R., 2014. Demersal fishing interactions with marine benthos in the Australian EEZ of the Southern Ocean: An assessment of the vulnerability of benthic habitats to impact by demersal gears. Final Report FRDC Project 2006/042. 258 pp.

[89] Sporcic, M., Pethybridge, H., Bulman, C.M., Hobday, A., Fuller, M. (2018). Ecological Risk Assessment for the Effects of Fishing. Final Report for the Heard Island and McDonald Islands Fishery: Demersal trawl sub-fishery 2010/11 to 2014/15. Report for the Australian Fisheries Management Authority. 141 pp.

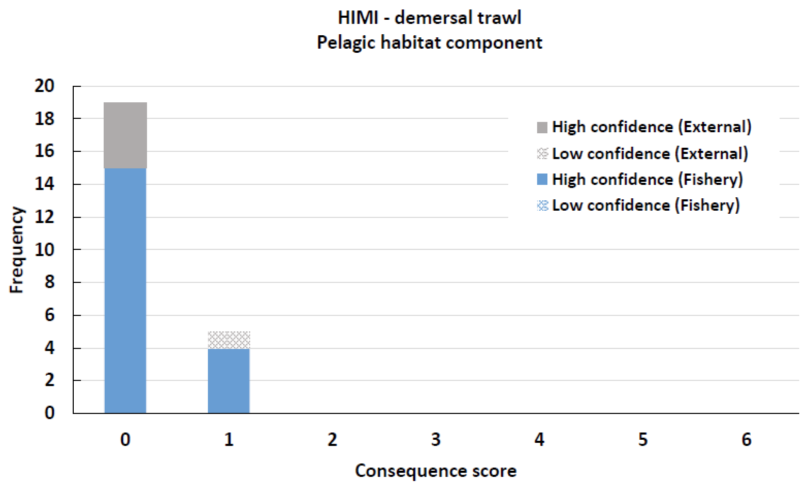

Figure 2.5. Habitat (pelagic): Frequency of consequence score by high and low confidence (not including activities impacting benthic habitats).

Benthic habitat assessment by Welsford indicates that the great majority of vulnerable organisms live on the seafloor in depths less than 1200 m. This range overlaps with the depths targeted by the trawl fishery, and to a lesser extent by the longline fishery. However due to the fact that the majority of trawling has focussed on a few relatively small fishing grounds, less than 1.5% of all the biomass in waters less than 1200 m are estimated to have been damaged or destroyed. Furthermore, the HIMI Marine Reserve, established in 2003, is estimated to contain over 40% of the biomass of the groups of benthic organisms considered as most vulnerable to bottom fishing at HIMI. Overall, an estimated 0.7% of the seafloor area within the EEZ at HIMI has had some level of interaction with bottom fishing gear between 1997 and 2013.

Data quality: Silver (pelagic)

Data quality: Gold (benthic)

Ecological > Habitats > Habitat impact > Habitat status

The status of the habitat types is a measure of the condition relative to a pristine state. Fishing may not be responsible for that habitat status, but it is important to note if fishing is taking place in pristine or disturbed habitats.

Habitat status: Excellent

Welsford et al (2014)[90] estimate that 1.5% of all benthic biota within fishable depths has been killed or damaged as a result of demersal fishing at HIMI between 1997 and 2013. The worst outcome at the level of taxa is for gorgonians, 2.7% predicted to have been killed or damaged over the same period. This relatively small amount of damage can be attributed to several factors, including the way the trawl and longline fishery operate, the spatial distribution of biota and the design of the HIMI Marine Reserve.

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[90] Welsford, D., Ewing, G.P., Constable, A.J., Hibberd, T., Kilpatrick, R., 2014. Demersal fishing interactions with marine benthos in the Australian EEZ of the Southern Ocean: An assessment of the vulnerability of benthic habitats to impact by demersal gears. Final Report FRDC Project 2006/042. 258 pp.

Data quality: Gold

Ecological > Ecological communities > Ecosystem status > Ecosystem status

This metric reports the ecosystem status in the region of the fishery.

Ecosystem Status: Excellent

Surveys and studies in the region, including assessments required under MSC certification (2017[91]) note that the water column and most of the benthic regions are in excellent condition. Large protected areas exclude fishing from more than 39% of water shallower than 100m, and the trawling footprint is small and reducing as longlining becomes the prevalent fishing method[92]. Removal of large toothfish is considered to have minimal ecosystem impact, although research is ongoing.

Data Quality: Gold

Ecological > Ecological communities > Ecosystem status > Species diversity

The measure of species diversity as a ratio between fished and unfished states.

Data quality: Not organised/analysed

Ecological > Carbon and Pollution > Macro-plastics > Plastic code of conduct

Macro-plastics are plastics that are visible to the naked eye, such as food containers and wrapping, equipment packaging, and fishing equipment. The metric notes a commitment to a zero waste overboard code of conduct to assess attempts to reduce accidental or intentional introduction of macro-plastics to the ocean. There are stated guidelines detailing Australia's guidelines regarding marine pollution from the Australian Maritime Safety Authority[93]:

Pollution of the marine environment by ships, including fishing vessels, is strictly controlled by the International Convention for the Prevention of Pollution from Ships (known as MARPOL).

To minimise pollution, MARPOL prohibits ships from discharging garbage into the sea except in very limited circumstances.

Australian MARPOL regulations apply to Australian fishing vessels wherever they are operating.

Data Quality: Bronze

Ecological > Carbon and Pollution > Carbon footprint > CO_2-equivalents

The emissions of climate forcing gases in kg CO_2-equivalents (CO_2e) per kg live weight fish caught, not including the supply chain after landing.

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[91] MSC 2017. https://fisheries.msc.org/en/fisheries/@@search? q¼toothfish&search¼ (last accessed 20 September 2017).

[92] Hornborg, S., A. J. Hobday, F. Ziegler, A. D. M. Smith and B. S. Green (2018). Shaping sustainability of seafood from capture fisheries integrating the perspectives of supply chain stakeholders through combining systems analysis tools. ICES Journal of Marine Science: https://doi.org/10.1093/icesjms/fsy1081.

[93] https://www.amsa.gov.au/marine-environment/marine-pollution/pollution-fishing-vessels
https://www.amsa.gov.au/marine-environment/marine-pollution/marpol-and-its-implementation-australia

Data Quality	Gear	Target species	Min (kg CO_2e/kg)	Average (kg CO_2e/kg)	Max (kg CO_2e/kg)	Reference	Description
Gold	Demersal longline	Patagonian toothfish		4.9		Hornborg et al accepted	Patagonian toothfish (CW) at HIMI, 2016, including bait use and refrigerants.
Gold	Otter trawl	Patagonian toothfish		7.2		Hornborg et al accepted	Patagonian toothfish (CW) at HIMI, 2016, including bait use and refrigerants.
Silver							
Bronze	Hooks and lines	Finfish	0.3		11.5	Parker and Tyedmers 2015	Global data, no refrigerants, unclear if bait fishing is included.
Bronze	Bottom trawl	Finfish	1.0	1.5	1.8	Parker and Tyedmers 2015	Oceania region, no refrigerants, year not specified.

Economic > Fishery Benefits > Net Economic Returns > Economic Rent

Net Economic Returns (NER) is equal to fishing revenue less fishing costs and measures the economic profit that is derived from fishing activity, it is measured by the Commonwealth as Net Economic Returns and by some States as Economic Rent.

Data Quality	Indicator	Year	Amount	Reference	Note
Not released	Net economic returns			Patterson, H, Noriega R, Georgeson, L, Larcombe, J and Curtotti, R (2017) Fishery status reports 2017, Australian Bureau of Agricultural and Resource Economics and Sciences, Canberra. CC BY 4.0.	Confidential - Estimates of NER are not available but are likely to be positive. Lower NER are likely for 2015–16 as there was significantly lower catch (a result of a lower TAC) and an increase in the level of uncaught TAC

Economic > Fishery Benefits > Gross Value of Production > Gross Value of Production

GVP calculated as the volume of catch multiplied by the average per unit beach price (AUD$).

Data Quality	Species/Fishery	Year	Amount	Reference	Note/Comment
Not released	HIMI	2015-2016		Patterson, H, Noriega R, Georgeson, L, Larcombe, J and Curtotti, R (2017) Fishery status reports 2017, Australian Bureau of Agricultural and Resource Economics and Sciences, Canberra. CC BY 4.0	

Economic > Fishery Benefits > Profitability > Financial Performance

Economic health of a fishery can be measured by the financial performance of the operators in the fleet. Fleet wide averages or distributions of levels of profitability indicate the extent to which the fishery is generating economic benefits for fishers.

Data Quality: Not found

Economic > Fishery Benefits > Latency > Underutilised Effort

Latency is fishery concessions that are not being fully utilised by fishers, for example, often the annual total allowable catch is left partially or largely uncaught for a fishery. Latency may appear as effort or uncaught TAC or inactive licences.

Data Quality	Indicator used	Year	Amount	Reference	Note
Bronze	Fishing right latency in fishing season	2015-2016	Low uncaught TAC	Patterson, H, Noriega R, Georgeson, L, Larcombe, J and Curtotti, R (2017) Fishery status reports 2017, Australian Bureau of Agricultural and Resource Economics and Sciences, Canberra. CC BY 4.0	

Economic > Community benefits > Value to community > GDP or GSP value

A fisheries contribution to Gross Domestic Production (GDP)/Gross State Product (GSP) is the total economic value that it generates directly, plus the indirect contribution made to other industries, which is also measured in value-add terms.

Data Quality: Not found

Economic > Community benefits > Wealth Spread > Distribution of fishing firm size

The spread of profits to owners and crew members indicates how widely benefits of fishing are distributed across the fishing community. A wide spread of benefits may be important to some fishery stakeholders. A narrow spread may not indicate a lack of distribution of benefits in the case where all participating businesses are the same size, or if other mechanisms are present to capture and distribute benefits such as high levels of employment of crew. The number of large business versus small business, classified by turnover (direct measure) or catch volume (proxy) may provide an indirect indicator: i.e. are economic returns from commercial fishing gained by one or two large businesses or a spread over many smaller businesses? **Data Quality:** Not released

Economic > Markets > Fish distribution > Fish receivers

One way of measuring benefits from a fishery is by assessing the flow of seafood through the supply chain. In many fishery jurisdictions, the first step in the supply chain is via licensed fish receivers who are allowed to receive fish for sale. They can also trade fish with other receivers. In some jurisdictions, commercial fishers must sell their catch to a receiver (although they can sell small amounts on wharves). While this restricts fishers' options for landing their catch, it means that fish can be tracked, reduces illegal fish trading and ensures that the Quota Management Systems (QMS) work effectively by ensuring catches do not exceed the total allowable catch or quota amounts for individual species. Receivers of fish may be fish processors, wholesalers or retailers.

In some jurisdictions, the fishers and fish receivers are integrated, such that they are effectively the same “business”. In Commonwealth fisheries, the total number of fish receivers per year may differ to the sum of the fish receivers per fishery because some receivers operate in more than one fishery.

Data obtained from AFMA for this demonstration phase of the project show the number of fish receivers in the HIMI fishery has remained stable since 2010.

	number of active fish receivers								
Fishery	2009	2010	2011	2012	2013	2014	2015	2016	2017
HIMI	3	2	2	2	2	2	2	2	2

Data Quality: Gold

Economic > Markets > Volatility in market price > Price volatility

Price volatility is the mean beach price for the target species (top one or five depending on price) over the given period (most recent ten years). The level of volatility is the standard deviation in mean price over this period. **Data Quality:** Not found

Economics > Energy costs > Energy Use > Fuel use per kg of fish harvested

Fuel use varies over time and between stocks and are best collected from industry on a yearly basis. Estimates for different fisheries should be compared with caution, and in particular comparing energy use between fisheries with different data quality which is not recommended (different data availability, may be e.g. old or not fisheries-specific). Estimates are provided for all levels of data quality if available and are given in L per kg live-weight.

Data Quality	Gear	Target species	Min (L/kg)	Average (L/kg)	Max (L/kg)	Reference	Description

Gold	Demersal longline	Patagonian toothfish		1.8		Hornborg et al accepted	LCA of Patagonian toothfish (CW) at HIMI, 2016, including bait and refrigerants
Gold	Otter trawl	Patagonian toothfish		2.6		Hornborg et al accepted	LCA of Patagonian toothfish (CW), at HIMI, 2016, including bait and refrigerants
Silver							
Bronze	Hooks and lines	Finfish	0.1		4.2	Parker and Tyedmers 2015	Global, unclear if bait fishing is included
Bronze	Bottom trawl	Finfish	0.4	0.5	0.7	Parker and Tyedmers 2015	Oceania region

Economic > Energy costs > Fossil fuel subsidies > Fuel subsidies directed to the fishery

Fossil fuel subsidies (fuel rebates) illustrate to which extent the fuel cost is reduced in the fishery, measured in AUD/kg live weight fish. Note that this form of tax exemption for fisheries is in Australia motivated from the sector not using roads (i.e. costs embedded in fuel price for road construction and maintenance), and are not formally reported as fuel subsidies in Australia.

Data Quality	Gear	Target species	Subsidy (AUD/kg)	Reference	Description
Gold	Demersal longline	Patagonian toothfish	0.71	Hornborg et al accepted	Fuel use from LCA of Patagonian toothfish (CW) at HIMI, 2016
Gold	Bottom trawl	Patagonian toothfish	1.06	Hornborg et al accepted	Fuel use from LCA of Patagonian toothfish (CW) at HIMI, 2016
Silver					
Bronze	All WA	All WA	0.46	Total tax claims per total landings in WA	Assuming WA (closest), 2015-16 (2016-17 also available), state level figures on landings are preliminary for 2015-16

Governance > Ecosystem governance > Bycatch mitigation > Description of the bycatch mitigation measures

Bycatch measures can be spatial (e.g. area closure), temporal (time closure, e.g. night setting only) or technical (bycatch reduction devices, hook size). This indicator describes the measures that are in place for a fishery – but not the rates of compliance. For example, spatial closures for different gear types are shown here for AFMA fisheries http://www.afma.gov.au/sustainability-environment/fishing-closures/.

There are a range of measures in place in Australia's sub-Antarctic fisheries to ensure levels of bycatch are minimised and mitigation strategies are implemented to avoid interactions.[94]

No discarding
Catch limits
Bycatch assessments
Move-on provisions
Seabird bycatch mitigation strategies

Data Quality: Gold

Governance > Ecosystem governance > Protected species mitigation > Description of the protected species mitigation measures

TEP mitigation measures can be spatial (e.g. area closure), temporal (time closure, e.g. night setting only) or technical (bycatch reduction devices, hook size). This indicator describes the measures that are in place for a fishery – but not the rates of compliance.

The management plans for the HIMI fishery require that all bycatch and offal be retained in order to limit possible interactions with marine mammals and seabirds. All retained bycatch is processed into fish meal or minced offal with the exception of Grey Rockcod and Unicorn Icefish, which are generally retained whole. Skates, sharks, jellyfish, sponges, crabs and coral are generally returned to the ocean as these species either have a high chance of survival, do not attract seabirds and marine mammals when discarded, or cannot be effectively processed through the meal plant or mincer.
The HIMI fishery also has strategies to avoid potential interactions with seabirds for long line and trawl operations, such as limited longline seasons, night setting, paired streamer lines, mesh size restrictions, prohibition on the use of plastic packaging bands and minimisation of lighting.[95]

Data Quality: Gold

Governance > Management system > Harvest strategy > Scope of the harvest strategy

Assessment can be based on scoring presence of the following: a harvest strategy designed to achieve management objectives; harvest control rules and tools; collection of relevant information to support the harvest strategy; and, assessment of stock status or the presence of the following key elements: Defined operational objectives for the fishery; Indicators of fishery performance related to the objectives; Reference points for performance indicators; A statement defining acceptable levels of risk to meeting objectives; A monitoring strategy to collect relevant data to assess fishery performance; A process for conducting assessment of fishery performance relative to objectives; and; Decision rules that control the intensity of fishing activity and/or catch.

The AAD, in collaboration with industry, regularly conducts fisheries-independent, random-stratified trawl surveys for target species (Patagonian toothfish and mackerel icefish) to collect relative abundance data, particularly of juvenile age classes. Harvest strategies for the target species are consistent with the precautionary approach implemented by the CCAMLR and have been used to set catch limits since the mid 1990s. The harvest strategies developed for the Heard Island and MacDonald Islands Fishery (HIMIF) are considered more precautionary than the guidelines of the

[94] http://www.afma.gov.au/wp-content/uploads/2014/11/Bycatch-and-discard-workplan-2013-2.pdf
[95] https://www.afma.gov.au/sites/g/files/net5531/f/uploads/2014/11/Bycatch-and-discard-workplan-2013-2.pdf

Commonwealth Fisheries Harvest Strategy Policy (DAFF 2007[96]). For mackerel icefish, the reference point dictates that the spawning stock biomass be maintained at 75 per cent of the level that would occur in the absence of fishing at the end of a two-year model projection. For Patagonian toothfish, the reference points dictate that median escapement of the spawning biomass at the end of a 35-year projection period is 50 per cent of median pre-exploitation level and that the probability of the spawning biomass dropping below 20 per cent of its pre-exploitation median level is less than 10 per cent over the projection.[97]

Data Quality: Gold

Governance > Management system > Management plans > Scope of management plan

Management plans can be assessed by evaluating the presence of minimum requirements, as follows: a description of the fishery, especially its current status and any established user rights: the management objectives; how these objectives are to be achieved; how the plan is to be reviewed and/or appealed, as well as the consultation process for review and appeal.

The Heard Island and McDonald Islands Fishery is managed under the Heard Island and McDonald Islands Fishery Management Plan 2002[98] which contains the following minimum requirements:

Area of the fishery
Objectives (Act s 17 (5))
Measures by which objectives attained (Act s 17(5))
Performance criteria for assessing measures to achieve objectives
Statutory fishing rights
Fisheries assessment plan

Data Quality: Gold

Governance > Institutional capacity > Accountability of decision making bodies > Level of Accountability

Accountability of Decision-making bodies. Performance of a fisheries management agency is based on the degree to which decision-making processes are consultative, the basis for decisions are fully explained, and information about decision making is publicly available. The assessment applied the three tiers of Principle 3.2.2 (d) 'Decision-making process' of the MSC Fisheries Standard v2.0 (2014) to determine whether the level of accountability was low, medium or high.

High level of accountability. This is demonstrated by the availability of a management plan, assessment report and catch determination policy, and of decision-making procedures and outcomes online. The fishery has achieved and maintained MSC certification since 2012, and this includes assessment of Principle 3 and 3.2.2 at the highest level.

Data Quality: Silver

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[96] DAFF (2007) Commonwealth Fisheries Harvest Strategy: policy and guidelines, Australian Government Department of Agriculture, Fisheries and Forestry, Canberra.
[97] Patterson, H, Noriega R, Georgeson, L, Larcombe, J and Curtotti, R (2017) Fishery status reports 2017, Australian Bureau of Agricultural and Resource Economics and Sciences, Canberra. CC BY 4.0.
[98] https://www.legislation.gov.au/Details/F2016C00640

Governance > Institutional capacity > Uncertainty management > Extent of incorporation of uncertainty in management of the targeted stock

This metric reports on the explicit incorporation of uncertainties in decision support processes used to inform and make appropriate choices of management actions. We recognise three levels of uncertainty: Low level of incorporation of uncertainty; Medium level of incorporation of uncertainty; High level of incorporation of uncertainty. These are based on: Major sources of uncertainty are identified; Assessment takes uncertainty into account; Frequency of monitoring of indicators is high; Monitoring of more than one indicator to support management decisions; Assessment evaluates stock status relative to reference points in a probabilistic way; Robustness of assessments are tested, Alternative hypotheses and assessment approaches are rigorously explored.

High level of incorporation of uncertainty in management of the targeted stock.	MSC Certification by SCS Global Services (2017). The fishery has achieved and maintained MSC certification since 2012, and this includes assessment of Principle 1.2.4.

Data Quality: Gold

Governance > Compliance > Compliance regime > Level of Compliance

Level of compliance with rules and regulations controlling catch can be assessed by audits that measure the agreement between 1) logbook and observer records; 2) catch disposal records submitted by fishers and fish receivers. It might also be assessed by counting the annual number of breaches/observed offences or enforcement actions, preferably scaled to the level of enforcement effort (e.g. $). This indicator can be scored on the basis of the presence of key monitoring, control and surveillance elements and capacities.

AFMA fisheries officers regularly inspect fishing boats and fish receivers. They often visit fishing ports and board boats at sea to try to ensure the rules of fishing are being followed.[99]

Data Quality: Bronze

Governance > Compliance > Surveillance > Surveillance Effort

Regulatory controls include logs and catch reporting, on-board observer programs, vessel inspections, vessel monitoring systems, and visual or electronic surveillance using radar or satellite by boat or by air. Higher degrees of surveillance, or coverage using multiple methods, provide greater levels of certainty in estimates of effort, fishing mortality, bycatch and discard levels, and interactions with protected/listed species. Report on the surveillance carried out on the fishery, as reported by the compliance branch responsible for the fishery

Surveillance effort score: undefined
AFMA uses different methods to monitor fishing activities in the Heard Island and McDonald Islands Fishery.

On-board observers - One of the main monitoring methods used by AFMA is on-board scientific observers. These observers are people employed by AFMA to go out on boats and independently

[99] http://www.afma.gov.au/fisheries/heard-island-mcdonald-island-fishery/

record the catch, effort and biological information of each fishing trip. They take samples from fish, such as the otoliths or ear bones, and use these to determine the age of the fish caught. Observers also record the length, weight and sex of each fish caught during a trip and report on the other wildlife that may be seen, the weather conditions, the composition of commercial catch fate of species that are caught as bycatch.
Boats in the Heard Island and McDonald Islands Fishery must carry an AFMA observer at all times.

Satellite tracking - A satellite monitoring system called a Vessel Monitoring System (VMS) is fitted to every boat in the fishery. This system helps AFMA to monitor vessel position, course and speed. The tracking unit regularly transmits the information through a communications satellite to a station on land. This information is sent by secure internet connection to a database at AFMA.

Compliance - AFMA fisheries officers regularly inspect fishing boats and fish receivers. They often visit fishing ports and board boats at sea to try to ensure the rules of fishing are being followed.[100]

Data Quality: Bronze

Governance > Adaptive capacity > Governance arrangements > Climate change recognition

Governance arrangements relevant to the fishery consider the impact of climate change on the fishery, as evidenced by documentation, policies and plans that describe how management is addressing climate change impacts. Does the fishery management plan, harvest strategy or research activity suggest that climate change is recognised, and integrated into management planning?

The influence of the environment on the distribution and abundance of target species in this fishery have been documented in published literature, and reported by the fishers. Climate change impacts have been recognised by the fishery, which is working with research partners to understand potential responses. Fishery-specific plans are being developed under the AFMA –led project "Adaptation of Commonwealth Fisheries Management to Climate Change (FRDC 2016-059)". This project will conclude in June 2019.

The National Harvest Strategy also recognizes that "*Variability in ocean conditions, due to natural variability, climate change or other factors, can affect the productivity of stocks. Fisheries should seek to account for that variability when developing and implementing harvest strategies*"[101]. The Guidelines for the Harvest Strategy provide explicit approaches for fisheries[102].
Data quality: Silver

Governance > Adaptive capacity > Coping strategies > Climate responses

The fishery has initiated coping strategies (directed) to reduce the impacts of climate change. Evidence of strategies that have been specifically implemented for the fishery might include codes of practice, restocking programs, early warning systems, and so on. The coping strategies may be for long-term change or for extreme events. A description of the climate change responses that have been implemented or explored in research or application are provided.

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[100] http://www.afma.gov.au/fisheries/heard-island-mcdonald-island-fishery/
[101] Department of Agriculture and Water Resources 2018, *Commonwealth Fisheries Harvest Strategy Policy*, Canberra, June. CC BY 4.0.
[102] Department of Agriculture and Water Resources 2018, *Guidelines for the Implementation of the Commonwealth Fisheries Harvest Strategy Policy*, Canberra, June. CC BY 4.0.

The influence of the environment on the distribution and catchability of target species in this fishery is the subject of active investigation.

Data quality: Bronze

Social and Ethical > Fishers wellbeing > Fisher satisfaction > Satisfaction scores

If available, fishery specific surveys of well-being or satisfaction, with interpretation required for the types of questions and sample. When surveys are not available other sources of data may need to include broader surveys (e.g. not fishery specific) or discussions with industry representatives, managers or fishers about the industry and their opinion of general fisher-wellbeing (note this will be subjective).

Data Quality: Not found

Social and Ethical > Fishers wellbeing > Age Structure > Proportion of fishers in standard age cohorts

Proportion of fishers in standard age cohorts that were involved in the fishery at any point in the previous 5 years. If the fishery is not attractive or difficult to enter, the age distribution will be skewed to older ages. **Data Quality:** Not released

Social and Ethical > Wider community > Community satisfaction with fishery > Community feedback

Evidence of processes in place to gather direct engagement with the community (diversely represented) to listen and respond to feedback. This may be through a range of means including formal and informal processes and may not be appropriate to all fisheries in the same way. In some cases Marine Stewardship Council accreditation may demonstrate some evidence of community engagement.

Community feedback: Medium.

The fishery has Marine Stewardship Certification. It has a management advisory committee, which could oversee a feedback process. Based on general FRDC community perception surveys, satisfaction with Australian fisheries is rated at 42%.

Data quality: Bronze.

Social and Ethical > Wider Community > Level of local employment > Percentage of local employment

The communities surrounding and supporting fisheries benefit from those fisheries when the majority of employees (direct and indirect) associated with the fishery activity are local. Can be reported as direct, indirect and downstream levels. **Data Quality:** Not found

Social and Ethical > Ethical - Human welfare > Protections in place > Legislation exists

Although all workers are automatically operating under legislation according to their state or territory to a safe work place, the extent to which there is awareness of the relevant Acts, and use of these if required, is highly variable and may be different for each business or individual operation within each fishery. See http://workplaceohs.com.au/legislation for a list of state acts and regulations.

Protections in Place: High

The Heard Island and McDonald Island Fishery is a commonwealth fishery. It operates under Commonwealth regulations (administered by Comcare) – WHS Act 2011 and WHS Regulations 2011. On-board training and safety drills are regularly undertaken due to operations occurring in Antarctic waters.

Data Quality: Gold

Social and Ethical > Ethical > Human welfare > Levels of compliance

Levels of compliance (or violations of) with Workplace Health and Safety. If references to Workplace Health and Safety exist in relation to the specific fishery, determine whether these are voluntary or recorded in anyway. If they are recorded, note the level of compliance. As they are likely to be voluntary, there will not likely be a record of compliance, but this may become more readily available in the future. **Data Quality:** Not found

Social and Ethical > Ethical-animal welfare > Animal welfare protections > Protections in place

At this early stage of development of animal welfare, any type of mention of animal welfare exists, it is probably the most appropriate. As this develops in to the future, assessments as to the level of engagement may become more relevant.

There are two observers on all trips to monitor compliance and collect data with move on provisions if a threshold of bycatch is reached and discharge of waste that might attract potential bycatch is prohibited (Department of Environment and Water Resources 2007)

Data Quality: Bronze

Social and Ethical > Ethical-animal welfare > Level of Compliance > Levels of compliance or violations of animal welfare

If there are any references to animal welfare protections or guidelines in fishery management plans and if reports exist, the indicator reports on the level of compliance or violations with welfare provisions.

Data Quality: Not found.

Social and Ethical > Climate-related > Access to information > Availability of information

This indicator describes available information that will help participants in the fishery adapt to changes. The assumption behind this indicator is that good information availability and flow will help fishers to adapt.

Availability of information: Medium
AFMA maintains a website for this fishery.

Data Quality: Gold.

Social and Ethical > Climate-related > Access to networks > Level of membership of industry association

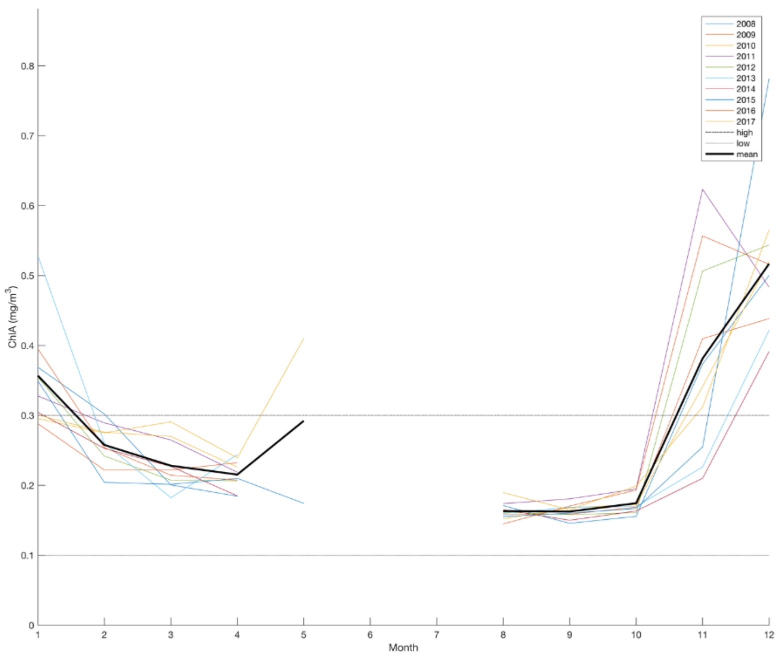
This metric assesses the presence or absence of a dedicated social media or social network group for the fishery. The fishery may still have a strong social network without a social media presence.

Network in place: Yes
AFMA is active on Facebook.

Data Quality: Bronze

External > Environmental Context > Productivity > Mean chlorophyll

A measure of environmental productivity is the biomass of phytoplankton, which in oceanic waters can be approximated by chlorophyll a concentration, as estimated from satellite (MODIS, oceandata.sci.gsfc.nasa.gov). Monthly chlorophyll values for a representative area of the fishery are shown with the mean productivity shown in solid black and references levels of low chlorophyll at 0.1 mg $m^{-3}$and high chlorophyll levels at 0.3 mg m^{-3}. This indicator shows the mean chlorophyll by month for the years 2008-2017. These data provide information on the relative environmental productivity in the fishery area. Missing data for some months can be due to ice cover. Variability in chlorophyll a concentration between years can indicate high environmental variability, while similar seasonal patterns indicate relative environmental stability.



Data Quality: Gold

External > Environmental Context > Environmental character > Description of the ecosystems

This metric provides a qualitative description of the ecosystem(s) in which the fishery occurs. The goal is to provide a general overview of these environments. The knowledge about which ecosystems are encountered during fishing activity is the indicator (rather than the response of the ecosystems to fishing).

Marine ecosystems are defined for the purposes of this indicator as the composition of plants, animals, and the marine environment (water masses, geomorphology). Types of marine ecosystems include estuaries, the sea floor, the mesopelagic zone, the pelagic zone, the inter-tidal zones, coral reefs, lagoons, and mangroves. A pelagic zone ecosystem for example, is defined by physical, chemical and biological features of the marine water column of the open ocean[103].

Description of the ecosystems: High

The Australian external territory of Heard Island and McDonald Islands (HIMI) is in the southern Indian Ocean, within the area covered by the Convention on the Conservation of Antarctic Marine Living Resources. The islands and their surrounding territorial waters (out to 12 nautical miles [nm]) are closed to fishing and regulated under the *Environment Protection and Management Ordinance 1987,* administered by the Australian Antarctic Division (AAD) of the Australian Government Department of the Environment and Energy. A 1 nm buffer zone around the territorial waters of HIMI extends the area closed to fishing to 13 nm. The fishery takes place in the pelagic waters in this region.

Data Quality: Gold

External > Climate related > Susceptibility of target species > Impacts on target species

Climate change directly affects the distribution, abundance and phenology of individual species. These changes then affect the fisheries that harvest these species, and can be a strong external influence on the fishery. These impacts can be positive (e.g. increased abundance), or negative (e.g. movements further from fishing ports), and to long-term warming, or short-term extreme events such as marine heatwaves. **Data Quality:** Not Found

External > Climate related > Susceptibility of key habitats > Habitat Impacts

Habitat impact: Low

Data Quality: Bronze

External > Contaminants in the environment > Detection system for seafood contaminants > Risk of contaminants

Potential risk for contamination from the marine environment combined with monitoring arrangements to be able to address risks needed to ensure food safety. Contaminants include those with maximum levels set for by Food Standards Code Australia: metal contaminants, non-metal

[103] Game, E. T., H. S. Grantham, A. J. Hobday, R. L. Pressey, A. T. Lombard, L. E. Beckley, K. Gjerde, R. H. Bustamante, H. P. Possingham and A. J. Richardson (2009). Pelagic protected areas: the missing dimension in ocean conservation. Trends in Ecology and Evolution **24**(7): 360-369 doi:310.1016/j.tree.2009.1001.1011.

contaminants, natural toxicants, and average and maximum levels of mercury in fish. Contaminants from poor handling after landing are not assessed but may be indirectly addressed.

Rubric for risk level:

Low risk	Medium risk	High risk
There are no documented levels of contaminants from the marine environment causing risk/diet restrictions to any consumer group in the fishery.	There may be seasonal/area/species/size-based risks of contaminants for some species.	Permanent diet restrictions of species caught to vulnerable consumers such as children or pregnant women.

Risk of Contaminants: Low

No specific monitoring arrangements found for marine contaminants on the fishery webpage: http://www.afma.gov.au/fisheries/heard-island-mcdonald-island-fishery/. Even if mercury levels occur in toothfish species, they are not at levels causing diet restrictions: https://link.springer.com/article/10.1007%2Fs00128-018-2326-4.

Data Quality: Silver

External > Contaminants in the environment > Management arrangements to ensure food safety related to contaminants > Evidence for arrangements

There is evidence of management arrangements to ensure food safety related to contaminants and food safety from the marine environment. No supply chain risks from poor handling are considered. Food standard 4.2.1 requires all seafood business in Australia to identify potential seafood safety hazards and put controls in place that are consistent with the risk.

Data quality: Not found

External > Market Drivers > Macroeconomic factors > Exchange Rates

A depreciating Australian dollar (or, increasing exchange rate) generally results in producers receiving a higher export price in Australian dollar terms, while an appreciating Australian dollar (or, decreasing exchange rate) results in a lower export price. Domestically, a depreciation of the Australian dollar encourages substitution from imported seafood to domestically produced seafood, as imported products become relatively more expensive. A lower exchange rate also makes Australian exports more competitive in world markets, as exported seafood become relatively cheaper in foreign currency terms.

National export trends are negatively related to exchange rate movements— the Australian dollar declined against the US dollar and Japanese yen from 1990–91 to 2000–01, with exports increasing in volume and value. Exchange rates for the Australian dollar increased against those currencies from 2001–02 to 2015–16. The real export value and volume of Australia's seafood exports decreased between 2005–06 and 2012–13 and then increased between 2012–13 and 2015–16—with a noticeable rise (43 per cent) in volume between 2014–15 and 2015–16.[104]

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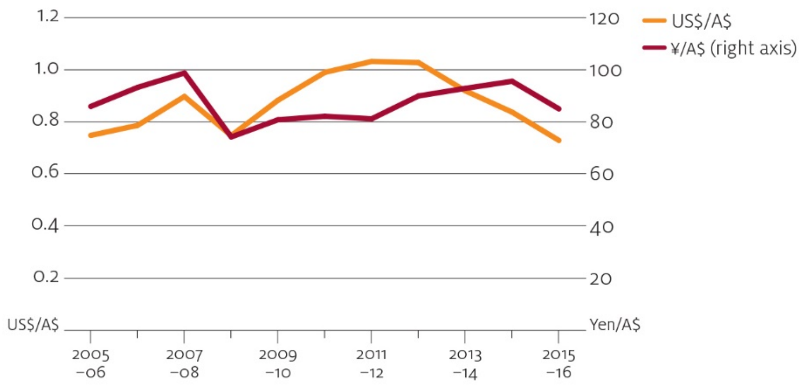
[104] Mobsby, D and Koduah, A 2017, Australian fisheries and aquaculture statistics 2016, FRDC project 2017-095. ABARES, Canberra, December. CC BY 4.0.



Data Quality: Gold

External > Market Drivers > Consumer Trends > Per person annual apparent consumption of seafood (kg)

Annual apparent consumption is estimated by adding the total edible quantity of seafood supplied domestically—that is, total production plus imported seafood— less exports of seafood. Apparent consumption provides an estimate of the total amount of seafood consumed in Australia assuming zero change in stocks.

The production quantity of Australian fishery and aquaculture products is reported by ABARES on a whole weight basis, whereas trade data are reported on a processed basis. To align the units of measurement between production and trade data, it is necessary to convert production volume to a processed edible equivalent.

Production volumes are adjusted to an edible quantity basis using species-specific conversion rates and excluding species that are known to be predominantly supplied for non-human consumption purposes, such as for aquaculture feed or bait. Imports and exports of seafood are sourced from Australian Bureau of Statistics (ABS) trade data and are reported as edible weight. The apparent consumption per person is calculated as the total apparent consumption divided by the total Australian population in each year. The method applied here is consistent with that used by ABARES to estimate apparent consumption of other agricultural commodities produced in Australia.

The FAO also compiles statistics on apparent consumption of seafood, applying a consistent method across all countries. FAO estimates indicate that annual consumption of seafood in Australia is around 26 kilograms per person in 2013 (FAO 2016[105]). The discrepancy between FAO and ABARES estimates reflects differences in methodological approaches to estimating consumption. Moreover, ABARES estimates seafood consumption on a processed edible basis, whereas the FAO provides its estimates on a whole weight basis.

In Australia, apparent consumption of seafood per person (edible equivalent) decreased, on average, at an annual rate of 0.6 per cent, from 14.6 kilograms in 2005– 06 to 13.8 kilograms per person in 2015–16. Annual apparent consumption is estimated by the Australian Bureau of Agricultural and Resource Economics and

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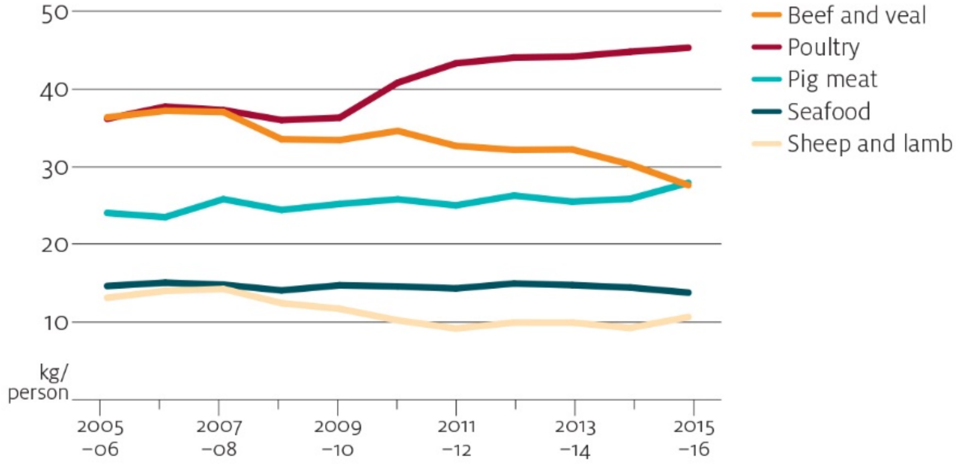
[105] The state of world fisheries and aquaculture 2016—opportunities and challenges, Food and Agriculture Organization of the United Nations, Rome.

Sciences by adding the total edible quantity of seafood supplied domestically—that is, total production plus imported seafood— less exports of seafood[106]

In comparison, global per capita apparent fish consumption increased from an average of 9.9 kg in the 1960s to 14.4 kg in the 1990s and 20.1 kg in 2014, with preliminary estimates for 2015 indicating further growth, exceeding 20 kg (FAO 2016). Australia's per person seafood consumption in 2013 was estimated by the FAO to be 26kg. The differences in estimates are accounted for by varying methods for calculating consumption. ABARES estimates seafood consumption on a processed edible basis, whereas the FAO provides its estimates on a whole weight basis.



Data quality: Gold

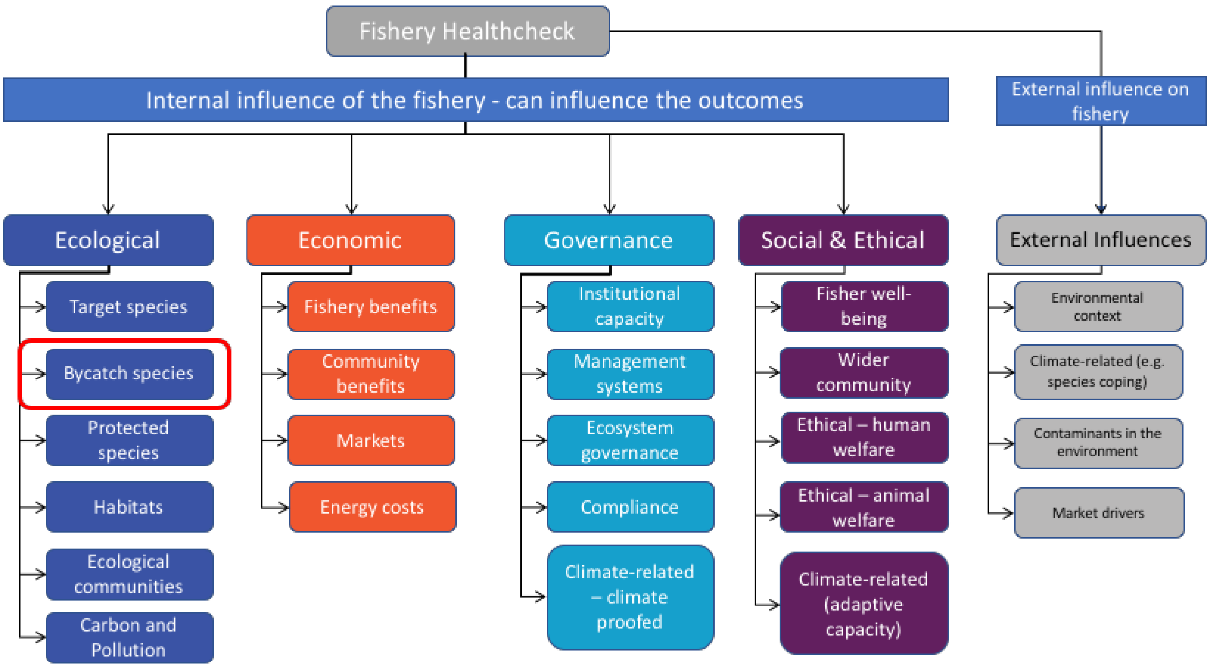
[106] Mobsby, D and Koduah, A 2017, *Australian fisheries and aquaculture statistics 2016*, FRDC 2017-095. ABARES, Canberra, December. CC BY 4.0

New South Wales Spanner Crab Fishery

The New South Wales commercial harvest of spanner crabs is a component of the NSW Ocean Trap and Line share management fishery. The fishery operates under a Fishery Management Strategy, which includes a description of the fishery and its management arrangements. The Strategy was developed as a consequence of a comprehensive environmental impact assessment process. The spanner crab fishery is a relatively small scale (< $1m), data limited, single method, single species fishery that is divided spatially into northern and southern zones. There are 29 fishing businesses that hold shares in the fishery. The GVP of the fishery is less than $1m which is less than 1% of the total GVP of NSW's commercial fisheries. Historically, the majority (> 90%) of the average annual catch of less than 200 tonnes is taken in the northern zone. The fishery is centrally managed by Fisheries NSW with spanner crab stocks shared with a small recreational fishery and Queensland. The northern zone of the fishery has been managed under a catch quota regime for the past 2 years and both zones will be combined into a single catch quota managed fishery in July 2018. Although the harvest operations of the NSW Ocean Trap and Line Fishery are approved as a wildlife trade operation, the majority of the catch is marketed domestically. (Source: Fisheries Guidelines Project)

Case Study Presentation Format

The case study documents are a collection of metrics, organised by the healthcheck structure:



The presentation of metrics will follow the following heading format:

Ecological > Bycatch species > Bycatch composition > Mean Trophic Level

Understand this to be an indicator (**Bycatch composition**) of the **Ecological** Component, **Bycatch species** subcomponent where the (in the figure and heading example above, is being measured by presenting Mean Trophic Level as the metric.

Ecological > Target species > Stock Status > Status of Australian Fish Stocks (SAFS)

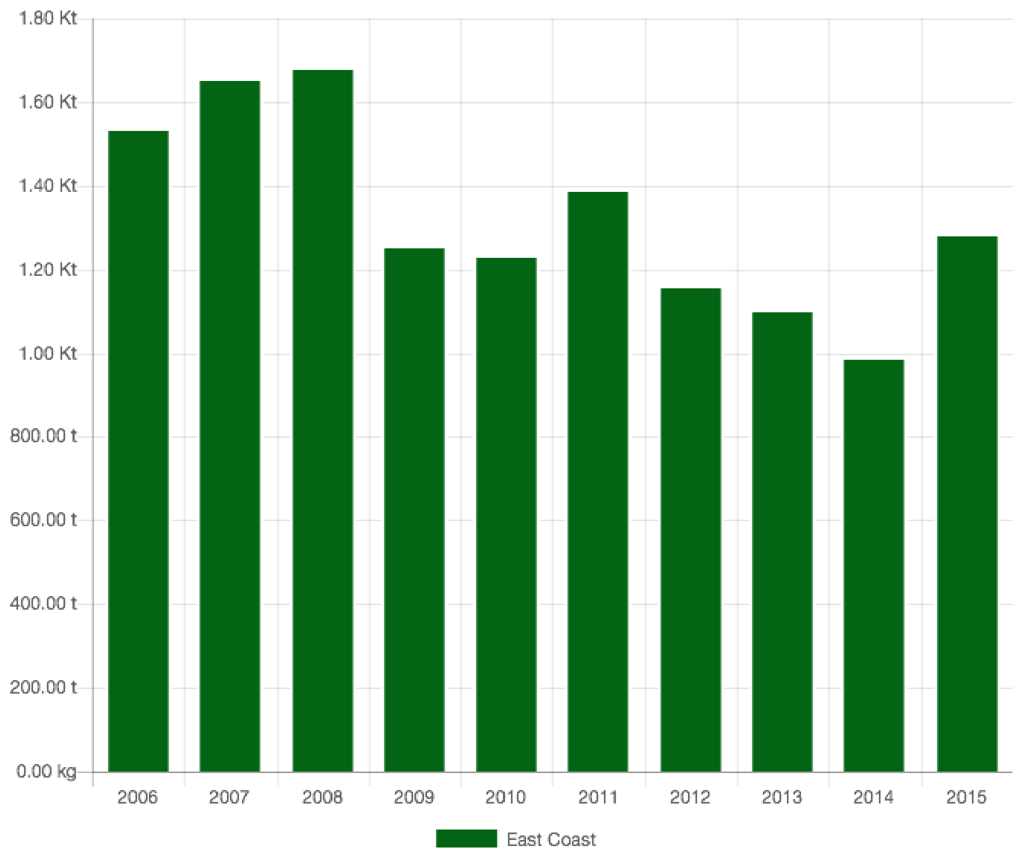
Target species in each fishery are the primary focus for this indicator. Status of these species is ideally assessed with the SAFS approach, however this may not cover all target species for each fishery. In that case, we indicate the number of unassessed species. These species could also be assessed by individual states or by alternative methods. **Data Quality:** Not found

Ecological > Target Species > Harvest Level > Catch weight

This metric is a proxy for harvest level. The harvested biomass for each species, provides information on the level of the catch. Trends in this metric over time can indicate declining availability of fish, quota restrictions, or changes in market demand. For Australian fisheries, trends are expected to be stable for most species.

The spanner crab is a highly regarded seafood product caught on the north coast of NSW. This species accounts for approximately 11% of the total Ocean Trap and Line Fishery catch each year caught using the spanner crab net gear. Recent catches[107] are:

[107] Catch data obtained from http://www.fish.gov.au/report/68-Spanner-Crab-2016



Commercial catch of Spanner Crab - note confidential catch not shown

Data quality: Gold

Ecological > Bycatch species > Bycatch composition > Mean Trophic Level

The trophic level is a measure of the position of an organism in a food web, starting at level 1 with primary producers, such as phytoplankton, then moving through the primary consumers at level **2** that eat the primary producers to the secondary consumers at level **3** that eat the primary consumers, and so on. The **bycatch mean trophic level** is an indicator of the mean level of the food chain for bycatch in a fishery.

This fishery has very low bycatch, and so this metric was not calculated

Data Quality: Not applicable

Ecological > Bycatch species > Bycatch amount > Total weight of bycatch

Bycatch weights for fishery are typically developed by specific projects, and require a range of assumptions due to issues with reporting and retention of bycatch. **Bycatch** estimates typically cover species that are not target species, while **discard** rates may also include undersized individuals of the target species. Kennelly (2018) provides estimates of discard rates, which include both target and bycatch species, and when discard rates are used, that information is noted for each fishery. Animals can be returned to the ocean alive or dead. The intention of this metric is to provide information on animals that are dead on return to the ocean.

Reference:

Kennelly, S.J., 2018. *Developing a National Bycatch Reporting System.* Final FRDC Report, ISBN 978-0-9924930-5-9, March, 2018. 99 pp.

A continuation of Kennelly (2018) is underway and will provide these data shortly.

Data Quality: Not organised/analysed

Ecological > Protected species > Capture amount > Captures

The number and diversity of TEP species captured by a fishery in the most recent year, provided as annual numbers.

Mandatory reporting of threatened and/or protected species interactions was implemented in this fishery in 2005. From the 2017 assessment[108], there were no interactions due to the Spanner Crab gear used in this fishery.

Data quality: Gold

Ecological > Protected species > Reporting > Level of monitoring

This indicator is to provide information on the level of coverage for a fishery. Annual measures are preferred.

Commercial fishers are not permitted to take either protected fish or fish protected from commercial fishing. These species are listed in clause 6 and clause 7 of the FM Regulation. A range of threatened species, other than fish, are protected by other legislation including the NSW Threatened Species Conservation Act 1995, the NSW National Parks and Wildlife Act 1974, and the Commonwealth Environment Protection and Biodiversity Conservation Act 1999. Such species may be classified as threatened, endangered or vulnerable and cannot be retained by commercial fishers.

Interactions with threatened species and species of public concern.
Although interactions with threatened species have not been commonly recorded in this fishery, this FMS includes two direct measures to obtain data on any such interactions. The first of these measures is a modification to the catch reporting system which incorporates mandatory reporting of fishers' interactions with threatened species during fishing operations (see management response 3.1a). Secondly, the implementation of a periodic observer survey will, inter alia, collect data on occurrences of threatened species in catches (see management response 1.2a). A number of management responses appearing in section 4 of this FMS are also aimed at minimising impacts on threatened species. These measures include educating fishers in the identification/avoidance of threatened species, using fishing closures and modifying gear use to minimise known interactions with threatened species, and implementing the provisions of any threatened species recovery plans and threat abatement plans (management response 3.1b).[109]

Data quality: Bronze

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[108] https://www.environment.gov.au/system/files/pages/9d8670c9-3f67-456a-b68b-1f87f8ffed62/files/application-2017.pdf
[109] https://www.dpi.nsw.gov.au/__data/assets/pdf_file/0005/632408/Ocean-Trawl-FMS.pdf

Ecological > Habitats > Habitat impact > Impact score

The habitat impact is an indicator of the effect the fishing gear has on the habitat. Different gear types have different impacts. See the scoring rubric.

Habitat Impact: Moderate, based on the gear type used in this fishery.

Data quality: Bronze

Ecological > Habitats > Habitat impact > Habitat status

The status of the habitat types is a measure of the condition relative to a pristine state. Fishing may not be responsible for that habitat status, but it is important to note if fishing is taking place in pristine or disturbed habitats.

Habitat status: Moderate – changing environment as a result of climate change has significantly impacted this system

Data quality: Bronze

Ecological > Ecological communities > Ecosystem status > Ecosystem status

This metric reports the ecosystem status in the region of the fishery.

Ecosystem Status: Moderate

The 2016 State of Environment report notes the following [110]

Seabed at depths of 25-250m*: The state is likely **poor to good** in the South-east and Temperate East marine regions*

Seabed at depths of 250-700m*: Seabed habitats are spatially restricted, with varying impacts as a result of pressures, resulting in varying state and trends. State is **poor to very poor** but improving in the South-east/Temperate East marine regions*

Data Quality: Bronze

Ecological > Ecological communities > Ecosystem status > Species diversity

The measure of species diversity as a ratio between fished and unfished states.

Data quality: Not found

Ecological > Carbon and Pollution > Macro-plastics > Plastic code of conduct

Macro-plastics are plastics that are visible to the naked eye, such as food containers and wrapping, equipment packaging, and fishing equipment. The metric notes a commitment to a zero waste overboard code of conduct to assess attempts to reduce accidental or intentional introduction of macro-plastics to the ocean. There are stated guidelines detailing Australia's guidelines regarding marine pollution from the Australian Maritime Safety Authority[111]:

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[110] https://soe.environment.gov.au/assessment-summary/marine-environment/state-and-trends-habitats-and-communities

[111] https://www.amsa.gov.au/marine-environment/marine-pollution/pollution-fishing-vessels
https://www.amsa.gov.au/marine-environment/marine-pollution/marpol-and-its-implementation-australia

Pollution of the marine environment by ships, including fishing vessels, is strictly controlled by the International Convention for the Prevention of Pollution from Ships (known as MARPOL).

To minimise pollution, MARPOL prohibits ships from discharging garbage into the sea except in very limited circumstances.

Australian MARPOL regulations apply to Australian fishing vessels wherever they are operating.

Data Quality: Bronze

Ecological > Carbon and Pollution > Carbon footprint > CO_2-equivalents

The emissions of climate forcing gases in kg CO_2-equivalents (CO_2e) per kg live weight fish caught, not including the supply chain after landing.

Data Quality	Gear	Target species	Min (kg CO_2e/kg)	Average (kg CO_2e/kg)	Max (kg CO_2e/kg)	Reference	Description
Gold							
Silver	Mixed	Snapper, leatherjacket		3.3		Parker et al 2015	Ocean trap and line fishery, 2002, half of fleet petrol based, other half diesel, no refrigerants or potential bait use included
Bronze	Pots and traps	Crustaceans	2.1	10.4	23.8	Parker and Tyedmers 2015	Oceania region, year and fuel type not specified, unclear if bait fishing is included

Economic > Fishery Benefits > Net Economic Returns > Economic Rent

Net Economic Returns (NER) is equal to fishing revenue less fishing costs and measures the economic profit that is derived from fishing activity, it is measured by the Commonwealth as Net Economic Returns and by some States as Economic Rent.

Data Quality	Indicator	Year	Amount	Reference	Note
Bronze	Economic rent	2012-2013	-$322	Voyer, M., K. Barclay, A. McIlgorm and N. Mazur (2016). Social and Economic Evaluation of NSW Coastal Professional	Estuary General Fishery/Ocean Trap Line/Ocean Haul combined Data from 57 responses

				Wild-Catch Fisheries: Valuing Coastal Fisheries (FRDC 2014-301). Canberra, Australia, Fisheries Research and Development Corporation (FRDC). July	from 989 contacted and only 46 responses were deemed useable

Economic > Fishery Benefits > Gross Value of Production > Gross Value of Production

GVP calculated as the volume of catch multiplied by the average per unit beach price (AUD$).

Data Quality	Species/Fishery	Year	Amount	Reference	Note/Comment
Bronze	Spanner Crab	2003-2008	$6,033	Structural Reform Program. Statistical information for industry. The NSW Ocean Trap and Line Fishery. (http://www.dpi.nsw.gov.au/__data/assets/pdf_file/0019/631603/OTL-infoV2.pdf)	Gross Value of Product (GVP) is based on reported landings by species using the corresponding Sydney Fish Market average monthly species price. For brevity it is reported to the nearest $1,000 for the 5 years (5yr $'000).

Economic > Fishery Benefits > Profitability > Financial Performance

Economic health of a fishery can be measured by the financial performance of the operators in the fleet. Fleet wide averages or distributions of levels of profitability indicate the extent to which the fishery is generating economic benefits for fishers.

Data Quality	Indicator used	Year	Amount	Reference	Note
Bronze	Boat gross margin	2012 - 2013	$58,029	Voyer, M., K. Barclay, A. McIlgorm and N. Mazur (2016). Social and Economic Evaluation of NSW Coastal Professional Wild-Catch Fisheries: Valuing Coastal	Combined Estuary General fishery/Ocean Trap and Line

				Fisheries (FRDC 2014-301). Canberra, Australia, Fisheries Research and Development Corporation (FRDC). July https://www.uts.edu.au/sites/default/files/fass-vcf-social-economic-evaluation-fisheries-report.pdf	fishery/Ocean Haul fishery Data from 57 responses from 989 contacted and only 46 responses were deemed useable

Economic > Fishery Benefits > Latency > Underutilised Effort

Latency is fishery concessions that are not being fully utilised by fishers, for example, often the annual total allowable catch is left partially or largely uncaught for a fishery. Latency may appear as effort or uncaught TAC or inactive licences.

Data Quality: Not found

Economic > Community benefits > Value to community > GDP or GSP value

A fisheries contribution to Gross Domestic Production (GDP)/Gross State Product (GSP) is the total economic value that it generates directly, plus the indirect contribution made to other industries, which is also measured in value-add terms.

Data Quality	Indicator used	Year	Amount	Reference	Note
Bronze	GSP	2012-2013	$7,405,000	NSW Government https://www.industry.nsw.gov.au/invest-in-nsw/about-nsw/economic-growth/industry-structure	Agriculture, forestry and fishing combined

Economic > Community benefits > Wealth Spread > Distribution of fishing firm size

The spread of profits to owners and crew members indicates how widely benefits of fishing are distributed across the fishing community. A wide spread of benefits may be important to some fishery stakeholders. A narrow spread may not indicate a lack of distribution of benefits in the case where all participating businesses are the same size, or if other mechanisms are present to capture and distribute benefits such as high levels of employment of crew. The number of large business versus small business, classified by turnover (direct measure) or catch volume (proxy) may provide an indirect indicator: i.e. are economic returns from commercial fishing gained by one or two large businesses or a spread over many smaller businesses? For the NSW Spanner Crab fishery, up to date data specific to the fishery is not available. However, data on the distribution of fishers by turn-over in the Ocean Trap and Line Fishery (of which Spanner Crab is a target species) in 2008 indicates that at that time, 63% of fishers reported a turn-over for 5 years of less than $200,000. That is, on average harvesting less than $40,000 worth of fish per year

Economic > Markets > Fish distribution > Fish receivers

One way of measuring benefits from a fishery is by assessing the flow of seafood through the supply chain. In many fishery jurisdictions, the first step in the supply chain is via licensed fish receivers who are allowed to receive fish for sale. They can also trade fish with other receivers. In some jurisdictions, commercial fishers must sell their catch to a receiver (although they can sell small amounts on wharves). While this restricts fishers' options for landing their catch, it means that fish can be tracked, reduces illegal fish trading and ensures that the Quota Management Systems (QMS) work effectively by ensuring catches do not exceed the total allowable catch or quota amounts for individual species. Receivers of fish may be fish processors, wholesalers or retailers.

In some jurisdictions, the fishers and fish receivers are integrated, such that they are effectively the same "business". In Commonwealth fisheries, the total number of fish receivers per year may differ to the sum of the fish receivers per fishery because some receivers operate in more than one fishery.

We are seeing if data for this NSW fishery exists

Brad Mackay, Executive Officer to CommFish NSW, at commfish.nsw@dpi.nsw.gov.au or (02) 6656 8921. Requested Aug 9, 2018

Data Quality: Not released

Economic > Markets > Volatility in market price > Price volatility

Price volatility is the mean beach price for the target species (top one or five depending on price) over the given period (most recent ten years). The level of volatility is the standard deviation in mean price over this period.

Data Quality	Species/Fishery	Year/Time period	Amount	Reference	Note
Bronze	NSW crab	2006-07 to 2015-16	$10.74/kg	Mobsby, D and Koduah, A 2017, Australian fisheries and aquaculture statistics 2016, Fisheries Research and Development Corporation project 2017-095. ABARES, Canberra, December. CC BY 4.0. Supporting data tables	For whole of NSW Standard deviation in mean beach price

Economics > Energy costs > Energy Use > Fuel use per kg of fish harvested

Fuel use varies over time and between stocks and are best collected from industry on a yearly basis. Estimates for different fisheries should be compared with caution, and in particular comparing energy use between fisheries with different data quality which is not recommended (different data availability, may be e.g. old or not fisheries-specific). Estimates are provided for all levels of data quality if available and are given in L per kg live-weight.

Data Quality	Gear	Target species	Min (L/kg)	Average (L/kg)	Max (L/kg)	Reference	Description

Gold							
Silver	Mixed gears	Snapper, leatherjacket		1.3		Parker et al 2015	Ocean trap and line fishery, 2002, lacking bait use
Bronze	Pots and traps	Crustaceans	0.8	3.8	9.5	Parker and Tyedmers 2015	Oceania region

Economic > Energy costs > Fossil fuel subsidies > Fuel subsidies directed to the fishery

Fossil fuel subsidies (fuel rebates) illustrate to which extent the fuel cost is reduced in the fishery, measured in AUD/kg live weight fish. Note that this form of tax exemption for fisheries is in Australia motivated from the sector not using roads (i.e. costs embedded in fuel price for road construction and maintenance), and are not formally reported as fuel subsidies in Australia.

Data Quality	Gear	Target species	Subsidy (AUD/kg)	Reference	Description
Gold					
Silver	Mixed gears	Snapper, leatherjacket	0.53	Parker et al 2015	Ocean trap and line fishery, 2002
Bronze	All NSW	All NSW	0.36	Total tax claims per total landings in NSW	2015-16 (2016-17 also available), state level figures on landings are preliminary for 2015-16

Governance > Ecosystem governance > Bycatch mitigation > Description of the bycatch mitigation measures

Bycatch measures can be spatial (e.g. area closure), temporal (time closure, e.g. night setting only) or technical (bycatch reduction devices, hook size). This indicator describes the measures that are in place for a fishery – but not the rates of compliance. For example, spatial closures for different gear types are shown here for AFMA fisheries http://www.afma.gov.au/sustainability-environment/fishing-closures/.

As part of the NSW Ocean Trap and Line Fishers Code of Practice, a fisher participating in the NSW Ocean Trap and Line Fishery will …

"…10. Conduct fishing operations in areas, at times, and in a manner, that minimises levels of bycatch
11. Use equipment (such as escape panels on fish traps and circle hooks) or methods that minimise mortality, stress and levels of bycatch, and minimise the opportunity for predation by birds.
12. Ensure best practice handling of bycatch (particularly with the removal of undersize spanner crabs from dillies to reduce the number of flippers or legs damaged during the removal process) and to achieve a premium quality product for the retained catch...

15. Promote slow lifting rates for traps to reduce pressure trauma and therefore maximise the likelihood of survival of bycatch. [112]

Data Quality: Gold

Governance > Ecosystem governance > Protected species mitigation > Description of the protected species mitigation measures

TEP mitigation measures can be spatial (e.g. area closure), temporal (time closure, e.g. night setting only) or technical (bycatch reduction devices, hook size). This indicator describes the measures that are in place for a fishery – but not the rates of compliance.

Although interactions with threatened species have not been commonly recorded in this fishery, a number of management responses appearing in section 4 of the FMS are aimed at minimising impacts on threatened species. These measures include educating fishers in the identification/avoidance of threatened species, using fishing closures and modifying gear use to minimise known interactions with threatened species, and implementing the provisions of any threatened species recovery plans and threat abatement plans.[113]

Data Quality: Bronze

Governance > Management system > Harvest strategy > Scope of the harvest strategy

Assessment can be based on scoring presence of the following: a harvest strategy designed to achieve management objectives; harvest control rules and tools; collection of relevant information to support the harvest strategy; and, assessment of stock status or the presence of the following key elements: Defined operational objectives for the fishery; Indicators of fishery performance related to the objectives; Reference points for performance indicators; A statement defining acceptable levels of risk to meeting objectives; A monitoring strategy to collect relevant data to assess fishery performance; A process for conducting assessment of fishery performance relative to objectives; and; Decision rules that control the intensity of fishing activity and/or catch.
The NSW Spanner crab fishery is part of the NSW Ocean Trap and Line fishery (OTLF) and is managed under the Fisheries Management Act 1994, and the following regulations made under this Act:

- Fisheries Management (General) Regulation 2010
- Fisheries Management (Supporting Plan) Regulation 2006
- Fisheries Management (Ocean Trap and Line Share Management Plan) Regulation 2006[114]

The NSW DPI is the State Government agency responsible for the administration of the Act. The OTLF is managed predominantly by input controls. Currently in the OTLF, only one person can be nominated to hold the primary endorsement in respect of a fishing business. Other licensed fishers may currently, subject to the criteria outlined in the Regulation, hold separate endorsements to operate in the fishery in the form of a 'skipper's endorsement'. Six classes of endorsement exist in

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[112] https://www.dpi.nsw.gov.au/__data/assets/pdf_file/0007/631375/NSW-Ocean-Trap-and-Line-Fishery-COP.pdf
[113] https://www.dpi.nsw.gov.au/__data/assets/pdf_file/0005/632408/Ocean-Trawl-FMS.pdf
[114] NSW Department of Primary Industries (2017) Assessment of the NSW Ocean Trap and Line Fishery - Prepared for the Department of the Environment and Energy for the purpose of assessment under Part 13 and 13(A) of the Environment Protection and Biodiversity Conservation Act 1999

the OTLF at the commencement of the Fishery Management Strategy, with the spanner crab having two endorsement types.[115]

Endorsement type	Endorsement description
Spanner crab (northern zone)	Authorises use of a spanner crab net to take spanner crab for sale from ocean waters that are north of a line drawn east from the southern breakwall at Yamba
Spanner crab (southern zone)	Authorises use of a spanner crab net to take spanner crab for sale from ocean waters that are south of a line drawn east from the southern breakwall at Yamba

Data Quality: Gold

Governance > Management system > Management plans > Scope of management plan

Management plans can be assessed by evaluating the presence of minimum requirements, as follows: a description of the fishery, especially its current status and any established user rights: the management objectives; how these objectives are to be achieved; how the plan is to be reviewed and/or appealed, as well as the consultation process for review and appeal.

The NSW Spanner Crab Fishery is managed under the Fisheries Management Act 1994 No 38[116], Fisheries Management (Ocean Trap and Line Share Management Plan) Regulation 2006[117], Fisheries Management Legislation Amendment (Spanner Crab) Regulation 2018 and the Fishery Management Strategy for the NSW Ocean Trap and Line Fishery[118] which contain the following minimum requirements:

Area of the fishery
Status of species within the fishery
Management controls and administration
Consultation

Data Quality: Gold

Governance > Institutional capacity > Accountability of decision making bodies > Level of Accountability

Accountability of Decision-making bodies. Performance of a fisheries management agency is based on the degree to which decision-making processes are consultative, the basis for decisions are fully explained, and information about decision making is publicly available. The assessment applied the three tiers of Principle 3.2.2 (d) 'Decision-making process' of the MSC Fisheries Standard v2.0 (2014) to determine whether the level of accountability was low, medium or high.

High level of accountability. This is demonstrated by publicly-available fishing rules, assessment of its biological stock status, and the availability of decision-making procedures and outcomes by its Recreational Fishing NSW Advisory Committee online.

[115] NSW Department of Primary Industries (2006) Fishery Management Strategy of the NSW Ocean Trap and Line Fishery. Cronulla, NSW.
[116] https://www.legislation.nsw.gov.au/#/view/act/1994/38
[117] https://www.legislation.nsw.gov.au/#/view/regulation/2006/738
[118] https://www.dpi.nsw.gov.au/__data/assets/pdf_file/0003/632406/OTL-FMS.pdf

Data Quality: Silver

Governance > Institutional capacity > Uncertainty management > Extent of incorporation of uncertainty in management of the targeted stock

This metric reports on the explicit incorporation of uncertainties in decision support processes used to inform and make appropriate choices of management actions. We recognise three levels of uncertainty: Low level of incorporation of uncertainty; Medium level of incorporation of uncertainty; High level of incorporation of uncertainty. These are based on: Major sources of uncertainty are identified; Assessment takes uncertainty into account; Frequency of monitoring of indicators is high; Monitoring of more than one indicator to support management decisions; Assessment evaluates stock status relative to reference points in a probabilistic way; Robustness of assessments are tested, Alternative hypotheses and assessment approaches are rigorously explored.

Medium level of incorporation of uncertainty in management of the targeted stock.	The assessment applied Principle 1.2.4 (c & d) 'Assessment of stock status: Uncertainty in the Assessment' of the MSC Fisheries Standard v2.0 (2014) to assess extent of incorporation of uncertainty in management of the targeted stock.

Data Quality: Silver

Governance > Compliance > Compliance regime > Level of Compliance

Level of compliance with rules and regulations controlling catch can be assessed by audits that measure the agreement between 1) logbook and observer records; 2) catch disposal records submitted by fishers and fish receivers. It might also be assessed by counting the annual number of breaches/observed offences or enforcement actions, preferably scaled to the level of enforcement effort (e.g. $). This indicator can be scored on the basis of the presence of key monitoring, control and surveillance elements and capacities.

NSW DPI has approximately 100 fisheries officers responsible for coordinating and implementing compliance strategies in NSW. These strategies include:

maximising voluntary compliance
providing effective deterrence for offences
providing effective support services.

Approximately 75 of these fisheries officers are located in areas along the NSW coast where the OTLF occurs. Their general duties include conducting patrols, inspecting commercial and recreational fishers and fishing gear, and recording rates of compliance.
A compliance strategic plan will be developed to provide the direction for education, advisory and enforcement services provided by NSW DPI for all designated commercial fishing activities, including the OTLF. To ensure that compliance service is delivered in a consistent manner, quality inspection guidelines will be developed. These guidelines will set out a procedural approach to be adopted when undertaking inspections of fishers and fishing gear in the OTLF. The quality inspection

guidelines will ensure that all issues requiring compliance by commercial fishers under this Fishery Management Strategy are subject to a compliance program.[119]

Data Quality: Bronze

Governance > Compliance > Surveillance > Surveillance Effort

Regulatory controls include logs and catch reporting, on-board observer programs, vessel inspections, vessel monitoring systems, and visual or electronic surveillance using radar or satellite by boat or by air. Higher degrees of surveillance, or coverage using multiple methods, provide greater levels of certainty in estimates of effort, fishing mortality, bycatch and discard levels, and interactions with protected/listed species. Report on the surveillance carried out on the fishery, as reported by the compliance branch responsible for the fishery

Surveillance effort score: undefined
DPI monitors compliance and detects contraventions of legislation by strategically analysing information from its own staff, informants, the general public, non-government organisations and other government agencies. Monitoring may take place through:

Regular and random formal inspections
Auditing including 'Quality Inspections' (to ensure consistent inspection standards)
Auditing services to assess compliance
Reviewing and monitoring information provided by the public or affected individuals
Analysing organisational information (compliance statistics)
Reviewing mandatory reporting of information by licence/permit holders
Tactical patrols, targeted investigations and compliance operations
Analysis of information reported to the 'Fishers Watch' reporting service and via other sources including reporting functions established by conditions of licences/permits/fishing authorities
These activities recognise the importance given by the general public to monitoring compliance and by gauging the effectiveness and awareness of education campaigns. Where possible, strategic partnerships with other agencies are developed to maximise cooperation where monitoring responsibilities overlap. The department also works closely with agencies with specific expertise in law enforcement or other relevant areas.[120]

Data Quality: Bronze

Governance > Adaptive capacity > Governance arrangements > Climate change recognition

Governance arrangements relevant to the fishery consider the impact of climate change on the fishery, as evidenced by documentation, policies and plans that describe how management is addressing climate change impacts. Does the fishery management plan, harvest strategy or research activity suggest that climate change is recognised, and integrated into management planning?

The management plans do not yet recognize the need for climate responses for this fishery.

The National Harvest Strategy also recognizes that "*Variability in ocean conditions, due to natural variability, climate change or other factors, can affect the productivity of stocks. Fisheries should seek*

[119] https://www.dpi.nsw.gov.au/__data/assets/pdf_file/0003/632406/OTL-FMS.pdf
[120] http://www.afma.gov.au/fisheries/heard-island-mcdonald-island-fishery/

to account for that variability when developing and implementing harvest strategies"[121]. The Guidelines for the Harvest Strategy provide explicit approaches for fisheries[122]. This strategy and guideline do not explicitly apply to state fisheries, but will provide guidance.
Data quality: Bronze

Governance > Adaptive capacity > Coping strategies > Climate responses

The fishery has initiated coping strategies (directed) to reduce the impacts of climate change. Evidence of strategies that have been specifically implemented for the fishery might include codes of practice, restocking programs, early warning systems, and so on. The coping strategies may be for long-term change or for extreme events. A description of the climate change responses that have been implemented or explored in research or application are provided.

There are no management actions currently implemented that address climate change impacts in the fishery.

Data quality: Bronze

Social and Ethical > Fishers wellbeing > Fisher satisfaction > Satisfaction scores

If available, fishery specific surveys of well-being or satisfaction, with interpretation required for the types of questions and sample. When surveys are not available other sources of data may need to include broader surveys (e.g. not fishery specific) or discussions with industry representatives, managers or fishers about the industry and their opinion of general fisher-wellbeing (note this will be subjective).

Data Quality: Not found

Social and Ethical > Fishers wellbeing > Age Structure > Proportion of fishers in standard age cohorts

Proportion of fishers in standard age cohorts that were involved in the fishery at any point in the previous 5 years. If the fishery is not attractive or difficult to enter, the age distribution will be skewed to older ages. **Data Quality:** Not released

Social and Ethical > Wider community > Community satisfaction with fishery > Community feedback

Evidence of processes in place to gather direct engagement with the community (diversely represented) to listen and respond to feedback. This may be through a range of means including formal and informal processes and may not be appropriate to all fisheries in the same way. In some cases Marine Stewardship Council accreditation may demonstrate some evidence of community engagement.

Community feedback: Medium.

[121] Department of Agriculture and Water Resources 2018, *Commonwealth Fisheries Harvest Strategy Policy*, Canberra, June. CC BY 4.0.
[122] Department of Agriculture and Water Resources 2018, *Guidelines for the Implementation of the Commonwealth Fisheries Harvest Strategy Policy*, Canberra, June. CC BY 4.0.

There is a crab management advisory committee, which could oversee a feedback process. Based on general FRDC community perception surveys, satisfaction with Australian fisheries is rated at 42%.

Data quality: Bronze.

Social and Ethical > Wider Community > Level of local employment > Percentage of local employment

The communities surrounding and supporting fisheries benefit from those fisheries when the majority of employees (direct and indirect) associated with the fishery activity are local. Can be reported as direct, indirect and downstream levels.

Indicator	Year	Amount	Reference	Note
Estimated employment	2016	42 people	Mobsby, D & Koduah, A (2017) Australian fisheries and aquaculture statistics 2016, Fisheries Research and Development Corporation project 2017-095. ABARES, Canberra, December. CC BY 4.0.	Rock lobster and crab potting for NSW

Data Quality: Silver

Social and Ethical > Ethical - Human welfare > Protections in place > Legislation exists

Although all workers are automatically operating under legislation according to their state or territory to a safe work place, the extent to which there is awareness of the relevant Acts, and use of these if required, is highly variable and may be different for each business or individual operation within each fishery. See http://workplaceohs.com.au/legislation for a list of state acts and regulations.

Protections in Place: Low

The Spanner Crab fishery operates under NSW New South Wales (WorkCover NSW) – WHS Act 2011 and WHS Regulation 2017.

Data Quality: Silver

Social and Ethical > Ethical > Human welfare > Levels of compliance

Levels of compliance (or violations of) with Workplace Health and Safety. If references to Workplace Health and Safety exist in relation to the specific fishery, determine whether these are voluntary or recorded in anyway. If they are recorded, note the level of compliance. As they are likely to be voluntary, there will not likely be a record of compliance, but this may become more readily available in the future. **Data Quality:** Not found

Social and Ethical > Ethical-animal welfare > Animal welfare protections > Protections in place

At this early stage of development of animal welfare, any type of mention of animal welfare exists, it is probably the most appropriate. As this develops in to the future, assessments as to the level of engagement may become more relevant. **Data Quality:** Not found.

Social and Ethical > Ethical-animal welfare > Level of Compliance > Levels of compliance or violations of animal welfare

If there are any references to animal welfare protections or guidelines in fishery management plans and if reports exist, the indicator reports on the level of compliance or violations with welfare provisions.

Data Quality: Not found.

Social and Ethical > Climate-related > Access to information > Availability of information

This indicator describes available information that will help participants in the fishery adapt to changes. The assumption behind this indicator is that good information availability and flow will help fishers to adapt.

Data Quality: Not found.

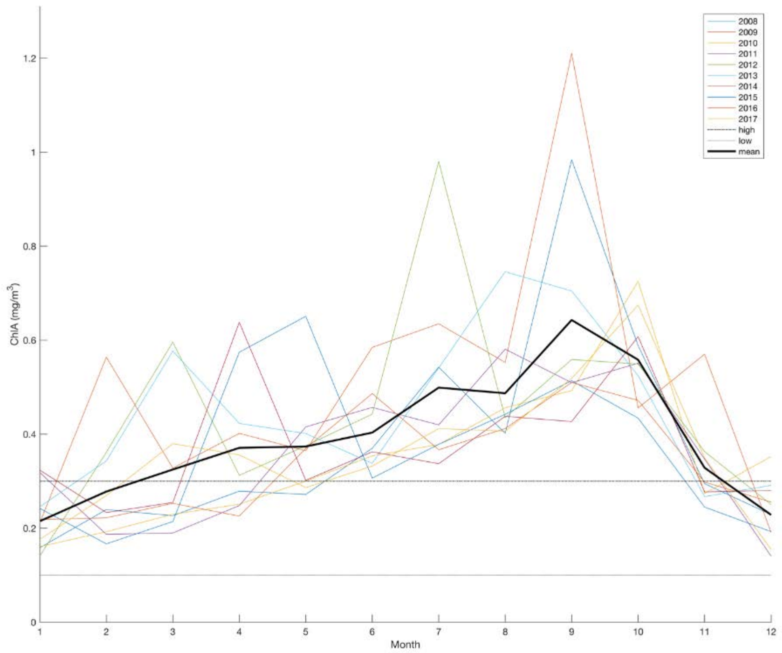
Social and Ethical > Climate-related > Access to networks > Level of membership of industry association

This metric assesses the presence or absence of a dedicated social media or social network group for the fishery. The fishery may still have a strong social network without a social media presence.

Data Quality: Not found.

External > Environmental Context > Productivity > Mean chlorophyll

A measure of environmental productivity is the biomass of phytoplankton, which in oceanic waters can be approximated by chlorophyll a concentration, as estimated from satellite (MODIS, oceandata.sci.gsfc.nasa.gov). Monthly chlorophyll values for a representative area of the fishery are shown with the mean productivity shown in solid black and references levels of low chlorophyll at 0.1 mg $m^{-3}$and high chlorophyll levels at 0.3 mg m^{-3}. This indicator shows the mean chlorophyll by month for the years 2008-2017. These data provide information on the relative environmental productivity in the fishery area. Missing data for some months can be due to ice cover. Variability in chlorophyll a concentration between years can indicate high environmental variability, while similar seasonal patterns indicate relative environmental stability.



Data Quality: Gold

External > Environmental Context > Environmental character > Description of the ecosystems

This metric provides a qualitative description of the ecosystem(s) in which the fishery occurs. The goal is to provide a general overview of these environments. The knowledge about which ecosystems are encountered during fishing activity is the indicator (rather than the response of the ecosystems to fishing).

Marine ecosystems are defined for the purposes of this indicator as the composition of plants, animals, and the marine environment (water masses, geomorphology). Types of marine ecosystems include estuaries, the sea floor, the mesopelagic zone, the pelagic zone, the inter-tidal zones, coral reefs, lagoons, and mangroves. A pelagic zone ecosystem for example, is defined by physical, chemical and biological features of the marine water column of the open ocean[123].

Description of the ecosystems: High

The fishery operates along the entire NSW coast, in continental shelf and slope waters. Spanner crabs are typically taken from depths of 30–80 m on the continental shelf, where the benthic habitat consists primarily of uniform, medium-fine sandy substrata with scattered, low-profile rocky reef[124].

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[123] Game, E. T., H. S. Grantham, A. J. Hobday, R. L. Pressey, A. T. Lombard, L. E. Beckley, K. Gjerde, R. H. Bustamante, H. P. Possingham and A. J. Richardson (2009). Pelagic protected areas: the missing dimension in ocean conservation. Trends in Ecology and Evolution **24**(7): 360-369 doi:310.1016/j.tree.2009.1001.1011.

[124] Spencer, D. M., I. W. Brown, M. J. Doubell, C. J. Brown, A. R. Rodriguez, S. Y. Lee, H. Zhang and C. J. Lemckert (2018). Bottom boundary layer cooling and wind-driven upwelling enhance the catchability of spanner crab (Ranina ranina) in South-East Queensland, Australia. Fisheries Oceanography: https://doi.org/10.1111/fog.12411.

Data Quality: Gold

External > Climate related > Susceptibility of target species > Impacts on target species

Climate change directly affects the distribution, abundance and phenology of individual species. These changes then affect the fisheries that harvest these species, and can be a strong external influence on the fishery. These impacts can be positive (e.g. increased abundance), or negative (e.g. movements further from fishing ports), and to long-term warming, or short-term extreme events such as marine heatwaves.

Sensitivity of some of the target species to climate change has been assessed[125]. Species in this fishery have sensitivities ranging from low to moderately high.

Common name	Species	Fishery	Score	Sensitivity
Gummy shark	Mustelus antarcticus	Ocean Trap and Line	6	MODERATELY HIGH
Blue mackerel	Scomber australasicus	Ocean Trap and Line	5	LOW
Snapper	Chrysophrys auratus	Ocean Trap and Line	5.5	MODERATE
Southern calamari	Sepioteuthis australis	Ocean Trap and Line	6	MODERATELY HIGH
Spanner crab	Ranina ranina	Ocean Trap and Line	5.25	MODERATE
Yellowtail kingfish	Seriola lalandi	Ocean Trap and Line	5.5	MODERATE

Data Quality: Silver

External > Climate related > Susceptibility of key habitats > Habitat Impacts

Habitat impact: Moderate

Changes in rainfall may affect inshore recruitment habitats.

Data Quality: Bronze

External > Contaminants in the environment > Detection system for seafood contaminants > Risk of contaminants

[125] Fulton EA, Hobday AJ, Pethybridge H, Blanchard J, Bulman C, Butler I, Cheung W, Gorton B, Hutton T, Lozano- Montes H, Matear R, Pecl G, Villanueva C, Zhang X (2018). *Decadal scale projection of changes in Australian fisheries stocks under climate change.* CSIRO Report to FRDC. FRDC Project No: 2016/139 – ONLINE.

Potential risk for contamination from the marine environment combined with monitoring arrangements to be able to address risks needed to ensure food safety. Contaminants include those with maximum levels set for by Food Standards Code Australia: metal contaminants, non-metal contaminants, natural toxicants, and average and maximum levels of mercury in fish. Contaminants from poor handling after landing are not assessed but may be indirectly addressed.

Rubric for risk level:

Low risk	Medium risk	High risk
There are no documented levels of contaminants from the marine environment causing risk/diet restrictions to any consumer group in the fishery.	There may be seasonal/area/species/size-based risks of contaminants for some species.	Permanent diet restrictions of species caught to vulnerable consumers such as children or pregnant women.

Risk of Contaminants: Low

No specific monitoring arrangements found for marine contaminants on the fishery webpage: https://www.daf.qld.gov.au/business-priorities/fisheries/monitoring-our-fisheries/commercial-fisheries/data-reports/sustainability-reporting/queensland-fisheries-summary/spanner-crab-fishery, but targeted species have low potential risk for contamination from the marine environment.

Data Quality: Silver

External > Contaminants in the environment > Management arrangements to ensure food safety related to contaminants > Evidence for arrangements

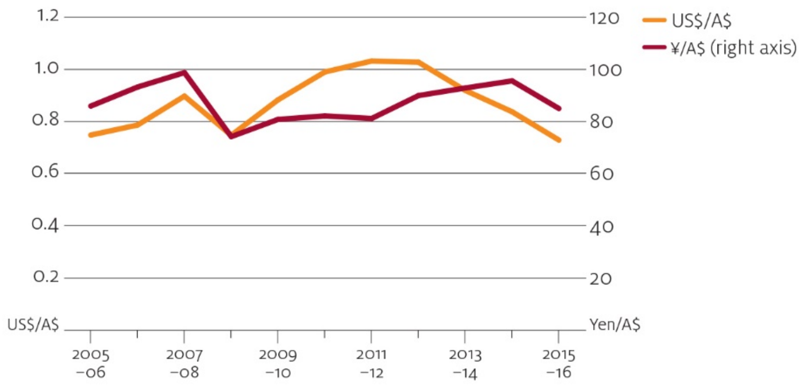
There is evidence of management arrangements to ensure food safety related to contaminants and food safety from the marine environment. No supply chain risks from poor handling are considered. Food standard 4.2.1 requires all seafood business in Australia to identify potential seafood safety hazards and put controls in place that are consistent with the risk.

Data Quality	
GOLD	
SILVER	There is an industry code of practise. https://www.dpi.nsw.gov.au/__data/assets/pdf_file/0007/631375/NSW-Ocean-Trap-and-Line-Fishery-COP.pdf
BRONZE	

External > Market Drivers > Macroeconomic factors > Exchange Rates

A depreciating Australian dollar (or, increasing exchange rate) generally results in producers receiving a higher export price in Australian dollar terms, while an appreciating Australian dollar (or, decreasing exchange rate) results in a lower export price. Domestically, a depreciation of the Australian dollar encourages substitution from imported seafood to domestically produced seafood, as imported products become relatively more expensive. A lower exchange rate also makes Australian exports more competitive in world markets, as exported seafood become relatively cheaper in foreign currency terms.

National export trends are negatively related to exchange rate movements— the Australian dollar declined against the US dollar and Japanese yen from 1990–91 to 2000–01, with exports increasing in volume and value. Exchange rates for the Australian dollar increased against those currencies from 2001–02 to 2015–16. The real export value and volume of Australia's seafood exports decreased between 2005–06 and 2012–13 and then increased between 2012–13 and 2015–16—with a noticeable rise (43 per cent) in volume between 2014–15 and 2015–16.[126]



Data Quality: Gold

External > Market Drivers > Consumer Trends > Per person annual apparent consumption of seafood (kg)

Annual apparent consumption is estimated by adding the total edible quantity of seafood supplied domestically—that is, total production plus imported seafood— less exports of seafood. Apparent consumption provides an estimate of the total amount of seafood consumed in Australia assuming zero change in stocks.

The production quantity of Australian fishery and aquaculture products is reported by ABARES on a whole weight basis, whereas trade data are reported on a processed basis. To align the units of measurement between production and trade data, it is necessary to convert production volume to a processed edible equivalent.

Production volumes are adjusted to an edible quantity basis using species-specific conversion rates and excluding species that are known to be predominantly supplied for non-human consumption purposes, such as for aquaculture feed or bait. Imports and exports of seafood are sourced from Australian Bureau of Statistics (ABS) trade data and are reported as edible weight. The apparent consumption per person is calculated as the total apparent consumption divided by the total Australian population in each year. The method applied here is consistent with that used by ABARES to estimate apparent consumption of other agricultural commodities produced in Australia.

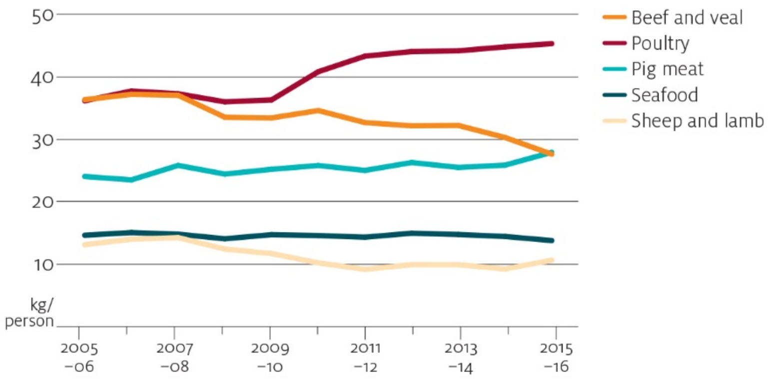
The FAO also compiles statistics on apparent consumption of seafood, applying a consistent method across all countries. FAO estimates indicate that annual consumption of seafood in Australia is around 26 kilograms per person in 2013 (FAO 2016[127]). The discrepancy between FAO and ABARES

[126] Mobsby, D and Koduah, A 2017, Australian fisheries and aquaculture statistics 2016, FRDC project 2017-095. ABARES, Canberra, December. CC BY 4.0.
[127] The state of world fisheries and aquaculture 2016—opportunities and challenges, Food and Agriculture Organization of the United Nations, Rome.

estimates reflects differences in methodological approaches to estimating consumption. Moreover, ABARES estimates seafood consumption on a processed edible basis, whereas the FAO provides its estimates on a whole weight basis.

In Australia, apparent consumption of seafood per person (edible equivalent) decreased, on average, at an annual rate of 0.6 per cent, from 14.6 kilograms in 2005– 06 to 13.8 kilograms per person in 2015–16. Annual apparent consumption is estimated by the Australian Bureau of Agricultural and Resource Economics and Sciences by adding the total edible quantity of seafood supplied domestically—that is, total production plus imported seafood— less exports of seafood[128]

In comparison, global per capita apparent fish consumption increased from an average of 9.9 kg in the 1960s to 14.4 kg in the 1990s and 20.1 kg in 2014, with preliminary estimates for 2015 indicating further growth, exceeding 20 kg (FAO 2016). Australia's per person seafood consumption in 2013 was estimated by the FAO to be 26kg. The differences in estimates are accounted for by varying methods for calculating consumption. ABARES estimates seafood consumption on a processed edible basis, whereas the FAO provides its estimates on a whole weight basis.



Data quality: Gold

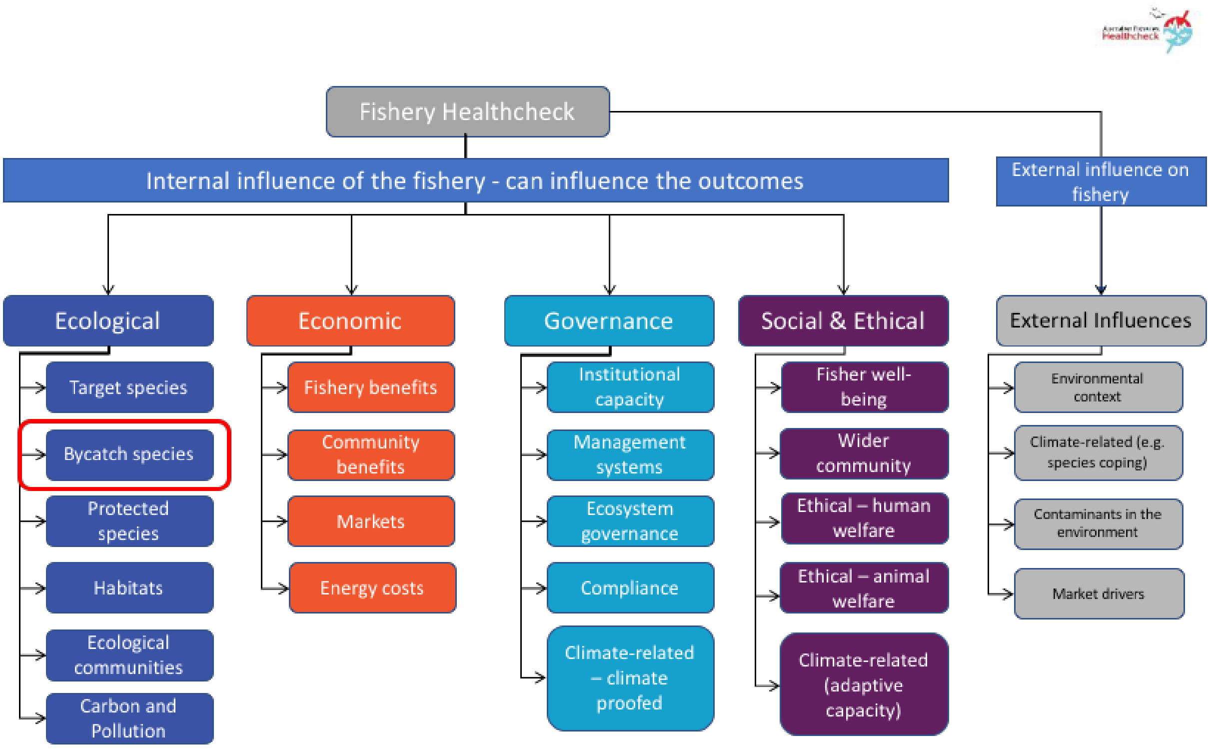
[128] Mobsby, D and Koduah, A 2017, *Australian fisheries and aquaculture statistics 2016*, FRDC 2017-095. ABARES, Canberra, December. CC BY 4.0

New South Wales Ocean Hauling Fishery

The New South Wales Ocean Hauling Fishery is broken up into 7 regions along the NSW coast and targets approximately 20 finfish species using commercial hauling and purse seine nets from sea beaches and in ocean waters within 3 nautical miles of the NSW coast. The catch is mainly made up of Pilchards (*Sardinops sagax*) 34%, sea mullet (*Mugil cephalus*) 30%, Australian Salmon (*Arripis trutta*) 17%, blue mackerel (*Scomber australasicus*) 8%, Yellowtail Scad (*Trachurus novaezelandiae*) 5% and Yellowfin Bream (*Acanthopagrus australis*) 2% of the total catch. How these fish are sold depends on the species, some are sold on the domestic market as fresh or frozen fillets, portions or whole fish, some are marketed for export. For example sea mullet roe (fish eggs) is exported to the Asian market. (Source: https://www.dpi.nsw.gov.au/fishing/commercial/fisheries/ocean-hauling

Case Study Presentation Format

The case study documents are a collection of metrics, organised by the healthcheck structure:



The presentation of metrics will follow the following heading format:

Ecological > Bycatch species > Bycatch composition > <u>Mean Trophic Level</u>

Understand this to be an indicator (**Bycatch composition**) of the **Ecological** Component, **Bycatch species** subcomponent where the (in the figure and heading example above, is being measured by presenting <u>Mean Trophic Level</u> as the metric.

Ecological > Target species > Stock Status > Status of Australian Fish Stocks (SAFS)

Target species in each fishery are the primary focus for this indicator. Status of these species is ideally assessed with the SAFS approach, however this may not cover all target species for each fishery. In that case, we indicate the number of unassessed species. These species could also be assessed by individual states or by alternative methods.

SpeciesName	StockName	StockStatus	Year
Australian Sardine	Eastern Australia	Sustainable	2016
Blue Mackerel	Eastern	Sustainable	2016
Eastern Australian Salmon	Eastern Australia	Sustainable	2016
Eastern School Prawn	New South Wales	Sustainable	2016
Gummy Shark	Southern Australia	Sustainable	2016
Luderick	Eastern Australia	Sustainable	2016
Mulloway	New South Wales	Overfished	2016
Sand Whiting	New South Wales	Sustainable	2016
School Shark	Southern Australia	Overfished	2016
Sea Mullet	Eastern Australia	Sustainable	2016
Tailor	Eastern Australia	Sustainable	2016
Yellowfin Bream	Eastern Australia	Sustainable	2016

Data Quality: Gold

Ecological > Target Species > Harvest Level > Catch weight

This metric is a proxy for harvest level. The harvested biomass for each species, provides information on the level of the catch. Trends in this metric over time can indicate declining availability of fish, quota restrictions, or changes in market demand. For Australian fisheries, trends are expected to be stable for most species.

The catch in the Ocean Haul fishery is mainly made up of Pilchards (*Sardinops sagax*) 34%, sea mullet (*Mugil cephalus*) 30%, Australian Salmon (*Arripis trutta*) 17%, blue mackerel (*Scomber australasicus*) 8%, Yellowtail Scad (*Trachurus novaezelandiae*) 5% and Yellowfin Bream (*Acanthopagrus australis*) 2% of the total catch

The estimates of retained catch[129], obtained from raised sampling are:

[129] Kennelly, S.J., 2018. *Developing a National Bycatch Reporting System.* Final FRDC Report, ISBN 978-0-9924930-5-9, March, 2018. 99 pp.

Table 7 - Discard estimates (and SE's) for each fishery and method with total estimates for all fisheries and methods derived from Table 6. Where there were no discard data available (and one could not assume zero discards or use discard estimates from other methods), those methods were removed.

Method	Tonnes Retained	SE	Days fished
Hauling net (general purpose)	2382.16	162.68	2244.20
Purse seine net	1780.64	291.51	1006.40
Pilchard, anchovy & bait net - beach based	56.87	11.34	93.00
Garfish net (hauling) - boat based	34.10	7.59	246.40
Garfish net (hauling) - beach based	7.40	3.15	25.40

Data quality: Silver

Ecological > Bycatch species > Bycatch composition > Mean Trophic Level

The trophic level is a measure of the position of an organism in a food web, starting at level 1 with primary producers, such as phytoplankton, then moving through the primary consumers at level **2** that eat the primary producers to the secondary consumers at level **3** that eat the primary consumers, and so on. The **bycatch mean trophic level** is an indicator of the mean level of the food chain for bycatch in a fishery. **Data Quality:** Not organised/analysed

Ecological > Bycatch species > Bycatch amount > Total weight of bycatch

Bycatch weights for fishery are typically developed by specific projects, and require a range of assumptions due to issues with reporting and retention of bycatch. **Bycatch** estimates typically cover species that are not target species, while **discard** rates may also include undersized individuals of the target species. Kennelly (2018) provides estimates of discard rates, which include both target and bycatch species, and when discard rates are used, that information is noted for each fishery. Animals can be returned to the ocean alive or dead. The intention of this metric is to provide information on animals that are dead on return to the ocean.

Reference:

Kennelly, S.J., 2018. *Developing a National Bycatch Reporting System.* Final FRDC Report, ISBN 978-0-9924930-5-9, March, 2018. 99 pp.

This fishery has several gear types, and discards for each method are recorded[130]

Table 7 - Discard estimates (and SE's) for each fishery and method with total estimates for all fisheries and methods derived from Table 6. Where there were no discard data available (and one could not assume zero discards or use discard estimates from other methods), those methods were removed. These latter fisheries accounted for an average of just 591.24 tonnes/year retained catch and 4512.55 days fished/year (4.3% and 5.3%, respectively).

Ocean Hauling

Method	Tonnes Retained	SE	Days fished	SE	Total Discards using retained wts to extrapolate (t)	SE	Total Discards using fishing effort to extrapolate (t)	SE
Hauling net (general purpose)	2382.16	162.68	2244.20	89.30	4.76	4.76	13.40	13.40
Purse seine net	1780.64	291.51	1006.40	41.68	0.00	0.00	0.00	0.00
Pilchard, anchovy & bait net - beach based	56.87	11.34	93.00	13.01	0.00	0.00	0.00	0.00
Garfish net (hauling) - boat based	34.10	7.59	246.40	19.17	0.00	0.00	0.00	0.00
Garfish net (hauling) - beach based	7.40	3.15	25.40	7.96	0.30	0.30	0.07	0.07

Data Quality: Gold

Ecological > Protected species > Capture amount > Captures

The number and diversity of TEP species captured by a fishery in the most recent year, provided as annual numbers.

For TEP species, only one fishery in NSW had any discards recorded in the available observer studies examined (the Ocean Trap and Line Fishery) and the numbers of individuals observed were very small. However, in addition, all commercial fishers in NSW are required to report any

[130] Kennelly, S.J., 2018. *Developing a National Bycatch Reporting System.* Final FRDC Report, ISBN 978-0-9924930-5-9, March, 2018. 99 pp.

TEP interactions on a dedicated form. The data so gathered for the only complete year available (2014-15) are provided in Table 9[131].

Table 9 – Number of TEP species reported as discarded in the NSW Commercial Fishers' Catch database for 2014-15.

Haul net	1 grey nurse shark

Data quality: Bronze

Ecological > Protected species > Reporting > Level of monitoring

This indicator is to provide information on the level of coverage for a fishery. Annual measures are preferred.

There are no data about the capture of threatened species attributable to the Ocean Hauling Fishery. Historically, information about capture rates and/or mortality due to fishing has not been recorded for threatened species as part of the monthly catch returns for fishers. Except for some of the protected fish and the little penguin, other threatened species are unlikely to be captured by the methods used in the fishery. Turtles and seasnakes could also be caught by most of the methods used in the fishery, but are unlikely to die as a result of capture as they are not towed through the water at a speed or in a manner which could drown them, and can be released alive.

Assessment of management responses proposed in the draft Fishery Management Strategy (FMS)
To minimise any potential impacts on threatened species, and/or to collect data to better understand any interactions between the fishery and threatened species, the draft FMS proposes to:

use scientific observers to document the likelihood of impact of ocean hauling methods on threatened species and to use that data to modify methods where necessary
document rate and species composition of bycatch and use best-practice methods for the handling of incidentally captured organisms
modify fishing practices to reduce the impacts on non-retained fauna
modify the catch and effort returns to collect and monitor information on sightings or captures of threatened species
develop a code of conduct for purse seiners with respect to appropriate handling methods for incidental catches of marine birds or mammals
implement provisions of recovery programs or threat abatement plans
continue the prohibition on taking protected fish (s19 of FM Act) and fish protected from commercial fishing (s20)
continue the prohibition of taking any species protected under other jurisdictional arrangements
continue to use fishing closures to control the time and area fished to minimise direct interactions with threatened species, populations or communities.[132]

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[131] Kennelly, S.J., 2018. *Developing a National Bycatch Reporting System.* Final FRDC Report, ISBN 978-0-9924930-5-9, March, 2018. 99 pp.
[132] https://www.dpi.nsw.gov.au/__data/assets/pdf_file/0004/632335/OHv2.pdf

Data quality: Bronze

Ecological > Habitats > Habitat impact > Impact score

The habitat impact is an indicator of the effect the fishing gear has on the habitat. Different gear types have different impacts. See the scoring rubric.

Habitat Impact: Major, based on the gear type used in this fishery.

Data quality: Bronze

Ecological > Habitats > Habitat impact > Habitat status

The status of the habitat types is a measure of the condition relative to a pristine state. Fishing may not be responsible for that habitat status, but it is important to note if fishing is taking place in pristine or disturbed habitats.

Habitat status: Moderate – changing environment as a result of climate change has significantly impacted this system

Data quality: Bronze

Ecological > Ecological communities > Ecosystem status > Ecosystem status

This metric reports the ecosystem status in the region of the fishery.

Ecosystem Status: Moderate

The 2016 State of Environment report notes the following [133]

Seabed at depths of 25-250m*: The state is likely **poor to good** in the South-east and Temperate East marine regions*

Seabed at depths of 250-700m*: Seabed habitats are spatially restricted, with varying impacts as a result of pressures, resulting in varying state and trends. State is **poor to very poor** but improving in the South-east/Temperate East marine regions*

Across most of the Temperate East Marine Region, where the demersal trawl footprint is greatest, there is very little information on seabed habitats, and, as a consequence, the impact of demersal trawling in this region is largely unknown. However, on a marine region scale, the Temperate East Marine Region, extensive trawling occurs almost continuously from the slope south of Swains Reefs in the Great Barrier Reef to eastern Bass Strait[134].

Data Quality: Bronze

Ecological > Ecological communities > Ecosystem status > Species diversity

The measure of species diversity as a ratio between fished and unfished states.

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[133] https://soe.environment.gov.au/assessment-summary/marine-environment/state-and-trends-habitats-and-communities

[134] https://soe.environment.gov.au/theme/marine-environment/topic/2016/commercial-and-recreational-fishing#footprint-of-australian-commercial-trawl-and-dredge-fisheries-as-a-percentage-of-imcra-bio-regions--71931

Data quality: Not organised/analysed

Ecological > Carbon and Pollution > Macro-plastics > Plastic code of conduct

Macro-plastics are plastics that are visible to the naked eye, such as food containers and wrapping, equipment packaging, and fishing equipment. The metric notes a commitment to a zero waste overboard code of conduct to assess attempts to reduce accidental or intentional introduction of macro-plastics to the ocean. There are stated guidelines detailing Australia's guidelines regarding marine pollution from the Australian Maritime Safety Authority[135]:

Pollution of the marine environment by ships, including fishing vessels, is strictly controlled by the International Convention for the Prevention of Pollution from Ships (known as MARPOL).

To minimise pollution, MARPOL prohibits ships from discharging garbage into the sea except in very limited circumstances.

Australian MARPOL regulations apply to Australian fishing vessels wherever they are operating.

Data Quality: Bronze

Ecological > Carbon and Pollution > Carbon footprint > CO_2-equivalents

The emissions of climate forcing gases in kg CO_2-equivalents (CO_2e) per kg live weight fish caught, not including the supply chain after landing.

Data Quality	Gear	Target species	Min (kg CO_2e/kg)	Average (kg CO_2e/kg)	Max (kg CO_2e/kg)	Reference	Description
Gold							
Silver							
Bronze	Surrounding nets	Small pelagics	0.1	0.2	0.5	Parker and Tyedmers 2015	Oceania region, year and fuel type not specified, no refrigerants included.

Economic > Fishery Benefits > Net Economic Returns > Economic Rent

Net Economic Returns (NER) is equal to fishing revenue less fishing costs and measures the economic profit that is derived from fishing activity, it is measured by the Commonwealth as Net Economic Returns and by some States as Economic Rent.

[135] https://www.amsa.gov.au/marine-environment/marine-pollution/pollution-fishing-vessels
https://www.amsa.gov.au/marine-environment/marine-pollution/marpol-and-its-implementation-australia

Data Quality	Indicator	Year	Amount	Reference	Note
Bronze	Economic rent	2012-2013	-$322	Voyer, M., K. Barclay, A. McIlgorm and N. Mazur (2016). Social and Economic Evaluation of NSW Coastal Professional Wild-Catch Fisheries: Valuing Coastal Fisheries (FRDC 2014-301). Canberra, Australia, Fisheries Research and Development Corporation (FRDC). July	Estuary General Fishery/Ocean Trap Line/Ocean Haul combined Data from 57 responses from 989 contacted and only 46 responses were deemed useable

Economic > Fishery Benefits > Gross Value of Production > Gross Value of Production

GVP calculated as the volume of catch multiplied by the average per unit beach price (AUD$).

Data Quality	Species/Fishery	Year	Amount	Reference	Note/Comment
Silver	Ocean Haul	2016-2017	$10.9 million	NSW Professional Fisherman's Association. Draft NSW Commercial Wild-Harvest Fishing RD&E Strategic Plan 2018-2023 (http://www.nswpfa.com.au/wp-content/uploads/2018/03/NSW-Commercial-Wild-Harvest-Fishing-Industry-RDE-Plan-2018-DRAFT.pdf)	Estimated commercial wild harvest
Silver	Ocean Haul	2015-2016	$10.8 million	NSW Professional Fisherman's Association. Draft NSW Commercial Wild-Harvest Fishing RD&E Strategic Plan 2018-2023 (http://www.nswpfa.com.au/wp-content/uploads/2018/03/NSW-Commercial-Wild-Harvest-Fishing-Industry-RDE-Plan-2018-DRAFT.pdf)	Estimated commercial wild harvest
Silver	Ocean Haul	2014-2015	$11.8 million	NSW Professional Fisherman's Association. Draft NSW Commercial Wild-Harvest Fishing RD&E Strategic Plan 2018-2023 (http://www.nswpfa.com.au/wp-	Estimated commercial wild harvest

				content/uploads/2018/03/NSW-Commercial-Wild-Harvest-Fishing-Industry-RDE-Plan-2018-DRAFT.pdf)	
Silver	Ocean Haul	2013-2014	$13.9 million	NSW Professional Fisherman's Association. Draft NSW Commercial Wild-Harvest Fishing RD&E Strategic Plan 2018-2023 (http://www.nswpfa.com.au/wp-content/uploads/2018/03/NSW-Commercial-Wild-Harvest-Fishing-Industry-RDE-Plan-2018-DRAFT.pdf)	Estimated commercial wild harvest
Silver	Ocean Haul	2012-2013	$9.3 million	NSW Professional Fisherman's Association. Draft NSW Commercial Wild-Harvest Fishing RD&E Strategic Plan 2018-2023 (http://www.nswpfa.com.au/wp-content/uploads/2018/03/NSW-Commercial-Wild-Harvest-Fishing-Industry-RDE-Plan-2018-DRAFT.pdf)	Estimated commercial wild harvest
Silver	Ocean Haul	2011-2012	$8.7 million	NSW Professional Fisherman's Association. Draft NSW Commercial Wild-Harvest Fishing RD&E Strategic Plan 2018-2023 (http://www.nswpfa.com.au/wp-content/uploads/2018/03/NSW-Commercial-Wild-Harvest-Fishing-Industry-RDE-Plan-2018-DRAFT.pdf)	Estimated commercial wild harvest
Silver	Ocean Haul	2010-2011	$10.9 million	NSW Professional Fisherman's Association. Draft NSW Commercial Wild-Harvest Fishing RD&E Strategic Plan 2018-2023 (http://www.nswpfa.com.au/wp-content/uploads/2018/03/NSW-Commercial-Wild-Harvest-Fishing-Industry-RDE-Plan-2018-DRAFT.pdf)	Estimated commercial wild harvest
Silver	Ocean Haul	2009-2010	$14.9 million	NSW Professional Fisherman's Association. Draft NSW Commercial Wild-	Estimated commercial wild harvest

				Harvest Fishing RD&E Strategic Plan 2018-2023 (http://www.nswpfa.com.au/wp-content/uploads/2018/03/NSW-Commercial-Wild-Harvest-Fishing-Industry-RDE-Plan-2018-DRAFT.pdf)	

Economic > Fishery Benefits > Profitability > Financial Performance

Economic health of a fishery can be measured by the financial performance of the operators in the fleet. Fleet wide averages or distributions of levels of profitability indicate the extent to which the fishery is generating economic benefits for fishers.

Data Quality	Indicator used	Year	Amount	Reference	Note
Bronze	Boat gross margin	2012 - 2013	$58,029	Voyer, M., K. Barclay, A. McIlgorm and N. Mazur (2016). Social and Economic Evaluation of NSW Coastal Professional Wild-Catch Fisheries: Valuing Coastal Fisheries (FRDC 2014-301). Canberra, Australia, Fisheries Research and Development Corporation (FRDC). July https://www.uts.edu.au/sites/default/files/fass-vcf-social-economic-evaluation-fisheries-report.pdf	Combined Estuary General fishery/Ocean Trap and Line fishery/Ocean Haul fishery Data from 57 responses from 989 contacted and only 46 responses were deemed useable

Economic > Fishery Benefits > Latency > Underutilised Effort

Latency is fishery concessions that are not being fully utilised by fishers, for example, often the annual total allowable catch is left partially or largely uncaught for a fishery. Latency may appear as effort or uncaught TAC or inactive licences.

Data Quality: Not found

Economic > Community benefits > Value to community > GDP or GSP value

A fisheries contribution to Gross Domestic Production (GDP)/Gross State Product (GSP) is the total economic value that it generates directly, plus the indirect contribution made to other industries, which is also measured in value-add terms.

Data Quality	Indicator used	Year	Amount	Reference	Note
Bronze	GSP	2012-2013	$7,405,000	NSW Government https://www.industry.nsw.gov.au/invest-in-nsw/about-nsw/economic-growth/industry-structure	Agriculture, forestry and fishing combined

Economic > Community benefits > Wealth Spread > Distribution of fishing firm size

The spread of profits to owners and crew members indicates how widely benefits of fishing are distributed across the fishing community. A wide spread of benefits may be important to some fishery stakeholders. A narrow spread may not indicate a lack of distribution of benefits in the case where all participating businesses are the same size, or if other mechanisms are present to capture and distribute benefits such as high levels of employment of crew. The number of large business versus small business, classified by turnover (direct measure) or catch volume (proxy) may provide an indirect indicator: i.e. are economic returns from commercial fishing gained by one or two large businesses or a spread over many smaller businesses?

For the NSW Ocean Haul Fishery, up to date data specific to the fishery is not available. However, data on the distribution of fishers by turn-over in 2008 indicates that at that time, 29% of fishers reported a turn-over for 5 years of less than $200,000. That is, on average harvesting less than $40,000 worth of fish per year.

For the prawn fishing sub-sector of the Ocean Haul fishery in NSW, ABS data from June 2017 provides the following information on the distribution of NSW Prawn fishing businesses by annual turn over size.

Zero to less than $50k	$50k to less than $200k	$200k to less than $2m	$2m to less than $5m	$5m to less than $10m	$10m or more
38	48	41	0	0	0

For the trawling, netting and seining sub-sector of the Ocean Haul fishery in NSW, ABS data from June 2017 provides the following information on the distribution of NSW trawling, netting and seining fishing businesses by annual turn over size.

Zero to less than $50k	$50k to less than $200k	$200k to less than $2m	$2m to less than $5m	$5m to less than $10m	$10m or more
46	82	53	3	0	0

Economic > Markets > Fish distribution > Fish receivers

One way of measuring benefits from a fishery is by assessing the flow of seafood through the supply chain. In many fishery jurisdictions, the first step in the supply chain is via licensed fish receivers who are allowed to receive fish for sale. They can also trade fish with other receivers. In some jurisdictions, commercial fishers must sell their catch to a receiver (although they can sell small amounts on wharves). While this restricts fishers' options for landing their catch, it means that fish can be tracked, reduces illegal fish trading and ensures that the Quota Management Systems (QMS) work effectively by ensuring catches do not exceed the total allowable catch or quota amounts for individual species. Receivers of fish may be fish processors, wholesalers or retailers.

In some jurisdictions, the fishers and fish receivers are integrated, such that they are effectively the same "business". In Commonwealth fisheries, the total number of fish receivers per year may differ to the sum of the fish receivers per fishery because some receivers operate in more than one fishery.

We are seeing if data for this NSW fishery exists

Brad Mackay, Executive Officer to CommFish NSW, at commfish.nsw@dpi.nsw.gov.au or (02) 6656 8921. Requested Aug 9, 2018

Data Quality: Not released

Economic > Markets > Volatility in market price > Price volatility

Price volatility is the mean beach price for the target species (top one or five depending on price) over the given period (most recent ten years). The level of volatility is the standard deviation in mean price over this period. **Data Quality:** Not found

Economics > Energy costs > Energy Use > Fuel use per kg of fish harvested

Fuel use varies over time and between stocks and are best collected from industry on a yearly basis. Estimates for different fisheries should be compared with caution, and in particular comparing energy use between fisheries with different data quality which is not recommended (different data availability, may be e.g. old or not fisheries-specific). Estimates are provided for all levels of data quality if available and are given in L per kg live-weight.

Data Quality	Gear	Target species	Min (L/kg)	Average (L/kg)	Max (L/kg)	Reference	Description
Gold							
Silver							
Bronze	Surrounding nets	Small pelagics	0.0	0.1	0.2	Parker and Tyedmers 2015	Oceania region

Economic > Energy costs > Fossil fuel subsidies > Fuel subsidies directed to the fishery

Fossil fuel subsidies (fuel rebates) illustrate to which extent the fuel cost is reduced in the fishery, measured in AUD/kg live weight fish. Note that this form of tax exemption for fisheries is in Australia motivated from the sector not using roads (i.e. costs embedded in fuel price for road construction and maintenance), and are not formally reported as fuel subsidies in Australia.

Data Quality	Gear	Target species	Subsidy (AUD/kg)	Reference	Description

Gold					
Silver					
Bronze	All NSW	All NSW	0.36	Total tax claims per total landings in NSW	2015-16 (2016-17 also available), state level figures on landings are preliminary for 2015-16

Governance > Ecosystem governance > Bycatch mitigation > Description of the bycatch mitigation measures

Bycatch measures can be spatial (e.g. area closure), temporal (time closure, e.g. night setting only) or technical (bycatch reduction devices, hook size). This indicator describes the measures that are in place for a fishery – but not the rates of compliance. For example, spatial closures for different gear types are shown here for AFMA fisheries http://www.afma.gov.au/sustainability-environment/fishing-closures/.

Bycatch consists of those animals that are discarded from the catch or retained for scientific purposes, and that part of the "catch" that is not landed but is killed as a result of interaction with fishing gear. Fish that are landed are sometimes discarded because there is no market for that type (or size) of fish, or because the regulations prevent the fish from being retained (e.g. if it is smaller than the minimum legal length or is a species protected from commercial fishing).
Anecdotal evidence and recorded landings suggest that catches within the fishery tend to be targeted at a single species and with little bycatch. Fishers observe schools prior to deploying nets and are thought to be able to determine catch composition with reasonable accuracy. Catches taken by beach haul nets generally consist of mature adults.[136]

Data Quality: Silver

Governance > Ecosystem governance > Protected species mitigation > Description of the protected species mitigation measures

TEP mitigation measures can be spatial (e.g. area closure), temporal (time closure, e.g. night setting only) or technical (bycatch reduction devices, hook size). This indicator describes the measures that are in place for a fishery – but not the rates of compliance.

As part of the NSW Ocean Hauling Fishery Commercial Fishers Code of Practice for Hauling Activities, fishers participating in the Ocean Haul fishery will:

"...
19. Be familiar with the list of, and methods of identifying, protected species and threatened species, populations and ecological communities that might be encountered during fishing operations.
20. Conduct fishing operations in areas, at times, and in a manner that minimises the potential for any interaction with protected species or threatened species, populations and ecological communities. Including minimising disturbance to nesting and feeding sites of migratory and resident shorebirds
21. Report the location, time and date, in the comment section of the Ocean Hauling monthly catch return, or other appropriate logbook, of any interaction with, or sighting of, individuals of marine protected species or threatened species, populations and ecological communities or any interactions

[136] https://www.dpi.nsw.gov.au/__data/assets/pdf_file/0004/632407/OH-FMS.pdf

with threatened or protected sea birds.
22. Return any captured individual of a protected species or a threatened species, population or ecological community to the water with the least possible harm.
23. Suspend the fishing operation if a cetacean (whale or dolphin) or turtle is captured, and allow the release of the animal from the net with the least possible harm….."[137]

Data Quality: Bronze

Governance > Management system > Harvest strategy > Scope of the harvest strategy

Assessment can be based on scoring presence of the following: a harvest strategy designed to achieve management objectives; harvest control rules and tools; collection of relevant information to support the harvest strategy; and, assessment of stock status or the presence of the following key elements: Defined operational objectives for the fishery; Indicators of fishery performance related to the objectives; Reference points for performance indicators; A statement defining acceptable levels of risk to meeting objectives; A monitoring strategy to collect relevant data to assess fishery performance; A process for conducting assessment of fishery performance relative to objectives; and; Decision rules that control the intensity of fishing activity and/or catch.

The Ocean Hauling Fishery is a share management fishery. This means that commercial fishers must hold sufficient shares to be eligible for an endorsement to operate in the fishery. An endorsement authorises the use of specific gear to take fish for sale from certain waters. The rules and regulations that apply to the fishery are contained in the Strategy and within the Fisheries Management (Ocean Haul Share Management Plan) Regulation 2006, the Fisheries Management Act 1994 No 38, the Fisheries Management (General) Regulation 2010 and Fisheries Management (Supporting Plan) Regulation 2006.
The fishery is managed by input controls which limit the fishing capacity of fishers by indirectly controlling the amount of fish caught. These controls include regulating the size and dimensions of fishing gear used, limiting the number of fishers who have access to each part of the fishery, entry criteria for new entrants and a range of closures including seasonal and weekend closures.[138][139]

Data Quality: Gold

Governance > Management system > Management plans > Scope of management plan

Management plans can be assessed by evaluating the presence of minimum requirements, as follows: a description of the fishery, especially its current status and any established user rights: the management objectives; how these objectives are to be achieved; how the plan is to be reviewed and/or appealed, as well as the consultation process for review and appeal.

The NSW Ocean Hauling Fishery is managed under the Fisheries Management Act 1994 No 38[140], Fisheries Management (Ocean Hauling Share Management Plan) Regulation 2006[141] and Fishery Management Strategy for the Ocean Hauling Fishery[142] which contain the following minimum requirements:

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[137] https://www.dpi.nsw.gov.au/__data/assets/pdf_file/0016/631303/OHF-Hauling-CoP-24-11-09.pdf
[138] https://www.dpi.nsw.gov.au/fishing/commercial/fisheries/ocean-hauling
[139] NSW Fisheries (2003) Fishery Management Strategy for the Ocean Hauling Fishery. Cronulla, NSW
[140] https://www.legislation.nsw.gov.au/#/view/act/1994/38
[141] https://www.legislation.nsw.gov.au/#/view/regulation/2006/736/full
[142] https://www.dpi.nsw.gov.au/__data/assets/pdf_file/0004/632407/OH-FMS.pdf

- Area of the fishery
- Status of species within the fishery
- Management controls and administration
- Consultation

Data Quality: Gold

Governance > Institutional capacity > Accountability of decision making bodies > Level of Accountability

Accountability of Decision-making bodies. Performance of a fisheries management agency is based on the degree to which decision-making processes are consultative, the basis for decisions are fully explained, and information about decision making is publicly available. The assessment applied the three tiers of Principle 3.2.2 (d) 'Decision-making process' of the MSC Fisheries Standard v2.0 (2014) to determine whether the level of accountability was low, medium or high.

High level of accountability. This is demonstrated by publicly-available management strategy, fishery rules and assessment reports, and the availability of decision-making procedures and outcomes by its Management Advisory Committee online.

Data Quality: Silver

Governance > Institutional capacity > Uncertainty management > Extent of incorporation of uncertainty in management of the targeted stock

This metric reports on the explicit incorporation of uncertainties in decision support processes used to inform and make appropriate choices of management actions. We recognise three levels of uncertainty: Low level of incorporation of uncertainty; Medium level of incorporation of uncertainty; High level of incorporation of uncertainty. These are based on: Major sources of uncertainty are identified; Assessment takes uncertainty into account; Frequency of monitoring of indicators is high; Monitoring of more than one indicator to support management decisions; Assessment evaluates stock status relative to reference points in a probabilistic way; Robustness of assessments are tested, Alternative hypotheses and assessment approaches are rigorously explored.

Medium level of incorporation of uncertainty in management of the targeted stock, noting that this is a multi species multi gear fishery and the extent of incorporation of uncertainty varies across species.	The assessment applied Principle 1.2.4 (c & d) 'Assessment of stock status: Uncertainty in the Assessment' of the MSC Fisheries Standard v2.0 (2014) to assess extent of incorporation of uncertainty in management of the targeted stock.

Data Quality: Silver

Governance > Compliance > Compliance regime > Level of Compliance

Level of compliance with rules and regulations controlling catch can be assessed by audits that measure the agreement between 1) logbook and observer records; 2) catch disposal records submitted by fishers and fish receivers. It might also be assessed by counting the annual number of breaches/observed offences or enforcement actions, preferably scaled to the level of enforcement effort (e.g. $). This indicator can be scored on the basis of the presence of key monitoring, control and surveillance elements and capacities.

NSW Fisheries has approximately 90 fisheries officers responsible for coordinating and implementing compliance strategies in NSW. These strategies include:

maximising voluntary compliance
providing effective deterrence for offences
providing effective support services.

Approximately 65 of these fisheries officers are located in areas along the NSW coast where the Ocean Hauling Fishery occurs. Their general duties include conducting patrols, inspecting commercial fishers and their gear, and recording rates of compliance. A compliance strategic plan is to be developed that will provide the direction for education, advisory and enforcement services provided by NSW Fisheries for the Ocean Hauling Fishery.
To ensure that compliance service is delivered in a consistent manner, quality inspection guidelines are being developed as part of this operational plan for inspections within the Ocean Hauling Fishery. These guidelines will set out a procedural approach to be adopted when undertaking inspections of fishers and fishing gear in the Ocean Hauling Fishery. The quality inspection guidelines will ensure that all issues requiring compliance by commercial fishers under this management strategy are subject to a compliance program, including the enforcement of by-product rules that apply to the fishery. [143]

Data Quality: Bronze

Governance > Compliance > Surveillance > Surveillance Effort

Regulatory controls include logs and catch reporting, on-board observer programs, vessel inspections, vessel monitoring systems, and visual or electronic surveillance using radar or satellite by boat or by air. Higher degrees of surveillance, or coverage using multiple methods, provide greater levels of certainty in estimates of effort, fishing mortality, bycatch and discard levels, and interactions with protected/listed species. Report on the surveillance carried out on the fishery, as reported by the compliance branch responsible for the fishery

Surveillance effort score: undefined
DPI monitors compliance and detects contraventions of legislation by strategically analysing information from its own staff, informants, the general public, non-government organisations and other government agencies. Monitoring may take place through:

Regular and random formal inspections
Auditing including 'Quality Inspections' (to ensure consistent inspection standards)
Auditing services to assess compliance
Reviewing and monitoring information provided by the public or affected individuals
Analysing organisational information (compliance statistics)
Reviewing mandatory reporting of information by licence/permit holders
Tactical patrols, targeted investigations and compliance operations
Analysis of information reported to the 'Fishers Watch' reporting service and via other sources including reporting functions established by conditions of licences/permits/fishing authorities
These activities recognise the importance given by the general public to monitoring compliance and by gauging the effectiveness and awareness of education campaigns. Where possible, strategic partnerships with other agencies are developed to maximise cooperation where monitoring

[143] https://www.dpi.nsw.gov.au/__data/assets/pdf_file/0004/632407/OH-FMS.pdf

responsibilities overlap. The department also works closely with agencies with specific expertise in law enforcement or other relevant areas.[144]

Data Quality: Bronze

Governance > Adaptive capacity > Governance arrangements > Climate change recognition

Governance arrangements relevant to the fishery consider the impact of climate change on the fishery, as evidenced by documentation, policies and plans that describe how management is addressing climate change impacts. Does the fishery management plan, harvest strategy or research activity suggest that climate change is recognised, and integrated into management planning?

The management plans do not yet recognize the need for climate responses for this fishery.

The National Harvest Strategy also recognizes that "*Variability in ocean conditions, due to natural variability, climate change or other factors, can affect the productivity of stocks. Fisheries should seek to account for that variability when developing and implementing harvest strategies*"[145]. The Guidelines for the Harvest Strategy provide explicit approaches for fisheries[146]. This strategy and guideline do not explicitly apply to state fisheries, but will provide guidance.
Data quality: Bronze

Governance > Adaptive capacity > Coping strategies > Climate responses

The fishery has initiated coping strategies (directed) to reduce the impacts of climate change. Evidence of strategies that have been specifically implemented for the fishery might include codes of practice, restocking programs, early warning systems, and so on. The coping strategies may be for long-term change or for extreme events. A description of the climate change responses that have been implemented or explored in research or application are provided.

There are no management actions currently implemented that address climate change impacts in the fishery.

Data quality: Bronze

Social and Ethical > Fishers wellbeing > Fisher satisfaction > Satisfaction scores

If available, fishery specific surveys of well-being or satisfaction, with interpretation required for the types of questions and sample. When surveys are not available other sources of data may need to include broader surveys (e.g. not fishery specific) or discussions with industry representatives, managers or fishers about the industry and their opinion of general fisher-wellbeing (note this will be subjective).

Data Quality: Not found

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[144] https://www.dpi.nsw.gov.au/__data/assets/pdf_file/0010/639874/Fisheries-compliance-prosecution-policy-and-procedure.pdf

[145] Department of Agriculture and Water Resources 2018, *Commonwealth Fisheries Harvest Strategy Policy*, Canberra, June. CC BY 4.0.

[146] Department of Agriculture and Water Resources 2018, *Guidelines for the Implementation of the Commonwealth Fisheries Harvest Strategy Policy*, Canberra, June. CC BY 4.0.

Social and Ethical > Fishers wellbeing > Age Structure > Proportion of fishers in standard age cohorts

Proportion of fishers in standard age cohorts that were involved in the fishery at any point in the previous 5 years. If the fishery is not attractive or difficult to enter, the age distribution will be skewed to older ages. **Data Quality:** Not released

Social and Ethical > Wider community > Community satisfaction with fishery > Community feedback

Evidence of processes in place to gather direct engagement with the community (diversely represented) to listen and respond to feedback. This may be through a range of means including formal and informal processes and may not be appropriate to all fisheries in the same way. In some cases Marine Stewardship Council accreditation may demonstrate some evidence of community engagement.

Community feedback: Low.

Indigenous representation is recognised to be low and stakeholder involvement in decision making is seen as needing to be improved (Ocean haul assessment report 4). It has a management advisory committee, which could oversee a feedback process.

Data quality: Bronze.

Social and Ethical > Wider Community > Level of local employment > Percentage of local employment

The communities surrounding and supporting fisheries benefit from those fisheries when the majority of employees (direct and indirect) associated with the fishery activity are local. Can be reported as direct, indirect and downstream levels.

Indicator	Year	Amount	Reference	Note
Estimated employment	2016	11 people	Mobsby, D & Koduah, A (2017) Australian fisheries and aquaculture statistics 2016, Fisheries Research and Development Corporation project 2017-095. ABARES, Canberra, December. CC BY 4.0.	Fish trawling, seining and netting for NSQ

Data Quality: Silver

Social and Ethical > Ethical - Human welfare > Protections in place > Legislation exists

Although all workers are automatically operating under legislation according to their state or territory to a safe work place, the extent to which there is awareness of the relevant Acts, and use of these if required, is highly variable and may be different for each business or individual operation within each fishery. See http://workplaceohs.com.au/legislation for a list of state acts and regulations.

Protections in Place: Low

Silver. The Ocean Haul fishery operates under NSW New South Wales (WorkCover NSW) – WHS Act 2011 and WHS Regulation 2017.

Data Quality: Silver

Social and Ethical > Ethical > Human welfare > Levels of compliance

Levels of compliance (or violations of) with Workplace Health and Safety. If references to Workplace Health and Safety exist in relation to the specific fishery, determine whether these are voluntary or recorded in anyway. If they are recorded, note the level of compliance. As they are likely to be voluntary, there will not likely be a record of compliance, but this may become more readily available in the future. **Data Quality:** Not found

Social and Ethical > Ethical-animal welfare > Animal welfare protections > Protections in place

At this early stage of development of animal welfare, any type of mention of animal welfare exists, it is probably the most appropriate. As this develops in to the future, assessments as to the level of engagement may become more relevant. **Data Quality:** Not found.

Social and Ethical > Ethical-animal welfare > Level of Compliance > Levels of compliance or violations of animal welfare

If there are any references to animal welfare protections or guidelines in fishery management plans and if reports exist, the indicator reports on the level of compliance or violations with welfare provisions.

Data Quality: Not found.

Social and Ethical > Climate-related > Access to information > Availability of information

This indicator describes available information that will help participants in the fishery adapt to changes. The assumption behind this indicator is that good information availability and flow will help fishers to adapt.

Data Quality: Not found.

Social and Ethical > Climate-related > Access to networks > Level of membership of industry association

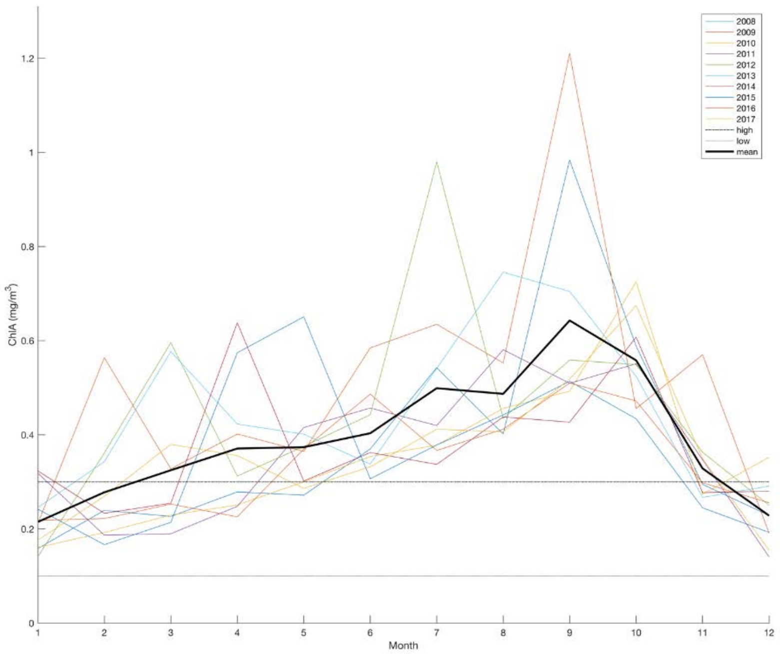
This metric assesses the presence or absence of a dedicated social media or social network group for the fishery. The fishery may still have a strong social network without a social media presence.

Data Quality: Not found.

External > Environmental Context > Productivity > Mean chlorophyll

A measure of environmental productivity is the biomass of phytoplankton, which in oceanic waters can be approximated by chlorophyll a concentration, as estimated from satellite (MODIS,

oceandata.sci.gsfc.nasa.gov). Monthly chlorophyll values for a representative area of the fishery are shown with the mean productivity shown in solid black and references levels of low chlorophyll at 0.1 mg $m^{-3}$and high chlorophyll levels at 0.3 mg m^{-3}. This indicator shows the mean chlorophyll by month for the years 2008-2017. These data provide information on the relative environmental productivity in the fishery area. Missing data for some months can be due to ice cover. Variability in chlorophyll a concentration between years can indicate high environmental variability, while similar seasonal patterns indicate relative environmental stability.



Data Quality: Gold

External > Environmental Context > Environmental character > Description of the ecosystems

This metric provides a qualitative description of the ecosystem(s) in which the fishery occurs. The goal is to provide a general overview of these environments. The knowledge about which ecosystems are encountered during fishing activity is the indicator (rather than the response of the ecosystems to fishing).

Marine ecosystems are defined for the purposes of this indicator as the composition of plants, animals, and the marine environment (water masses, geomorphology). Types of marine ecosystems include estuaries, the sea floor, the mesopelagic zone, the pelagic zone, the inter-tidal zones, coral reefs, lagoons, and mangroves. A pelagic zone ecosystem for example, is defined by physical, chemical and biological features of the marine water column of the open ocean[147].

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[147] Game, E. T., H. S. Grantham, A. J. Hobday, R. L. Pressey, A. T. Lombard, L. E. Beckley, K. Gjerde, R. H. Bustamante, H. P. Possingham and A. J. Richardson (2009). Pelagic protected areas: the missing dimension in ocean conservation. Trends in Ecology and Evolution **24**(7): 360-369 doi:310.1016/j.tree.2009.1001.1011.

Description of the ecosystems: High

The fishery takes place over soft bottom habitats.

Data Quality: Silver

External > Climate related > Susceptibility of target species > Impacts on target species

Climate change directly affects the distribution, abundance and phenology of individual species. These changes then affect the fisheries that harvest these species, and can be a strong external influence on the fishery. These impacts can be positive (e.g. increased abundance), or negative (e.g. movements further from fishing ports), and to long-term warming, or short-term extreme events such as marine heatwaves.

Sensitivity of some of the target species to climate change has been assessed[148]. Species in this fishery have sensitivities ranging from moderate to moderately high.

Common name	Species	Fishery	Score	Sensitivity
Australian salmon - eastern	Arripis trutta	Ocean Hauling	5.5	MODERATE
Australian sardine	Sardinops sagax	Ocean Hauling	5	LOW
Blue mackerel	Scomber australasicus	Ocean Hauling	5	LOW

Data Quality: Silver

External > Climate related > Susceptibility of key habitats > Habitat Impacts

Habitat impact: Moderate

This fishery is occurring in the rapidly changing area influenced by the East Australia Current[149]

Data Quality: Bronze

External > Contaminants in the environment > Detection system for seafood contaminants > Risk of contaminants

Potential risk for contamination from the marine environment combined with monitoring arrangements to be able to address risks needed to ensure food safety. Contaminants include those with maximum levels set for by Food Standards Code Australia: metal contaminants, non-metal contaminants, natural toxicants, and average and maximum levels of mercury in fish. Contaminants from poor handling after landing are not assessed but may be indirectly addressed.

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[148] Fulton EA, Hobday AJ, Pethybridge H, Blanchard J, Bulman C, Butler I, Cheung W, Gorton B, Hutton T, Lozano-Montes H, Matear R, Pecl G, Villanueva C, Zhang X (2018). *Decadal scale projection of changes in Australian fisheries stocks under climate change.* CSIRO Report to FRDC. FRDC Project No: 2016/139 – ONLINE.

[149] Suthers, I. M., J. D. Everett, M. Roughan, J. W. Young, P. R. Oke, S. A. Condie, J. R. Hartog, A. J. Hobday, P. A. Thompson, K. Ridgway, M. E. Baird, C. S. Hassler, G. B. Brassington, M. Byrne, N. L. Holbrook and H. A. Malcolm (2011). The strengthening East Australian Current, its eddies and biological effects - an introduction and overview. Deep Sea Research Part II: Topical Studies in Oceanography **58**: 538–546.

Rubric for risk level:

Low risk	Medium risk	High risk
There are no documented levels of contaminants from the marine environment causing risk/diet restrictions to any consumer group in the fishery.	There may be seasonal/area/species/size-based risks of contaminants for some species.	Permanent diet restrictions of species caught to vulnerable consumers such as children or pregnant women.

Risk of Contaminants: Medium

No specific monitoring arrangements found for marine contaminants on the fishery webpage: https://www.dpi.nsw.gov.au/fishing/commercial/fisheries/ocean-hauling, targeted species have medium potential risk for contamination from the marine environment. Warm-water finfish (e.g. snappers, basse, wrasse) may in different seasons, areas and at larger sizes contain natural toxins (such as ciguatera).

Data Quality: Silver

External > Contaminants in the environment > Management arrangements to ensure food safety related to contaminants > Evidence for arrangements

There is evidence of management arrangements to ensure food safety related to contaminants and food safety from the marine environment. No supply chain risks from poor handling are considered. Food standard 4.2.1 requires all seafood business in Australia to identify potential seafood safety hazards and put controls in place that are consistent with the risk.

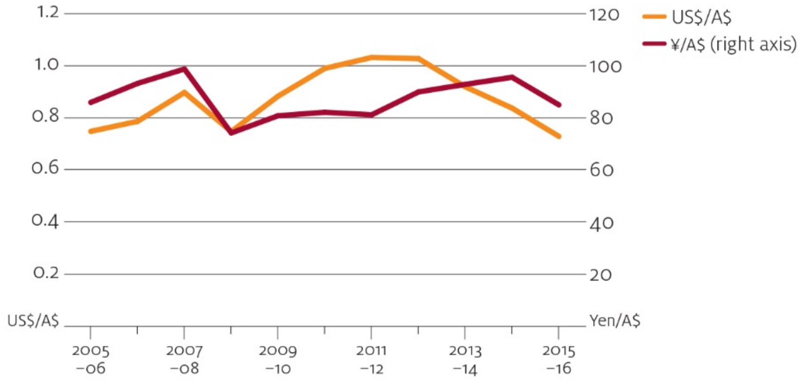
Data Quality	
GOLD	
SILVER	There is an industry code of practise. https://www.dpi.nsw.gov.au/__data/assets/pdf_file/0016/631303/OHF-Hauling-CoP-24-11-09.pdf
BRONZE	

External > Market Drivers > Macroeconomic factors > Exchange Rates

A depreciating Australian dollar (or, increasing exchange rate) generally results in producers receiving a higher export price in Australian dollar terms, while an appreciating Australian dollar (or, decreasing exchange rate) results in a lower export price. Domestically, a depreciation of the Australian dollar encourages substitution from imported seafood to domestically produced seafood, as imported products become relatively more expensive. A lower exchange rate also makes Australian exports more competitive in world markets, as exported seafood become relatively cheaper in foreign currency terms.

National export trends are negatively related to exchange rate movements— the Australian dollar declined against the US dollar and Japanese yen from 1990–91 to 2000–01, with exports increasing in volume and value. Exchange rates for the Australian dollar increased against those currencies from 2001–02 to 2015–16. The real export value and volume of Australia's seafood exports decreased

between 2005–06 and 2012–13 and then increased between 2012–13 and 2015–16—with a noticeable rise (43 per cent) in volume between 2014–15 and 2015–16.[150]



Data Quality: Gold

External > Market Drivers > Consumer Trends > Per person annual apparent consumption of seafood (kg)

Annual apparent consumption is estimated by adding the total edible quantity of seafood supplied domestically—that is, total production plus imported seafood— less exports of seafood. Apparent consumption provides an estimate of the total amount of seafood consumed in Australia assuming zero change in stocks.

The production quantity of Australian fishery and aquaculture products is reported by ABARES on a whole weight basis, whereas trade data are reported on a processed basis. To align the units of measurement between production and trade data, it is necessary to convert production volume to a processed edible equivalent.

Production volumes are adjusted to an edible quantity basis using species-specific conversion rates and excluding species that are known to be predominantly supplied for non-human consumption purposes, such as for aquaculture feed or bait. Imports and exports of seafood are sourced from Australian Bureau of Statistics (ABS) trade data and are reported as edible weight. The apparent consumption per person is calculated as the total apparent consumption divided by the total Australian population in each year. The method applied here is consistent with that used by ABARES to estimate apparent consumption of other agricultural commodities produced in Australia.

The FAO also compiles statistics on apparent consumption of seafood, applying a consistent method across all countries. FAO estimates indicate that annual consumption of seafood in Australia is around 26 kilograms per person in 2013 (FAO 2016[151]). The discrepancy between FAO and ABARES estimates reflects differences in methodological approaches to estimating consumption. Moreover, ABARES estimates seafood consumption on a processed edible basis, whereas the FAO provides its estimates on a whole weight basis.

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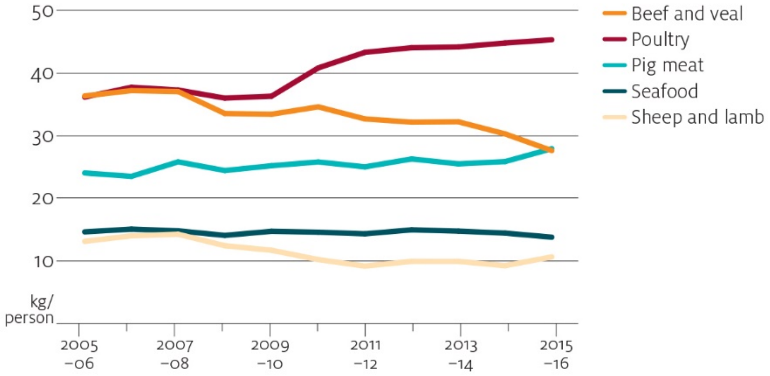
[150] Mobsby, D and Koduah, A 2017, Australian fisheries and aquaculture statistics 2016, FRDC project 2017-095. ABARES, Canberra, December. CC BY 4.0.
[151] The state of world fisheries and aquaculture 2016—opportunities and challenges, Food and Agriculture Organization of the United Nations, Rome.

In Australia, apparent consumption of seafood per person (edible equivalent) decreased, on average, at an annual rate of 0.6 per cent, from 14.6 kilograms in 2005– 06 to 13.8 kilograms per person in 2015–16. Annual apparent consumption is estimated by the Australian Bureau of Agricultural and Resource Economics and Sciences by adding the total edible quantity of seafood supplied domestically—that is, total production plus imported seafood— less exports of seafood[152]

In comparison, global per capita apparent fish consumption increased from an average of 9.9 kg in the 1960s to 14.4 kg in the 1990s and 20.1 kg in 2014, with preliminary estimates for 2015 indicating further growth, exceeding 20 kg (FAO 2016). Australia's per person seafood consumption in 2013 was estimated by the FAO to be 26kg. The differences in estimates are accounted for by varying methods for calculating consumption. ABARES estimates seafood consumption on a processed edible basis, whereas the FAO provides its estimates on a whole weight basis.



Data quality: Gold

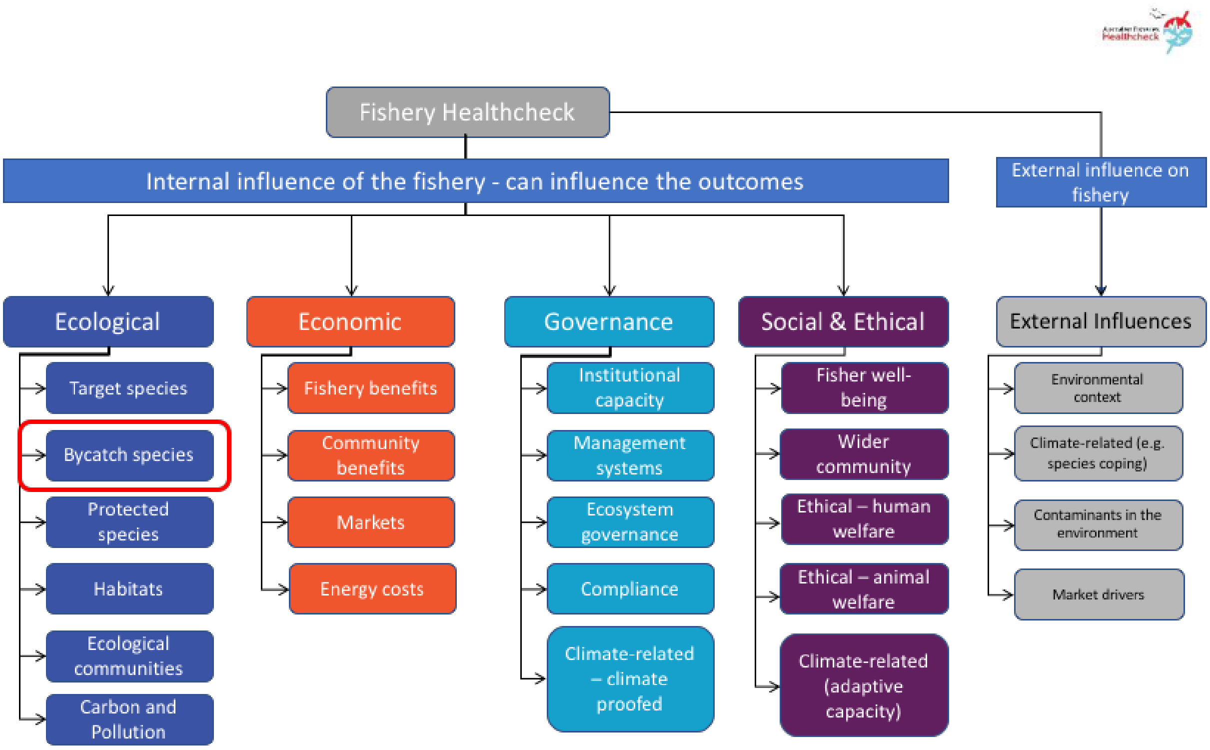
[152] Mobsby, D and Koduah, A 2017, *Australian fisheries and aquaculture statistics 2016*, FRDC 2017-095. ABARES, Canberra, December. CC BY 4.0

Northern Territory Mud Crab Fishery

The Northern Territory Mud Crab Fishery (MCF) Fishery is primarily based on the capture of the Giant Mud Crab (*Scylla serrata*), and to a far lesser extent (<1% of catch) the Orange Mud Crab (*Scylla olivacea*). The Giant Mud Crab is a highly prized and iconic species that forms the basis of one of the NT's key wild harvest fisheries, is a popular recreational target species, and is an important resource to Aboriginal Territorians for customary harvest and cultural practices. Mud crab fishing activity is carried out in coastal waters and estuaries, and the requirement for boat ramps to access fishing areas has resulted in areas of operation overlapping between sectors, necessitating the need for joint management and agreement on management arrangements. Mud crab fishing can occur to the edge of the Australian Fishing Zone, however crabbers generally operate in coastal and estuarine areas, predominantly on mud flats or creeks and rivers. The NT Government has worked with Aboriginal Land Councils to negotiate agreements that allow permit free access and provide benefits back to Traditional Owners. The most productive commercial fishing grounds are in the Gulf of Carpentaria (GoC) and the Darwin area and limited commercial effort occurs off the Arnhem Land coast and far west coast due to access and logistic issues. The commercial fishery has accreditation to export product, with most product sold on the domestic market through the Sydney and Melbourne fish markets. The fishery currently generates an average Gross Value of Production (GVP) in the order of $4-5 million per annum. (Source: Fisheries Guidelines Project)

Case Study Presentation Format

The case study documents are a collection of metrics, organised by the healthcheck structure:



The presentation of metrics will follow the following heading format:

Ecological > Bycatch species > Bycatch composition > Mean Trophic Level

Understand this to be an indicator (**Bycatch composition**) of the **Ecological** Component, **Bycatch species** subcomponent where the (in the figure and heading example above, is being measured by presenting Mean Trophic Level as the metric.

Ecological > Target species > Stock Status > Status of Australian Fish Stocks (SAFS)

Target species in each fishery are the primary focus for this indicator. Status of these species is ideally assessed with the SAFS approach, however this may not cover all target species for each fishery. In that case, we indicate the number of unassessed species. These species could also be assessed by individual states or by alternative methods.

SpeciesName	StockName	StockStatus	Year
MUD CRABS	East Coast	Sustainable	2016
MUD CRABS	Gulf of Carpentaria	Sustainable	2016

Data Quality: Gold

Ecological > Target Species > Harvest Level > Catch weight

This metric is a proxy for harvest level. The harvested biomass for each species, provides information on the level of the catch. Trends in this metric over time can indicate declining availability of fish, quota restrictions, or changes in market demand. For Australian fisheries, trends are expected to be stable for most species.

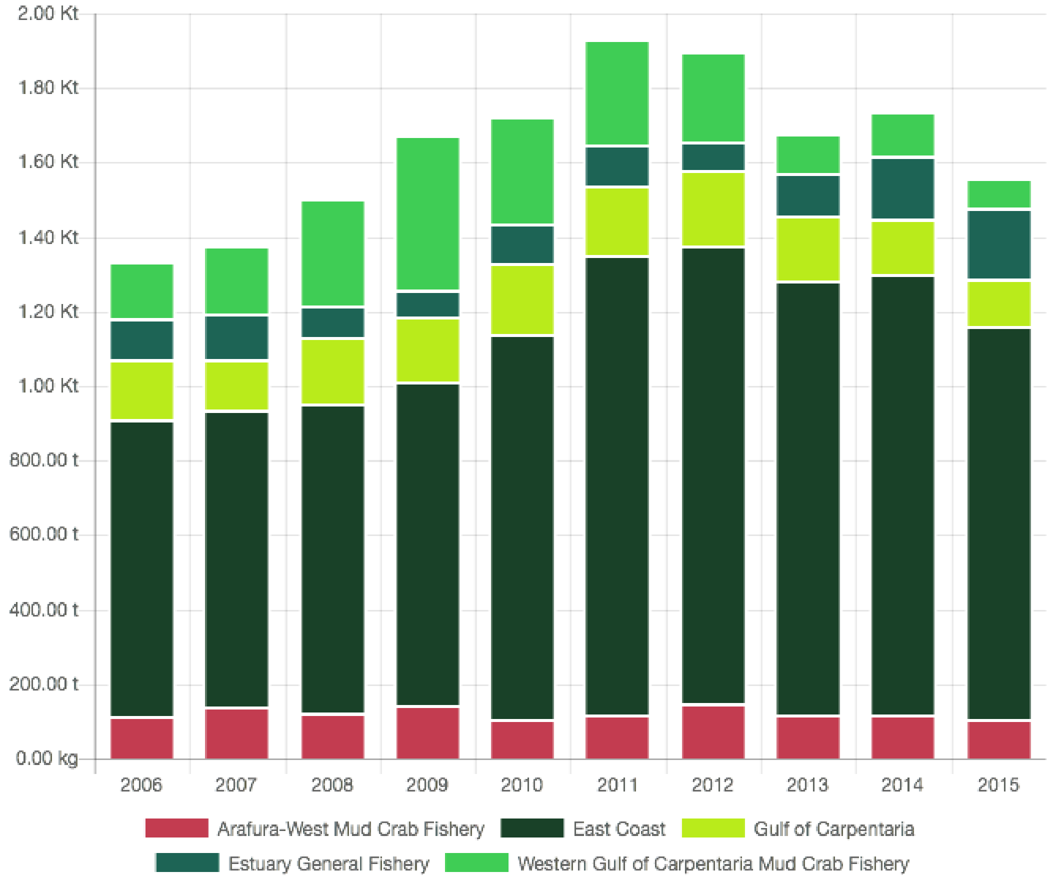
Catch data for most of these fisheries are derived from compulsory monthly logbooks submitted by commercial licensees, summaries of which have been provided since 2013 in annual “Status of Key Northern Territory Fish Stocks Reports” (NTG, 2015, 2016, 2017). NT Fisheries provided all relevant data from these fisheries to this project - going back as far as 1983. Kennelly (2018)

Table 24 – Retained annual average catches (and SE’s) from the Northern Territory’s commercial fisheries, using the most recently available years of data. Kennelly (2018)

Fishery	Methods	Years	Retained (t)	SE
Mud Crab	Pots and bait gillnets	2012-2016	224.16	50.39

Recent catches[153] of mudcrab retained are:

[153] http://www.fish.gov.au/report/41-MUD-CRABS-2016



Commercial catch of Mud Crab - note confidential catch not shown

Data quality: Gold

Ecological > Bycatch species > Bycatch composition > Mean Trophic Level

The trophic level is a measure of the position of an organism in a food web, starting at level 1 with primary producers, such as phytoplankton, then moving through the primary consumers at level **2** that eat the primary producers to the secondary consumers at level **3** that eat the primary consumers, and so on. The **bycatch mean trophic level** is an indicator of the mean level of the food chain for bycatch in a fishery.

This fishery has very low bycatch, and so this metric was not calculated

Data Quality: Not applicable

Ecological > Bycatch species > Bycatch amount > Total weight of bycatch

Bycatch weights for fishery are typically developed by specific projects, and require a range of assumptions due to issues with reporting and retention of bycatch. **Bycatch** estimates typically cover species that are not target species, while **discard** rates may also include undersized individuals of the target species. Kennelly (2018) provides estimates of discard rates, which include both target and bycatch species, and when discard rates are used, that information is noted for each fishery. Animals can be returned to the ocean alive or dead. The intention of this metric is to provide information on animals that are dead on return to the ocean.

Reference:

Kennelly, S.J., 2018. *Developing a National Bycatch Reporting System.* Final FRDC Report, ISBN 978-0-9924930-5-9, March, 2018. 99 pp.

There has been no observer programme in this fishery so no NT-based discard estimates are available. Instead, Kennelly (2018)[154] applied the average NSW retained:discard ratio for its mud crab fishery. This is a ratio of 1:0.15 (SE 0.02) or a discard rate of 13%. Kennelly (2018) calculated discard estimates for each fishery in the Northern Territory including Mud Crab (Table 26).

Fishery	Retained catch (tonnes)	SE	Discarded catch (tonnes)	SE
Mud Crab	224.16	50.39	33.40	8.48

Data Quality: Bronze

Ecological > Protected species > Capture amount > Captures

The number and diversity of TEP species captured by a fishery in the most recent year, provided as annual numbers.

The Mud Crab fishery (pots) is considered to pose little risk of interaction with TEPS.

Information about interactions with TEPs in the Northern Territory's commercial fisheries comes from the 3 recent status reports (NTG, 2015, 2016, 2017) which summarise data from industry logbooks and the observer programmes. Kennelly (2018).

Mud Crab	2013-15	Logbooks	None

Data quality: Bronze

Ecological > Protected species > Reporting > Level of monitoring

This indicator is to provide information on the level of coverage for a fishery. Annual measures are preferred.

Northern Territory's observer programmes where regular monitoring of catches and bycatches (including discards) occurs in several fisheries – these are among the few extant observer programs running in Australia's non-Commonwealth jurisdictions. All data collected from these programmes since 2011 were provided to this project by NT Fisheries (Saunders, pers. comm.)

[154] Kennelly, S.J., 2018. *Developing a National Bycatch Reporting System.* Final FRDC Report, ISBN 978-0-9924930-5-9, March, 2018. 99 pp.

and mainly concerned the largest (and more non-selective) fisheries in the jurisdiction – the Demersal, Timor Reef, Barramundi and Offshore Net and Line fisheries[155].

Data quality: Gold

Ecological > Habitats > Habitat impact > Impact score

The habitat impact is an indicator of the effect the fishing gear has on the habitat. Different gear types have different impacts. See the scoring rubric.

Habitat Impact: Moderate, based on the gear type used in this fishery.

Data quality: Bronze

Ecological > Habitats > Habitat impact > Habitat status

The status of the habitat types is a measure of the condition relative to a pristine state. Fishing may not be responsible for that habitat status, but it is important to note if fishing is taking place in pristine or disturbed habitats.

Habitat status: Excellent

Data quality: Bronze

Ecological > Ecological communities > Ecosystem status > Ecosystem status

This metric reports the ecosystem status in the region of the fishery.

Ecosystem Status: Good

This fishery takes place in the coastal and estuarine areas of the Northern Territory where the SOE report considers that the ecosystem status is good.[156]

Data Quality: Bronze

Ecological > Ecological communities > Ecosystem status > Species diversity

The measure of species diversity as a ratio between fished and unfished states.

Data quality: Not found

Ecological > Carbon and Pollution > Macro-plastics > Plastic code of conduct

Macro-plastics are plastics that are visible to the naked eye, such as food containers and wrapping, equipment packaging, and fishing equipment. The metric notes a commitment to a zero waste overboard code of conduct to assess attempts to reduce accidental or intentional introduction of macro-plastics to the ocean. There are stated guidelines detailing Australia's guidelines regarding marine pollution from the Australian Maritime Safety Authority[157]:

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[155] http://icic.net.au/wp-content/uploads/2018/03/2015-208-DLD.pdf
[156] https://soe.environment.gov.au/assessment-summary/marine-environment/state-and-trends-habitats-and-communities
[157] https://www.amsa.gov.au/marine-environment/marine-pollution/pollution-fishing-vessels

Pollution of the marine environment by ships, including fishing vessels, is strictly controlled by the International Convention for the Prevention of Pollution from Ships (known as MARPOL).

To minimise pollution, MARPOL prohibits ships from discharging garbage into the sea except in very limited circumstances.

Australian MARPOL regulations apply to Australian fishing vessels wherever they are operating.

Data Quality: Bronze

Ecological > Carbon and Pollution > Carbon footprint > CO₂-equivalents

The emissions of climate forcing gases in kg CO_2-equivalents (CO_2e) per kg live weight fish caught, not including the supply chain after landing.

Data Quality	Gear	Target species	Min (kg CO_2e/kg)	Average (kg CO_2e/kg)	Max (kg CO_2e/kg)	Reference	Description
Gold							
Silver							
Bronze	Pots and traps	Crustaceans	2.1	10.4	23.8	Parker and Tyedmers 2015	Oceania region, year and fuel type not specified, unclear if bait fishing is included, no refrigerants included.

Economic > Fishery Benefits > Net Economic Returns > Economic Rent

Net Economic Returns (NER) is equal to fishing revenue less fishing costs and measures the economic profit that is derived from fishing activity, it is measured by the Commonwealth as Net Economic Returns and by some States as Economic Rent. **Data Quality:** Not found

Economic > Fishery Benefits > Gross Value of Production > Gross Value of Production

GVP calculated as the volume of catch multiplied by the average per unit beach price (AUD$).

Data Quality	**Species/Fishery**	**Year**	**Amount**	**Reference**	**Note/Comment**
Silver	Mud crab	2015-2016	$2,984,000	Mobsby, D & Koduah, A (2017) Australian fisheries and aquaculture statistics	Preliminary Total crab for State

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https://www.amsa.gov.au/marine-environment/marine-pollution/marpol-and-its-implementation-australia

				2016, Fisheries Research and Development Corporation project 2017-095. ABARES, Canberra, December. CC BY 4.0.	
Silver	Mud crab	2014-2015	$4,578,000	Mobsby, D & Koduah, A (2017) Australian fisheries and aquaculture statistics 2016, Fisheries Research and Development Corporation project 2017-095. ABARES, Canberra, December. CC BY 4.0.	Total crab for State
Silver	Mud crab	2013-2001	$4,221,000	Mobsby, D & Koduah, A (2017) Australian fisheries and aquaculture statistics 2016, Fisheries Research and Development Corporation project 2017-095. ABARES, Canberra, December. CC BY 4.0.	Total crab for State

Economic > Fishery Benefits > Profitability > Financial Performance

Economic health of a fishery can be measured by the financial performance of the operators in the fleet. Fleet wide averages or distributions of levels of profitability indicate the extent to which the fishery is generating economic benefits for fishers.

Data Quality: Not found

Economic > Fishery Benefits > Latency > Underutilised Effort

Latency is fishery concessions that are not being fully utilised by fishers, for example, often the annual total allowable catch is left partially or largely uncaught for a fishery. Latency may appear as effort or uncaught TAC or inactive licences.

Data Quality: Not found

Economic > Community benefits > Value to community > GDP or GSP value

A fisheries contribution to Gross Domestic Production (GDP)/Gross State Product (GSP) is the total economic value that it generates directly, plus the indirect contribution made to other industries, which is also measured in value-add terms.

Data Quality	Indicator used	Year	Amount	Reference	Note

Bronze	GSP	2015-2016	$582,000,000	Northern Territory Government (2017) Northern Territory Economy Quick Facts – March quarter 2017 https://business.nt.gov.au/__data/assets/pdf_file/0009/426429/economy-quick-facts-quarter-201703.pdf	Combined Agriculture, fishing and forestry
Bronze	GSP	2016-2017	$697,000,000	Northern Territory Government (2017) Gross State Product 2016-17. Department of Treasury and Finance. Released 17 November 2017 https://treasury.nt.gov.au/__data/assets/pdf_file/0003/489153/Gross-State-Product-2016-2017.pdf	Agriculture, Forestry and Fisheries combined
Bronze	GSP	2015-2016	$642,000,000	Northern Territory Government (2017) Gross State Product 2016-17. Department of Treasury and Finance. Released 17 November 2017 https://treasury.nt.gov.au/__data/assets/pdf_file/0003/489153/Gross-State-Product-2016-2017.pdf	Agriculture, Forestry and Fisheries combined

Economic > Community benefits > Wealth Spread > Distribution of fishing firm size

The spread of profits to owners and crew members indicates how widely benefits of fishing are distributed across the fishing community. A wide spread of benefits may be important to some fishery stakeholders. A narrow spread may not indicate a lack of distribution of benefits in the case where all participating businesses are the same size, or if other mechanisms are present to capture and distribute benefits such as high levels of employment of crew. The number of large business versus small business, classified by turnover (direct measure) or catch volume (proxy) may provide an indirect indicator: i.e. are economic returns from commercial fishing gained by one or two large businesses or a spread over many smaller businesses?

For the Mud Crab fishery in NT, ABS data from June 2017 provides the following information on the distribution of NT Rock lobster and crab potting fishing businesses by annual turn over size (note there are no rock lobster fisheries in NT therefore 100% of these firms as assumed to be fishing in the Mud Crab fishery).

Zero to less than $50k	$50k to less than $200k	$200k to less than $2m	$2m to less than $5m	$5m to less than $10m	$10m or more
3	12	4	0	0	0

Economic > Markets > Fish distribution > Fish receivers

One way of measuring benefits from a fishery is by assessing the flow of seafood through the supply chain. In many fishery jurisdictions, the first step in the supply chain is via licensed fish receivers who are allowed to receive fish for sale. They can also trade fish with other receivers. In some jurisdictions, commercial fishers must sell their catch to a receiver (although they can sell small amounts on wharves). While this restricts fishers' options for landing their catch, it means that fish can be tracked, reduces illegal fish trading and ensures that the Quota Management Systems (QMS) work effectively by ensuring catches do not exceed the total allowable catch or quota amounts for individual species. Receivers of fish may be fish processors, wholesalers or retailers.

In some jurisdictions, the fishers and fish receivers are integrated, such that they are effectively the same "business". In Commonwealth fisheries, the total number of fish receivers per year may differ to the sum of the fish receivers per fishery because some receivers operate in more than one fishery.

Northern Territory Fish Trader Processors are not limited to any Fishery and licences can be used to on sell any fish or aquatic product. A limited number of licenses are used by a specific Fishery as listed below, but these licenses are not limited to only sell from that Fishery. There are currently 40 licenses that are active[158], including 6 that are specifically linked to the Mud Crab fishery.

Data Quality: Silver

Economic > Markets > Volatility in market price > Price volatility

Price volatility is the mean beach price for the target species (top one or five depending on price) over the given period (most recent ten years). The level of volatility is the standard deviation in mean price over this period.

Data Quality	Species/Fishery	Year/Time period	Amount	Reference	Note
Bronze	NT crab	2006-07 to 2015-16	$12.06/kg	Mobsby, D and Koduah, A 2017, Australian fisheries and aquaculture statistics 2016, Fisheries Research and Development Corporation project 2017-095. ABARES, Canberra, December. CC BY 4.0. Supporting data tables	For whole of NT Note no catch data (tonnage) given for 2008-09 and 2009-10

[158] Source: August 2018 via Ann Schubert, Senior Licensing Officer, Department of Primary Industry and Resources, Northern Territory Government, ann.schubert@nt.gov.au

Economics > Energy costs > Energy Use > Fuel use per kg of fish harvested

Fuel use varies over time and between stocks and are best collected from industry on a yearly basis. Estimates for different fisheries should be compared with caution, and in particular comparing energy use between fisheries with different data quality which is not recommended (different data availability, may be e.g. old or not fisheries-specific). Estimates are provided for all levels of data quality if available and are given in L per kg live-weight.

Data Quality	Gear	Target species	Min (L/kg)	Average (L/kg)	Max (L/kg)	Reference	Description
Gold							
Silver							
Bronze	Pots and traps	Crustaceans	0.8	3.8	9.5	Parker and Tyedmers 2015	Oceania region, unclear if bait use is included

Economic > Energy costs > Fossil fuel subsidies > Fuel subsidies directed to the fishery

Fossil fuel subsidies (fuel rebates) illustrate to which extent the fuel cost is reduced in the fishery, measured in AUD/kg live weight fish. Note that this form of tax exemption for fisheries is in Australia motivated from the sector not using roads (i.e. costs embedded in fuel price for road construction and maintenance), and are not formally reported as fuel subsidies in Australia.

Data Quality	Gear	Target species	Subsidy (AUD/kg)	Reference	Description
Gold					
Silver					
Bronze	All NT	All NT	0.13	Total tax claims per total landings in NT	2015-16 (2016-17 also available), state level figures on landings are preliminary for 2015-16

Governance > Ecosystem governance > Bycatch mitigation > Description of the bycatch mitigation measures

Bycatch measures can be spatial (e.g. area closure), temporal (time closure, e.g. night setting only) or technical (bycatch reduction devices, hook size). This indicator describes the measures that are in place for a fishery – but not the rates of compliance. For example, spatial closures for different gear types are shown here for AFMA fisheries http://www.afma.gov.au/sustainability-environment/fishing-closures/.

One of the objects of the Northern Territory Mud Crab Fishery Management Plan is to:

to manage the fishery resource, in accordance with the principles of ecologically sustainable development, to ensure the promotion of appropriate protection of:
the resource and its habitats; and

by-product species and by-catch species[159]

Data Quality: Bronze

Governance > Ecosystem governance > Protected species mitigation > Description of the protected species mitigation measures

TEP mitigation measures can be spatial (e.g. area closure), temporal (time closure, e.g. night setting only) or technical (bycatch reduction devices, hook size). This indicator describes the measures that are in place for a fishery – but not the rates of compliance. **Data Quality:** Not found

Governance > Management system > Harvest strategy > Scope of the harvest strategy

Assessment can be based on scoring presence of the following: a harvest strategy designed to achieve management objectives; harvest control rules and tools; collection of relevant information to support the harvest strategy; and, assessment of stock status or the presence of the following key elements: Defined operational objectives for the fishery; Indicators of fishery performance related to the objectives; Reference points for performance indicators; A statement defining acceptable levels of risk to meeting objectives; A monitoring strategy to collect relevant data to assess fishery performance; A process for conducting assessment of fishery performance relative to objectives; and; Decision rules that control the intensity of fishing activity and/or catch.

A key element of Fishery Management Framework development is to identify the utilisation of the resource and access arrangements between sectors. This may progress to the fishery undergoing a formal allocation process, in which case this process would be guided by the 'Northern Territory Fisheries Allocation Policy'. The Policy was developed by the Department of Primary Industry and Resources to address the issues related to the allocation of access between extractive user groups. Current use of the resource is based on ratios of the reported figures published in the Status of Key Northern Territory Fish Stocks reports. Utilising the recreational fishing, and traditional harvest information that is available, as a proportion of the total harvest, on average these sectors account for around 6% and 5%respectively. The Fishing Tour Operator sector accounts for less than 1%.[160]

Data Quality: Gold

Governance > Management system > Management plans > Scope of management plan

Management plans can be assessed by evaluating the presence of minimum requirements, as follows: a description of the fishery, especially its current status and any established user rights: the management objectives; how these objectives are to be achieved; how the plan is to be reviewed and/or appealed, as well as the consultation process for review and appeal.

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[159] https://legislation.nt.gov.au/Search/~/link.aspx?_id=AE76B23CBF2F4EDA8A275732BC1DFD79&_z=z
[160] Department of Primary Industry and Resources (2017). Management Framework for the Northern Territory Mud Crab Fishery 2017.

The Northern Territory Mud Crab Fishery is managed under the Fisheries Act[161], Fisheries Regulations[162] and the Mud Crab Fishery Management Plan[163], which contains the following minimum requirements:

Description of the fishery
Licencing, units of entitlement and nominated places
Review after 5 years

Data Quality: Gold

Governance > Institutional capacity > Accountability of decision making bodies > Level of Accountability

Accountability of Decision-making bodies. Performance of a fisheries management agency is based on the degree to which decision-making processes are consultative, the basis for decisions are fully explained, and information about decision making is publicly available. The assessment applied the three tiers of Principle 3.2.2 (d) 'Decision-making process' of the MSC Fisheries Standard v2.0 (2014) to determine whether the level of accountability was low, medium or high.

High level of accountability. This is demonstrated by the publicly-available management plan, and regulations and rules for both the commercial fishery, and recreational fishery, and the availability of decision-making procedures and outcomes from the Management Advisory Committee on request.

Data Quality: Silver

Governance > Institutional capacity > Uncertainty management > Extent of incorporation of uncertainty in management of the targeted stock

This metric reports on the explicit incorporation of uncertainties in decision support processes used to inform and make appropriate choices of management actions. We recognise three levels of uncertainty: Low level of incorporation of uncertainty; Medium level of incorporation of uncertainty; High level of incorporation of uncertainty. These are based on: Major sources of uncertainty are identified; Assessment takes uncertainty into account; Frequency of monitoring of indicators is high; Monitoring of more than one indicator to support management decisions; Assessment evaluates stock status relative to reference points in a probabilistic way; Robustness of assessments are tested, Alternative hypotheses and assessment approaches are rigorously explored.

Low level of incorporation of uncertainty in management of the targeted stock.	The assessment applied Principle 1.2.4 (c & d) 'Assessment of stock status: Uncertainty in the Assessment' of the MSC Fisheries Standard v2.0 (2014) to assess extent of incorporation of uncertainty in management of the targeted stock.

Data Quality: Silver

161 https://legislation.nt.gov.au/Legislation/FISHERIES-ACT
162 https://legislation.nt.gov.au/en/Legislation/FISHERIES-REGULATIONS
163 https://legislation.nt.gov.au/en/Legislation/MUD-CRAB-FISHERY-MANAGEMENT-PLAN

Governance > Compliance > Compliance regime > Level of Compliance

Level of compliance with rules and regulations controlling catch can be assessed by audits that measure the agreement between 1) logbook and observer records; 2) catch disposal records submitted by fishers and fish receivers. It might also be assessed by counting the annual number of breaches/observed offences or enforcement actions, preferably scaled to the level of enforcement effort (e.g. $). This indicator can be scored on the basis of the presence of key monitoring, control and surveillance elements and capacities.

A compulsory requirement for commercial fishers is to record information on catch and effort levels and other details on fishing operations. Logbook returns are submitted to NT Fisheries monthly and entered into the database. Current details recorded in the logbooks include:

Operator details
Month of operation
Number of days in the month fished
The Fishing Grid(s) fishing activity occurred in
The area location of the fishing activity
The number of pots set
The number of times the pots were pulled twice
The landed weight of mud crab
The species and landed weight of byproduct
The number and species of bycatch caught
The trader product was sold to
Any direct interactions with Threatened, Endangered and Protected Species (TEPS)

It is proposed to move to an ELog system for catch reporting at the earliest opportunity.[164]

Data Quality: Bronze

Governance > Compliance > Surveillance > Surveillance Effort

Regulatory controls include logs and catch reporting, on-board observer programs, vessel inspections, vessel monitoring systems, and visual or electronic surveillance using radar or satellite by boat or by air. Higher degrees of surveillance, or coverage using multiple methods, provide greater levels of certainty in estimates of effort, fishing mortality, bycatch and discard levels, and interactions with protected/listed species. Report on the surveillance carried out on the fishery, as reported by the compliance branch responsible for the fishery

Surveillance effort score: undefined
An electronic Vessel Monitoring System (VMS) will also be introduced in the commercial fleet in 2018.[165]
The NT Police are the responsible agency for enforcing provisions of the NT Fisheries Act, and its subordinate legislation including the NT Fisheries Regulations, and the Mud Crab Fishery Management Plan.
Effective compliance is created through the presence of Water Police officers and authorised and accredited Marine Rangers, as well as through detection and prosecution of illegal activity.

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[164] https://dpir.nt.gov.au/__data/assets/pdf_file/0007/448243/mud-crab-fishery-mgt-framework-2017.pdf
[165] https://dpir.nt.gov.au/news/2017/september/new-harvest-strategy-to-protect-mud-crabs

Compliance activities include routine patrols and planned responses to risks identified in the fishery, with an emphasis on serious risks.[166]

Data Quality: Bronze

Governance > Adaptive capacity > Governance arrangements > Climate change recognition

Governance arrangements relevant to the fishery consider the impact of climate change on the fishery, as evidenced by documentation, policies and plans that describe how management is addressing climate change impacts. Does the fishery management plan, harvest strategy or research activity suggest that climate change is recognised, and integrated into management planning?

The management plans do not yet recognize the need for climate responses for this fishery.

The Northern Territory government is developing guidance for industries exposed to climate extremes, variability and change.

The National Harvest Strategy also recognizes that "*Variability in ocean conditions, due to natural variability, climate change or other factors, can affect the productivity of stocks. Fisheries should seek to account for that variability when developing and implementing harvest strategies*"[167]. The Guidelines for the Harvest Strategy provide explicit approaches for fisheries[168]. This strategy and guideline do not explicitly apply to state fisheries, but will provide guidance.
Data quality: Bronze

Governance > Adaptive capacity > Coping strategies > Climate responses

The fishery has initiated coping strategies (directed) to reduce the impacts of climate change. Evidence of strategies that have been specifically implemented for the fishery might include codes of practice, restocking programs, early warning systems, and so on. The coping strategies may be for long-term change or for extreme events. A description of the climate change responses that have been implemented or explored in research or application are provided.

There are no management actions currently implemented that address climate change impacts in the fishery.

Data quality: Bronze

Social and Ethical > Fishers wellbeing > Fisher satisfaction > Satisfaction scores

If available, fishery specific surveys of well-being or satisfaction, with interpretation required for the types of questions and sample. When surveys are not available other sources of data may need to include broader surveys (e.g. not fishery specific) or discussions with industry representatives, managers or fishers about the industry and their opinion of general fisher-wellbeing (note this will be subjective).

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[166] https://dpir.nt.gov.au/__data/assets/pdf_file/0007/448243/mud-crab-fishery-mgt-framework-2017.pdf

[167] Department of Agriculture and Water Resources 2018, *Commonwealth Fisheries Harvest Strategy Policy*, Canberra, June. CC BY 4.0.

[168] Department of Agriculture and Water Resources 2018, *Guidelines for the Implementation of the Commonwealth Fisheries Harvest Strategy Policy*, Canberra, June. CC BY 4.0.

Satisfaction score: Not applicable
Social research is currently underway for this fishery, with results expected late 2018.

Data Quality: Bronze

Social and Ethical > Fishers wellbeing > Age Structure > Proportion of fishers in standard age cohorts

Proportion of fishers in standard age cohorts that were involved in the fishery at any point in the previous 5 years. If the fishery is not attractive or difficult to enter, the age distribution will be skewed to older ages. **Data Quality:** Not released

Social and Ethical > Wider community > Community satisfaction with fishery > Community feedback

Evidence of processes in place to gather direct engagement with the community (diversely represented) to listen and respond to feedback. This may be through a range of means including formal and informal processes and may not be appropriate to all fisheries in the same way. In some cases Marine Stewardship Council accreditation may demonstrate some evidence of community engagement.

Community feedback: Medium.

There is a crab management advisory committee. Based on general FRDC community perception surveys, satisfaction with Australian fisheries is rated at 42%.

Data quality: Bronze.

Social and Ethical > Wider Community > Level of local employment > Percentage of local employment

The communities surrounding and supporting fisheries benefit from those fisheries when the majority of employees (direct and indirect) associated with the fishery activity are local. Can be reported as direct, indirect and downstream levels.

Indicator	Year	Amount	Reference	Note
Estimated employment	2016	12 people	Mobsby, D & Koduah, A (2017) Australian fisheries and aquaculture statistics 2016, Fisheries Research and Development Corporation project 2017-095. ABARES, Canberra, December. CC BY 4.0.	Rock lobster and crab potting for NT

Data Quality: Silver

Social and Ethical > Ethical - Human welfare > Protections in place > Legislation exists

Although all workers are automatically operating under legislation according to their state or territory to a safe work place, the extent to which there is awareness of the relevant Acts, and use of these if required, is highly variable and may be different for each business or individual operation within each fishery. See http://workplaceohs.com.au/legislation for a list of state acts and regulations.

Protections in Place: Low

The Mud Crab fishery operates under Northern Territory (NT WorkSafe) – WHS (National Uniform Legislation) Act 2011 and WHS (National Uniform Legislation) Regulation 2011.

Data Quality: Silver

Social and Ethical > Ethical > Human welfare > Levels of compliance

Levels of compliance (or violations of) with Workplace Health and Safety. If references to Workplace Health and Safety exist in relation to the specific fishery, determine whether these are voluntary or recorded in anyway. If they are recorded, note the level of compliance. As they are likely to be voluntary, there will not likely be a record of compliance, but this may become more readily available in the future. **Data Quality:** Not found

Social and Ethical > Ethical-animal welfare > Animal welfare protections > Protections in place

At this early stage of development of animal welfare, any type of mention of animal welfare exists, it is probably the most appropriate. As this develops in to the future, assessments as to the level of engagement may become more relevant. **Data Quality:** Not found.

Social and Ethical > Ethical-animal welfare > Level of Compliance > Levels of compliance or violations of animal welfare

If there are any references to animal welfare protections or guidelines in fishery management plans and if reports exist, the indicator reports on the level of compliance or violations with welfare provisions.

Data Quality: Not found.

Social and Ethical > Climate-related > Access to information > Availability of information

This indicator describes available information that will help participants in the fishery adapt to changes. The assumption behind this indicator is that good information availability and flow will help fishers to adapt.

Data Quality: Not found.

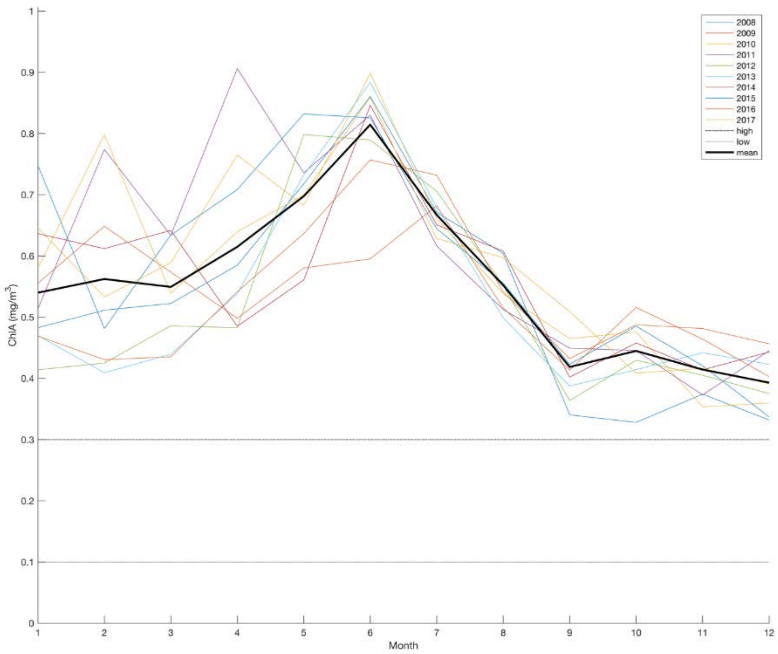
Social and Ethical > Climate-related > Access to networks > Level of membership of industry association

This metric assesses the presence or absence of a dedicated social media or social network group for the fishery. The fishery may still have a strong social network without a social media presence.

Data Quality: Not found.

External > Environmental Context > Productivity > Mean chlorophyll

A measure of environmental productivity is the biomass of phytoplankton, which in oceanic waters can be approximated by chlorophyll a concentration, as estimated from satellite (MODIS, oceandata.sci.gsfc.nasa.gov). Monthly chlorophyll values for a representative area of the fishery are shown with the mean productivity shown in solid black and references levels of low chlorophyll at 0.1 mg $m^{-3}$and high chlorophyll levels at 0.3 mg m^{-3}. This indicator shows the mean chlorophyll by month for the years 2008-2017. These data provide information on the relative environmental productivity in the fishery area. Missing data for some months can be due to ice cover. Variability in chlorophyll a concentration between years can indicate high environmental variability, while similar seasonal patterns indicate relative environmental stability.



Data Quality: Gold

External > Environmental Context > Environmental character > Description of the ecosystems

This metric provides a qualitative description of the ecosystem(s) in which the fishery occurs. The goal is to provide a general overview of these environments. The knowledge about which ecosystems are encountered during fishing activity is the indicator (rather than the response of the ecosystems to fishing).

Marine ecosystems are defined for the purposes of this indicator as the composition of plants, animals, and the marine environment (water masses, geomorphology). Types of marine ecosystems include estuaries, the sea floor, the mesopelagic zone, the pelagic zone, the inter-tidal zones, coral reefs, lagoons, and mangroves. A pelagic zone ecosystem for example, is defined by physical, chemical and biological features of the marine water column of the open ocean[169].

Description of the ecosystems: High

The fishery takes place in coastal and estuarine areas, generally with muddy or sandy sediments.

Data Quality: Silver

External > Climate related > Susceptibility of target species > Impacts on target species

Climate change directly affects the distribution, abundance and phenology of individual species. These changes then affect the fisheries that harvest these species, and can be a strong external influence on the fishery. These impacts can be positive (e.g. increased abundance), or negative (e.g. movements further from fishing ports), and to long-term warming, or short-term extreme events such as marine heatwaves. **Data Quality:** Not Found

External > Climate related > Susceptibility of key habitats > Habitat Impacts

Habitat impact: Moderate.

Mangrove dieoffs associated with El Nino events (2015/16) have been reported and were exacerbated by climate related warming and rainfall declines[170]

Data Quality: Bronze

External > Contaminants in the environment > Detection system for seafood contaminants > Risk of contaminants

Potential risk for contamination from the marine environment combined with monitoring arrangements to be able to address risks needed to ensure food safety. Contaminants include those with maximum levels set for by Food Standards Code Australia: metal contaminants, non-metal contaminants, natural toxicants, and average and maximum levels of mercury in fish. Contaminants from poor handling after landing are not assessed but may be indirectly addressed.

Rubric for risk level:

Low risk	Medium risk	High risk
There are no documented levels of contaminants from the marine environment causing risk/diet restrictions to any	There may be seasonal/area/species/size-based risks of contaminants for some species.	Permanent diet restrictions of species caught to vulnerable consumers such as children or pregnant women.

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[169] Game, E. T., H. S. Grantham, A. J. Hobday, R. L. Pressey, A. T. Lombard, L. E. Beckley, K. Gjerde, R. H. Bustamante, H. P. Possingham and A. J. Richardson (2009). Pelagic protected areas: the missing dimension in ocean conservation. Trends in Ecology and Evolution **24**(7): 360-369 doi:310.1016/j.tree.2009.1001.1011.

[170] Duke, N. C., J. M. Kovacs, A. D. Griffiths, L. Preece, D. J. E. Hill, P. v. Oosterzee, J. Mackenzie, H. S. Morning and D. Burrows (2017). Large-scale dieback of mangroves in Australia's Gulf of Carpentaria: a severe ecosystem response, coincidental with an unusually extreme weather event. Marine and Freshwater Research **68**(10): 1816-1829 https://doi.org/1810.1071/MF16322.

consumer group in the fishery.

Risk of Contaminants: Low

No specific monitoring arrangements found for marine contaminants on the fishery webpage: https://nt.gov.au/marine/commercial-fishing/mud-crab-industry-and-licences, but targeted species have low potential risk for contamination from the marine environment.

Data Quality: Silver

External > Contaminants in the environment > Management arrangements to ensure food safety related to contaminants > Evidence for arrangements

There is evidence of management arrangements to ensure food safety related to contaminants and food safety from the marine environment. No supply chain risks from poor handling are considered. Food standard 4.2.1 requires all seafood business in Australia to identify potential seafood safety hazards and put controls in place that are consistent with the risk.

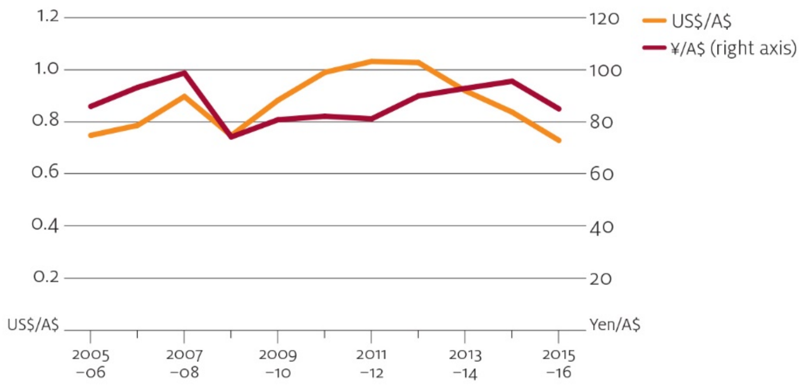
Data Quality	
GOLD	
SILVER	There is an industry code of practise. https://www.c-aid.com.au/wp-content/uploads/NTCodeofPracticeNTMudCrabFishery.pdf
BRONZE	

External > Market Drivers > Macroeconomic factors > Exchange Rates

A depreciating Australian dollar (or, increasing exchange rate) generally results in producers receiving a higher export price in Australian dollar terms, while an appreciating Australian dollar (or, decreasing exchange rate) results in a lower export price. Domestically, a depreciation of the Australian dollar encourages substitution from imported seafood to domestically produced seafood, as imported products become relatively more expensive. A lower exchange rate also makes Australian exports more competitive in world markets, as exported seafood become relatively cheaper in foreign currency terms.

National export trends are negatively related to exchange rate movements— the Australian dollar declined against the US dollar and Japanese yen from 1990–91 to 2000–01, with exports increasing in volume and value. Exchange rates for the Australian dollar increased against those currencies from 2001–02 to 2015–16. The real export value and volume of Australia's seafood exports decreased between 2005–06 and 2012–13 and then increased between 2012–13 and 2015–16—with a noticeable rise (43 per cent) in volume between 2014–15 and 2015–16.[171]

[171] Mobsby, D and Koduah, A 2017, Australian fisheries and aquaculture statistics 2016, FRDC project 2017-095. ABARES, Canberra, December. CC BY 4.0.



Data Quality: Gold

External > Market Drivers > Consumer Trends > Per person annual apparent consumption of seafood (kg)

Annual apparent consumption is estimated by adding the total edible quantity of seafood supplied domestically—that is, total production plus imported seafood— less exports of seafood. Apparent consumption provides an estimate of the total amount of seafood consumed in Australia assuming zero change in stocks.

The production quantity of Australian fishery and aquaculture products is reported by ABARES on a whole weight basis, whereas trade data are reported on a processed basis. To align the units of measurement between production and trade data, it is necessary to convert production volume to a processed edible equivalent.

Production volumes are adjusted to an edible quantity basis using species-specific conversion rates and excluding species that are known to be predominantly supplied for non-human consumption purposes, such as for aquaculture feed or bait. Imports and exports of seafood are sourced from Australian Bureau of Statistics (ABS) trade data and are reported as edible weight. The apparent consumption per person is calculated as the total apparent consumption divided by the total Australian population in each year. The method applied here is consistent with that used by ABARES to estimate apparent consumption of other agricultural commodities produced in Australia.

The FAO also compiles statistics on apparent consumption of seafood, applying a consistent method across all countries. FAO estimates indicate that annual consumption of seafood in Australia is around 26 kilograms per person in 2013 (FAO 2016[172]). The discrepancy between FAO and ABARES estimates reflects differences in methodological approaches to estimating consumption. Moreover, ABARES estimates seafood consumption on a processed edible basis, whereas the FAO provides its estimates on a whole weight basis.

In Australia, apparent consumption of seafood per person (edible equivalent) decreased, on average, at an annual rate of 0.6 per cent, from 14.6 kilograms in 2005– 06 to 13.8 kilograms per person in 2015–16. Annual apparent consumption is estimated by the Australian Bureau of Agricultural and

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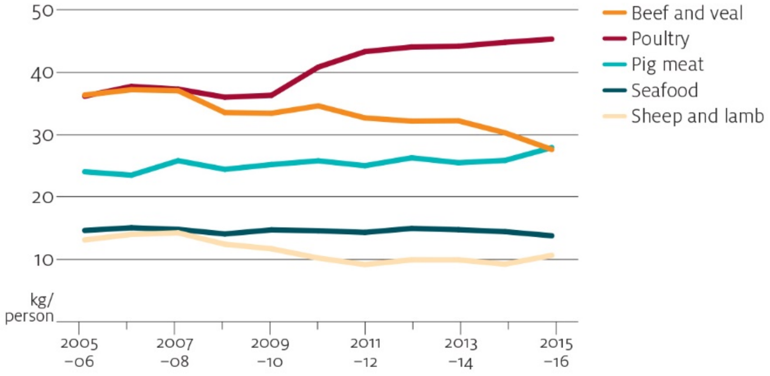
[172] The state of world fisheries and aquaculture 2016—opportunities and challenges, Food and Agriculture Organization of the United Nations, Rome.

Resource Economics and Sciences by adding the total edible quantity of seafood supplied domestically—that is, total production plus imported seafood— less exports of seafood[173]

In comparison, global per capita apparent fish consumption increased from an average of 9.9 kg in the 1960s to 14.4 kg in the 1990s and 20.1 kg in 2014, with preliminary estimates for 2015 indicating further growth, exceeding 20 kg (FAO 2016). Australia's per person seafood consumption in 2013 was estimated by the FAO to be 26kg. The differences in estimates are accounted for by varying methods for calculating consumption. ABARES estimates seafood consumption on a processed edible basis, whereas the FAO provides its estimates on a whole weight basis.



Data quality: Gold

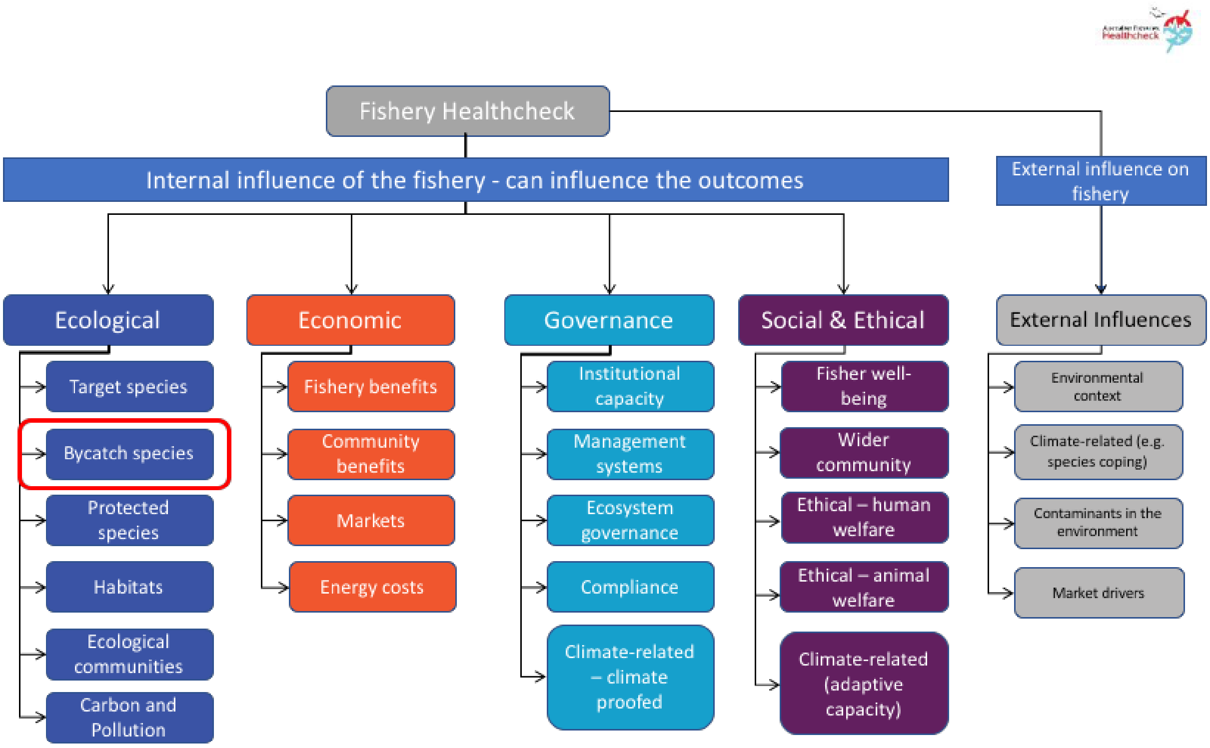
[173] Mobsby, D and Koduah, A 2017, *Australian fisheries and aquaculture statistics 2016*, FRDC 2017-095. ABARES, Canberra, December. CC BY 4.0

Northern Territory Offshore Snapper Fishery

The Northern Territory Offshore Snapper Fishery (OSF: comprising the Demersal and Timor Reef Fisheries) is NT's most valuable commercial fishery of $24M. These are multi-species and multi-gear fisheries, (each managed separately with regard to licences and Independent Transferrable Quotas) covering all NT and Commonwealth waters (under the OCS NT Fishery Joint Authority arrangements). The majority of the catch is sold domestically in Australia in Sydney and Melbourne being the primary markets and a small percentage is exported to then European Union and the US. The recreational and Fishing Tour Operator catch is limited due to distance and there is little existing data for recreational activity and catch, with management via bag and possession limits. The indigenous take is also limited due to distance offshore. (Source: Fisheries Guidelines Project).

Case Study Presentation Format

The case study documents are a collection of metrics, organised by the healthcheck structure:



The presentation of metrics will follow the following heading format:

Ecological > Bycatch species > Bycatch composition > <u>Mean Trophic Level</u>

Understand this to be an indicator (**Bycatch composition**) of the **Ecological** Component, **Bycatch species** subcomponent where the (in the figure and heading example above, is being measured by presenting <u>Mean Trophic Level</u> as the metric.

Ecological > Target species > Stock Status > Status of Australian Fish Stocks (SAFS)

Target species in each fishery are the primary focus for this indicator. Status of these species is ideally assessed with the SAFS approach, however this may not cover all target species for each fishery. In that case, we indicate the number of unassessed species. These species could also be assessed by individual states or by alternative methods.

Australian Blacktip Shark	Gulf of Carpentaria	Undefined	2016
Australian Blacktip Shark	North and West Coast	Sustainable	2016
Black Jewfish	Northern Territory	Overfished	2016
Golden Snapper	Northern Territory	Overfished	2016
Grey Mackerel	Gulf of Carpentaria	Sustainable	2016
Grey Mackerel	North West Northern Territory	Sustainable	2016
Sandbar Shark	Western Australia	Transitional-recovering	2016
Spanish Mackerel	Northern Territory	Sustainable	2016
Spotted Mackerel	Northern Australia	Sustainable	2016

Data Quality: Gold

Ecological > Target Species > Harvest Level > Catch weight

This metric is a proxy for harvest level. The harvested biomass for each species, provides information on the level of the catch. Trends in this metric over time can indicate declining availability of fish, quota restrictions, or changes in market demand. For Australian fisheries, trends are expected to be stable for most species.

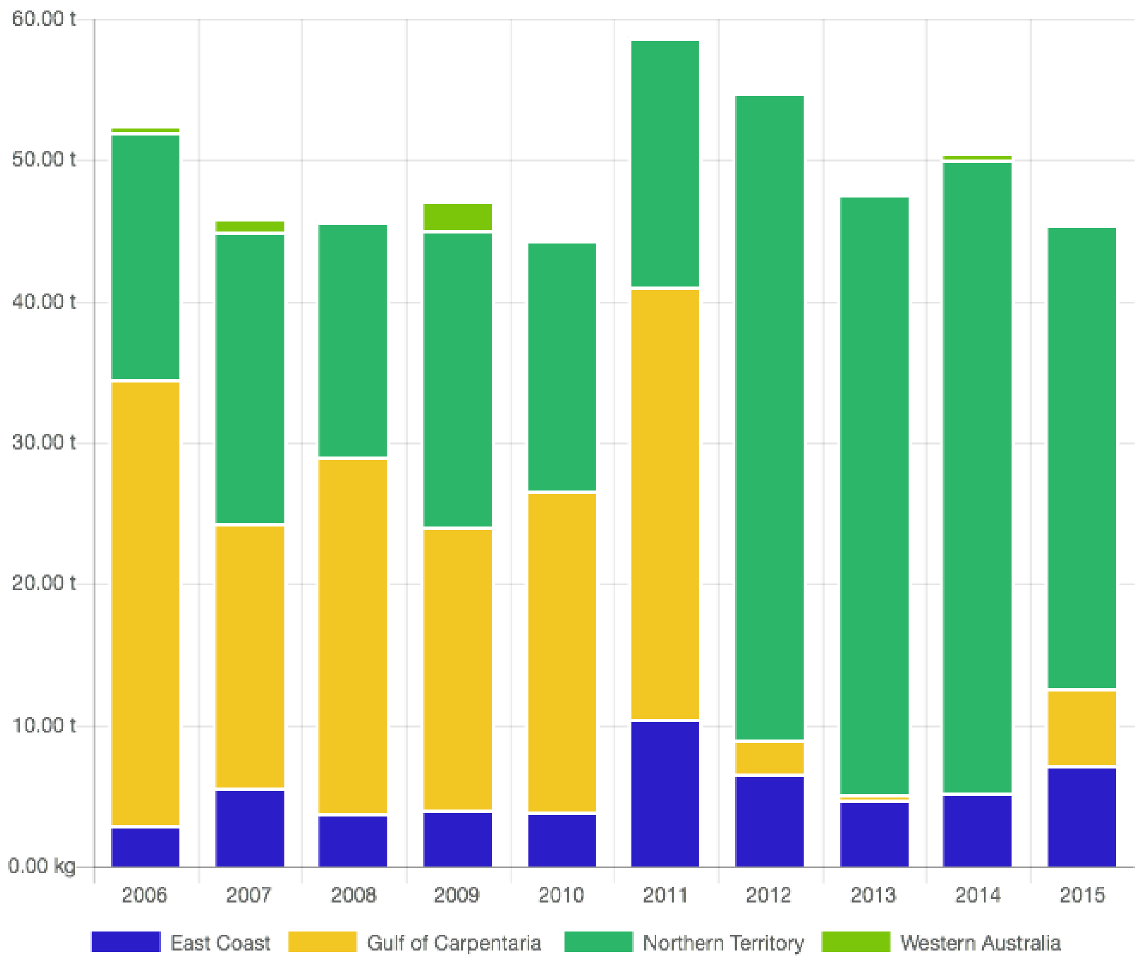
The Demersal fishery targets a range of Tropical Snappers (*Lutjanus* spp. and *Pristipomoides* spp.) using fish traps, hand lines, droplines and demersal trawl nets (the latter permitted only in two defined zones).

Catch data for most of these fisheries are derived from compulsory monthly logbooks submitted by commercial licensees, summaries of which have been provided since 2013 in annual “Status of Key Northern Territory Fish Stocks Reports” (NTG, 2015, 2016, 2017). NT Fisheries provided all relevant data from these fisheries to this project - going back as far as 1983. Kennelly (2018)

Table 24 – Retained annual average catches (and SE's) from the Northern Territory's commercial fisheries, using the most recently available years of data. Kennelly (2018)

Fishery	Methods	Years	Retained (t)	SE
Demersal	Traps, hand lines, droplines, demersal trawls	2012-2016	2453.17	197.26

Recent catches[174] are:



Commercial catch of Golden Snapper - note confidential catch not shown

Data quality: Gold

Ecological > Bycatch species > Bycatch composition > Mean Trophic Level

[174] http://www.fish.gov.au/report/31-Golden-Snapper-2016

The trophic level is a measure of the position of an organism in a food web, starting at level 1 with primary producers, such as phytoplankton, then moving through the primary consumers at level **2** that eat the primary producers to the secondary consumers at level **3** that eat the primary consumers, and so on. The **bycatch mean trophic level** is an indicator of the mean level of the food chain for bycatch in a fishery. **Data Quality:** Not organised/analysed

Ecological > Bycatch species > Bycatch amount > Total weight of bycatch

Bycatch weights for fishery are typically developed by specific projects, and require a range of assumptions due to issues with reporting and retention of bycatch. **Bycatch** estimates typically cover species that are not target species, while **discard** rates may also include undersized individuals of the target species. Kennelly (2018) provides estimates of discard rates, which include both target and bycatch species, and when discard rates are used, that information is noted for each fishery. Animals can be returned to the ocean alive or dead. The intention of this metric is to provide information on animals that are dead on return to the ocean.

Reference:

Kennelly, S.J., 2018. *Developing a National Bycatch Reporting System.* Final FRDC Report, ISBN 978-0-9924930-5-9, March, 2018. 99 pp.

Kennelly (2018)[175] reports that the fishery targets a range of Tropical Snappers (*Lutjanus* spp. and *Pristipomoides* spp.) using fish traps, hand lines, droplines and demersal trawl nets (the latter permitted only in two defined zones). Turtle Exclusion Devices are required in the trawl gear and operators use square mesh codends to reduce unwanted bycatches and improve catch quality. Bycatch in this fishery is routinely quantified by on-board observers. Kennelly (2018) estimated annual average retained:discard ratio of 1:0.14 (SE 0.02) for a discard rate of 12.1% (SE 2.02). Discarded species included Trevallies, Scads and Sharks. Kennelly (2018) calculated discard estimates for each fishery in the Northern Territory including the demersal offshore snapper (Table 26).

Fishery	Retained catch (tonnes)	SE	Discarded catch (tonnes)	SE
Demersal	2453.17	197.26	393.23	35.90

Data Quality: Bronze

Ecological > Protected species > Capture amount > Captures

The number and diversity of TEP species captured by a fishery in the most recent year, provided as annual numbers.

The Demersal fisheries are required to have turtle exclusion devices by law and are reported to have consistently few interactions with TEPS compared to similar fisheries elsewhere (eg in

[175] Kennelly, S.J., 2018. *Developing a National Bycatch Reporting System.* Final FRDC Report, ISBN 978-0-9924930-5-9, March, 2018. 99 pp.

Western Australia). Most interactions are with Narrow Sawfish and Scalloped Hammerhead Sharks. Kennelly (2018)[176]

Information about interactions with TEPs in the Northern Territory's commercial fisheries comes from the 3 recent status reports (NTG, 2015, 2016, 2017) which summarise data from industry logbooks and the observer programmes.

Table 27 – Estimates of interactions between the Northern Territory's commercial fisheries and TEP species.

Year	Source	Interactions with TEP species
2013	Observers	16 interactions over 30 days with sea snakes, Narrow Sawfish and turtles
2014	Observers	18 interactions over 40 days with sea snakes, Narrow Sawfish, two dolphins and a turtle
2015	Observers	8 interactions over 31 days with sea snakes, Narrow Sawfish and a Grey Nurse Shark
2016	Observers	106 interactions over 60 days with Scalloped Hammerhead Sharks, Narrow Sawfish, Sea snakes with 11 turtles and one Devil Pygmy Ray caught
2017	Observers	49 interactions over 36 days with Scalloped Hammerhead Sharks, Narrow Sawfish with 1 Dolphin and Pygmy Devil Ray

Data quality: Silver

Ecological > Protected species > Reporting > Level of monitoring

This indicator is to provide information on the level of coverage for a fishery. Annual measures are preferred.

Northern Territory's observer programmes where regular monitoring of catches and bycatches (including discards) occurs in several fisheries – these are among the few extant observer programs running in Australia's non-Commonwealth jurisdictions. All data collected from these programmes since 2011 were provided by NT Fisheries (Saunders, pers. comm.) and mainly concerned the largest (and more non-selective) fisheries in the jurisdiction – the Demersal, Timor Reef, Barramundi and Offshore Net and Line fisheries[177].

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[176] Kennelly, S.J., 2018. *Developing a National Bycatch Reporting System.* Final FRDC Report, ISBN 978-0-9924930-5-9, March, 2018. 99 pp.
[177] http://icic.net.au/wp-content/uploads/2018/03/2015-208-DLD.pdf

Data quality: Gold

Ecological > Habitats > Habitat impact > Impact score

The habitat impact is an indicator of the effect the fishing gear has on the habitat. Different gear types have different impacts. See the scoring rubric.

Habitat Impact: Minor, based on the gear type used in this fishery.

Data quality: Bronze

Ecological > Habitats > Habitat impact > Habitat status

The status of the habitat types is a measure of the condition relative to a pristine state. Fishing may not be responsible for that habitat status, but it is important to note if fishing is taking place in pristine or disturbed habitats.

Habitat status: Excellent

Data quality: Bronze

Ecological > Ecological communities > Ecosystem status > Ecosystem status

This metric reports the ecosystem status in the region of the fishery.

Ecosystem Status: Good

This fishery takes place in remote offshore areas of the Northern Territory towards the Western Australian border, where past harvesting of sharks and demersal species has impacted the region. The SOE report considers that the ecosystem status is good.[178]

Data Quality: Bronze

Ecological > Ecological communities > Ecosystem status > Species diversity

The measure of species diversity as a ratio between fished and unfished states.

Data quality: Not found

Ecological > Carbon and Pollution > Macro-plastics > Plastic code of conduct

Macro-plastics are plastics that are visible to the naked eye, such as food containers and wrapping, equipment packaging, and fishing equipment. The metric notes a commitment to a zero waste overboard code of conduct to assess attempts to reduce accidental or intentional introduction of macro-plastics to the ocean. There are stated guidelines detailing Australia's guidelines regarding marine pollution from the Australian Maritime Safety Authority[179]:

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[178] https://soe.environment.gov.au/assessment-summary/marine-environment/state-and-trends-habitats-and-communities

[179] https://www.amsa.gov.au/marine-environment/marine-pollution/pollution-fishing-vessels
https://www.amsa.gov.au/marine-environment/marine-pollution/marpol-and-its-implementation-australia

Pollution of the marine environment by ships, including fishing vessels, is strictly controlled by the International Convention for the Prevention of Pollution from Ships (known as MARPOL).

To minimise pollution, MARPOL prohibits ships from discharging garbage into the sea except in very limited circumstances.

Australian MARPOL regulations apply to Australian fishing vessels wherever they are operating.

Data Quality: Bronze

Ecological > Carbon and Pollution > Carbon footprint > CO_2-equivalents

The emissions of climate forcing gases in kg CO_2-equivalents (CO_2e) per kg live weight fish caught, not including the supply chain after landing.

Data Quality	Gear	Target species	Min (kg CO_2e/kg)	Average (kg CO_2e/kg)	Max (kg CO_2e/kg)	Reference	Description
Gold							
Silver							
Bronze	Gillnet	Finfish	0.8		4.2	Parker and Tyedmers 2015	Global, assume diesel, no refrigerants included
Bronze	Demersal trawl	Finfish	1.0	1.5	1.8	Parker and Tyedmers 2015	Oceania region, year not specified, assume diesel, no refrigerants included
Bronze	Pots and traps	Finfish					Not collected
Bronze	Hooks and lines	Finfish	0.3		11.5	Parker and Tyedmers 2015	Global, assume diesel, unclear if bait fishing is included, no refrigerants included

Economic > Fishery Benefits > Net Economic Returns > Economic Rent

Net Economic Returns (NER) is equal to fishing revenue less fishing costs and measures the economic profit that is derived from fishing activity, it is measured by the Commonwealth as Net Economic Returns and by some States as Economic Rent. **Data Quality:** Not found

Economic > Fishery Benefits > Gross Value of Production > Gross Value of Production

GVP calculated as the volume of catch multiplied by the average per unit beach price (AUD$).

Data Quality	Species/Fishery	Year	Amount	Reference	Note/Comment
Gold	Goldband snapper	2015-2016	$3,173,000	Mobsby, D & Koduah, A (2017) Australian fisheries and aquaculture statistics 2016, Fisheries Research and Development Corporation project 2017-095. ABARES, Canberra, December. CC BY 4.0.	Preliminary
Gold	Goldband snapper	2014-2015	$3,820,000	Mobsby, D & Koduah, A (2017) Australian fisheries and aquaculture statistics 2016, Fisheries Research and Development Corporation project 2017-095. ABARES, Canberra, December. CC BY 4.0.	
Gold	Goldband snapper	2013-2012	$4,824,000	Mobsby, D & Koduah, A (2017) Australian fisheries and aquaculture statistics 2016, Fisheries Research and Development Corporation project 2017-095. ABARES, Canberra, December. CC BY 4.0.	

Economic > Fishery Benefits > Profitability > Financial Performance

Economic health of a fishery can be measured by the financial performance of the operators in the fleet. Fleet wide averages or distributions of levels of profitability indicate the extent to which the fishery is generating economic benefits for fishers.

Data Quality: Not found

Economic > Fishery Benefits > Latency > Underutilised Effort

Latency is fishery concessions that are not being fully utilised by fishers, for example, often the annual total allowable catch is left partially or largely uncaught for a fishery. Latency may appear as effort or uncaught TAC or inactive licences.

Data Quality: Not found

Economic > Community benefits > Value to community > GDP or GSP value

A fisheries contribution to Gross Domestic Production (GDP)/Gross State Product (GSP) is the total economic value that it generates directly, plus the indirect contribution made to other industries, which is also measured in value-add terms.

Data Quality	Indicator used	Year	Amount	Reference	Note
Bronze	GSP	2015-2016	$582,000,000	Northern Territory Government (2017) Northern Territory Economy Quick Facts – March quarter 2017 https://business.nt.gov.au/__data/assets/pdf_file/0009/426429/economy-quick-facts-quarter-201703.pdf	Combined Agriculture, fishing and forestry
Bronze	GSP	2016-2017	$697,000,000	Northern Territory Government (2017) Gross State Product 2016-17. Department of Treasury and Finance. Released 17 November 2017 https://treasury.nt.gov.au/__data/assets/pdf_file/0003/489153/Gross-State-Product-2016-2017.pdf	Agriculture, Forestry and Fisheries combined
Bronze	GSP	2015-2016	$642,000,000	Northern Territory Government (2017) Gross State Product 2016-17. Department of Treasury and Finance. Released 17 November 2017 https://treasury.nt.gov.au/__data/assets/pdf_file/0003/489153/Gross-State-Product-2016-2017.pdf	Agriculture, Forestry and Fisheries combined

Economic > Community benefits > Wealth Spread > Distribution of fishing firm size

The spread of profits to owners and crew members indicates how widely benefits of fishing are distributed across the fishing community. A wide spread of benefits may be important to some fishery stakeholders. A narrow spread may not indicate a lack of distribution of benefits in the case where all participating businesses are the same size, or if other mechanisms are present to capture and distribute benefits such as high levels of employment of crew. The number of large business versus small business, classified by turnover (direct measure) or catch volume (proxy) may provide an indirect indicator: i.e. are economic returns from commercial fishing gained by one or two large businesses or a spread over many smaller businesses? **Data Quality:** Not organised/analysed

Economic > Markets > Fish distribution > Fish receivers

One way of measuring benefits from a fishery is by assessing the flow of seafood through the supply chain. In many fishery jurisdictions, the first step in the supply chain is via licensed fish receivers who are allowed to receive fish for sale. They can also trade fish with other receivers. In some jurisdictions, commercial fishers must sell their catch to a receiver (although they can sell small amounts on wharves). While this restricts fishers' options for landing their catch, it means that fish can be tracked, reduces illegal fish trading and ensures that the Quota Management Systems (QMS) work effectively by ensuring catches do not exceed the total allowable catch or quota amounts for individual species. Receivers of fish may be fish processors, wholesalers or retailers.

In some jurisdictions, the fishers and fish receivers are integrated, such that they are effectively the same "business". In Commonwealth fisheries, the total number of fish receivers per year may differ to the sum of the fish receivers per fishery because some receivers operate in more than one fishery.

Northern Territory Fish Trader Processors are not limited to any Fishery and licences can be used to on sell any fish or aquatic product. A limited number of licenses are used by a specific Fishery as listed below, but these licenses are not limited to only sell from that Fishery. There are currently 40 licenses that are active[180], including 7 that are specifically linked to the Offshore Snapper Fishery.

Data Quality: Silver

Economic > Markets > Volatility in market price > Price volatility

Price volatility is the mean beach price for the target species (top one or five depending on price) over the given period (most recent ten years). The level of volatility is the standard deviation in mean price over this period. **Data Quality:** Not found

Economics > Energy costs > Energy Use > Fuel use per kg of fish harvested

Fuel use varies over time and between stocks and are best collected from industry on a yearly basis. Estimates for different fisheries should be compared with caution, and in particular comparing energy use between fisheries with different data quality which is not recommended (different data availability, may be e.g. old or not fisheries-specific). Estimates are provided for all levels of data quality if available and are given in L per kg live-weight.

Data Quality	Gear	Target species	Min (L/kg)	Average (L/kg)	Max (L/kg)	Reference	Description
Gold							
Silver							

[180] Source: August 2018 via Ann Schubert, Senior Licensing Officer, Department of Primary Industry and Resources, Northern Territory Government, ann.schubert@nt.gov.au

Bronze	Bottom trawls	Finfish	0.4	0.5	0.7	Parker and Tyedmers 2015	Oceania region
Bronze	Hooks and lines	Finfish	0.1		4.2	Parker and Tyedmers 2015	Global, unclear if bait fishing is included
Bronze	Gillnets	Finfish	0.3		1.5	Parker and Tyedmers 2015	Global

Economic > Energy costs > Fossil fuel subsidies > Fuel subsidies directed to the fishery

Fossil fuel subsidies (fuel rebates) illustrate to which extent the fuel cost is reduced in the fishery, measured in AUD/kg live weight fish. Note that this form of tax exemption for fisheries is in Australia motivated from the sector not using roads (i.e. costs embedded in fuel price for road construction and maintenance), and are not formally reported as fuel subsidies in Australia.

Data Quality	Gear	Target species	Subsidy (AUD/kg)	Reference	Description
Gold					
Silver					
Bronze	All NT	All NT	0.13	Total tax claims per total landings in NT	2015-16 (2016-17 also available), state level figures on landings are preliminary for 2015-16

Governance > Ecosystem governance > Bycatch mitigation > Description of the bycatch mitigation measures

Bycatch measures can be spatial (e.g. area closure), temporal (time closure, e.g. night setting only) or technical (bycatch reduction devices, hook size). This indicator describes the measures that are in place for a fishery – but not the rates of compliance. For example, spatial closures for different gear types are shown here for AFMA fisheries http://www.afma.gov.au/sustainability-environment/fishing-closures/.

All combined bycatch species currently have a review trigger of 10% of the total annual catch for the demersal fishery. The finfish trawl fishery currently has a bycatch review trigger of 35%. Potential impacts resulting from changes to bycatch composition arising from the introduction of ITQ are addressed through application of performance indicators in the decision rule tables (refer Appendix 1). The tables have been developed for current demersal fishery gears and include specific bycatch objectives to maintain bycatch weight below 10% (hook & trap gears), 25% (finfish longline gear) and 35% (finfish trawl gear) respectively of the previous year's total catch weight estimate, amending bycatch performance indicators and placing precautionary triggers and appropriate management actions to be taken if triggered. Suitable bycatch tables have been developed for finfish longline and trawl gears and are incorporated into the decision rules. Note: deliberate wasting (discarding) of fish once it has been chilled will not be condoned (i.e. even if fish has low market demand) and may be legislated against and appropriate penalties imposed if the practice is observed. Fisheries will periodically review the fisheries catch composition to ensure the bycatch triggers are maintained at an appropriate level. The Decision Rules tables described in Appendix 1 of the Management Arrangements for the Northern Territory's Demersal Fishery allow for additional observer monitoring and research at Industry cost if concerns arise over combined group, bycatch or other catch issues.[181]

Data Quality: Silver

Governance > Ecosystem governance > Protected species mitigation > Description of the protected species mitigation measures

TEP mitigation measures can be spatial (e.g. area closure), temporal (time closure, e.g. night setting only) or technical (bycatch reduction devices, hook size). This indicator describes the measures that are in place for a fishery – but not the rates of compliance. **Data Quality:** Not found

Governance > Management system > Harvest strategy > Scope of the harvest strategy

Assessment can be based on scoring presence of the following: a harvest strategy designed to achieve management objectives; harvest control rules and tools; collection of relevant information to support the harvest strategy; and, assessment of stock status or the presence of the following key elements: Defined operational objectives for the fishery; Indicators of fishery performance related to the objectives; Reference points for performance indicators; A statement defining acceptable levels of risk to meeting objectives; A monitoring strategy to collect relevant data to assess fishery performance; A process for conducting assessment of fishery performance relative to objectives; and; Decision rules that control the intensity of fishing activity and/or catch.

The Northern Territory Offshore Snapper fishery at the present time does not have a dedicated harvest strategy. The Northern Territory Fisheries Harvest Strategy Policy (the Policy) provides an overarching framework for the development of consistent harvest strategies for Northern Territory fisheries, to provide clarity and certainty to all users regarding management decisions and further the objectives of the NT Fisheries Act 1988. The Guidelines for implementing the Northern Territory Fisheries Harvest Strategy Policy (the Guidelines) have been developed to assist with the implementation of harvest strategies under the Policy and provide guidance on applying the Policy in various fishery circumstances. The Guidelines are intended to support harvest strategy development across the full range of Northern Territory fisheries and are consistent with, and utilities text and information contained within the National Guidelines to Develop Fishery Harvest Strategies (Sloan et al. 2014)[182]

Data Quality: Bronze

Governance > Management system > Management plans > Scope of management plan

Management plans can be assessed by evaluating the presence of minimum requirements, as follows: a description of the fishery, especially its current status and any established user rights: the management objectives; how these objectives are to be achieved; how the plan is to be reviewed and/or appealed, as well as the consultation process for review and appeal.

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[181] https://dpir.nt.gov.au/__data/assets/pdf_file/0009/383265/demersal-fisheries-framework-2015.pdf

[182] Department of Primary Industry and Resources (2016). Guidelines for implementing the Northern Territory Fisheries Harvest Strategy Policy.

The Northern Territory Offshore Snapper fishery is managed under the Fisheries Act[183] and Fisheries Regulations[184], which contain the following minimum requirements

Licencing, permits and vessel registration
Area of fishery

Data Quality: Gold

Governance > Institutional capacity > Accountability of decision making bodies > Level of Accountability

Accountability of Decision-making bodies. Performance of a fisheries management agency is based on the degree to which decision-making processes are consultative, the basis for decisions are fully explained, and information about decision making is publicly available. The assessment applied the three tiers of Principle 3.2.2 (d) 'Decision-making process' of the MSC Fisheries Standard v2.0 (2014) to determine whether the level of accountability was low, medium or high.

Medium level of accountability. This is demonstrated by the publicly-available management framework and arrangements, which include decision rules for setting harvest levels. Information about decision-making procedures and outcomes, including stock assessments and proceedings of the relevant Fisheries Advisory Committee, are not publicly available online.

Data Quality: Silver

Governance > Institutional capacity > Uncertainty management > Extent of incorporation of uncertainty in management of the targeted stock

This metric reports on the explicit incorporation of uncertainties in decision support processes used to inform and make appropriate choices of management actions. We recognise three levels of uncertainty: Low level of incorporation of uncertainty; Medium level of incorporation of uncertainty; High level of incorporation of uncertainty. These are based on: Major sources of uncertainty are identified; Assessment takes uncertainty into account; Frequency of monitoring of indicators is high; Monitoring of more than one indicator to support management decisions; Assessment evaluates stock status relative to reference points in a probabilistic way; Robustness of assessments are tested, Alternative hypotheses and assessment approaches are rigorously explored.

Medium level of incorporation of uncertainty in management of the targeted stock, noting that this is a multi species multi gear fishery and the extent of incorporation of uncertainty varies across species.	The assessment applied Principle 1.2.4 (c & d) 'Assessment of stock status: Uncertainty in the Assessment' of the MSC Fisheries Standard v2.0 (2014) to assess extent of incorporation of uncertainty in management of the targeted stock.

Data Quality: Silver

[183] https://legislation.nt.gov.au/Legislation/FISHERIES-ACT
[184] https://legislation.nt.gov.au/Legislation/FISHERIES-REGULATIONS

Governance > Compliance > Compliance regime > Level of Compliance

Level of compliance with rules and regulations controlling catch can be assessed by audits that measure the agreement between 1) logbook and observer records; 2) catch disposal records submitted by fishers and fish receivers. It might also be assessed by counting the annual number of breaches/observed offences or enforcement actions, preferably scaled to the level of enforcement effort (e.g. $). This indicator can be scored on the basis of the presence of key monitoring, control and surveillance elements and capacities.

Onboard fishery observers record and monitor target, group and bycatch species. Logbooks currently record target and grouped species by number (trap and dropline gear) and weight (trawl gear). Bycatch species are recorded by weight. Observer data is often used to verify logbook data. To enable the timely identification of individual grouped species, it is proposed that daily logbooks will be completed and provided to Fisheries at the completion of each trip, and within seven days of unloading, not monthly as is the case now. Monthly market detail logbooks shall also be provided within seven days of the vessel unloading.[185]

Data Quality: Bronze

Governance > Compliance > Surveillance > Surveillance Effort

Regulatory controls include logs and catch reporting, on-board observer programs, vessel inspections, vessel monitoring systems, and visual or electronic surveillance using radar or satellite by boat or by air. Higher degrees of surveillance, or coverage using multiple methods, provide greater levels of certainty in estimates of effort, fishing mortality, bycatch and discard levels, and interactions with protected/listed species. Report on the surveillance carried out on the fishery, as reported by the compliance branch responsible for the fishery

Surveillance effort score: undefined

Compliance with management controls is achieved through wharf-side inspections and as an adjunct to surveillance activities undertaken for other NT and Commonwealth managed fisheries.[186]

Data Quality: Bronze

Governance > Adaptive capacity > Governance arrangements > Climate change recognition

Governance arrangements relevant to the fishery consider the impact of climate change on the fishery, as evidenced by documentation, policies and plans that describe how management is addressing climate change impacts. Does the fishery management plan, harvest strategy or research activity suggest that climate change is recognised, and integrated into management planning?

The management plans do not yet recognize the need for climate responses for this fishery.

The Northern Territory government is developing guidance for industries exposed to climate extremes, variability and change.

[185] https://dpir.nt.gov.au/__data/assets/pdf_file/0009/383265/demersal-fisheries-framework-2015.pdf
[186] http://www.territorystories.nt.gov.au/jspui/bitstream/10070/250120/1/FN29.pdf

The National Harvest Strategy also recognizes that "*Variability in ocean conditions, due to natural variability, climate change or other factors, can affect the productivity of stocks. Fisheries should seek to account for that variability when developing and implementing harvest strategies*"[187]. The Guidelines for the Harvest Strategy provide explicit approaches for fisheries[188]. This strategy and guideline do not explicitly apply to state fisheries, but will provide guidance.
Data quality: Bronze

Governance > Adaptive capacity > Coping strategies > Climate responses

The fishery has initiated coping strategies (directed) to reduce the impacts of climate change. Evidence of strategies that have been specifically implemented for the fishery might include codes of practice, restocking programs, early warning systems, and so on. The coping strategies may be for long-term change or for extreme events. A description of the climate change responses that have been implemented or explored in research or application are provided.

There are no management actions currently implemented that address climate change impacts in the fishery.

Data quality: Bronze

Social and Ethical > Fishers wellbeing > Fisher satisfaction > Satisfaction scores

If available, fishery specific surveys of well-being or satisfaction, with interpretation required for the types of questions and sample. When surveys are not available other sources of data may need to include broader surveys (e.g. not fishery specific) or discussions with industry representatives, managers or fishers about the industry and their opinion of general fisher-wellbeing (note this will be subjective).

Data Quality: Not found

Social and Ethical > Fishers wellbeing > Age Structure > Proportion of fishers in standard age cohorts

Proportion of fishers in standard age cohorts that were involved in the fishery at any point in the previous 5 years. If the fishery is not attractive or difficult to enter, the age distribution will be skewed to older ages. **Data Quality:** Not released

Social and Ethical > Wider community > Community satisfaction with fishery > Community feedback

Evidence of processes in place to gather direct engagement with the community (diversely represented) to listen and respond to feedback. This may be through a range of means including formal and informal processes and may not be appropriate to all fisheries in the same way. In some cases Marine Stewardship Council accreditation may demonstrate some evidence of community engagement.

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[187] Department of Agriculture and Water Resources 2018, *Commonwealth Fisheries Harvest Strategy Policy*, Canberra, June. CC BY 4.0.
[188] Department of Agriculture and Water Resources 2018, *Guidelines for the Implementation of the Commonwealth Fisheries Harvest Strategy Policy*, Canberra, June. CC BY 4.0.

Community feedback: Medium.

Indigenous participation is seen to be restricted (Public consultation report 2006). There is a management advisory committee, which could oversee a feedback process. Based on general FRDC community perception surveys, satisfaction with Australian fisheries is rated at 42%.

Data quality: Bronze.

Social and Ethical > Wider Community > Level of local employment > Percentage of local employment

The communities surrounding and supporting fisheries benefit from those fisheries when the majority of employees (direct and indirect) associated with the fishery activity are local. Can be reported as direct, indirect and downstream levels. **Data Quality:** Not found

Social and Ethical > Ethical - Human welfare > Protections in place > Legislation exists

Although all workers are automatically operating under legislation according to their state or territory to a safe work place, the extent to which there is awareness of the relevant Acts, and use of these if required, is highly variable and may be different for each business or individual operation within each fishery. See http://workplaceohs.com.au/legislation for a list of state acts and regulations.

Protections in Place: Low

The Offshore Snapper fishery operates under Northern Territory (NT WorkSafe) – WHS (National Uniform Legislation) Act 2011 and WHS (National Uniform Legislation) Regulation 2011.

Data Quality: Silver

Social and Ethical > Ethical > Human welfare > Levels of compliance

Levels of compliance (or violations of) with Workplace Health and Safety. If references to Workplace Health and Safety exist in relation to the specific fishery, determine whether these are voluntary or recorded in anyway. If they are recorded, note the level of compliance. As they are likely to be voluntary, there will not likely be a record of compliance, but this may become more readily available in the future. **Data Quality:** Not found

Social and Ethical > Ethical-animal welfare > Animal welfare protections > Protections in place

At this early stage of development of animal welfare, any type of mention of animal welfare exists, it is probably the most appropriate. As this develops in to the future, assessments as to the level of engagement may become more relevant. **Data Quality:** Not found.

Social and Ethical > Ethical-animal welfare > Level of Compliance > Levels of compliance or violations of animal welfare

If there are any references to animal welfare protections or guidelines in fishery management plans and if reports exist, the indicator reports on the level of compliance or violations with welfare provisions.

Data Quality: Not found.

Social and Ethical > Climate-related > Access to information > Availability of information

This indicator describes available information that will help participants in the fishery adapt to changes. The assumption behind this indicator is that good information availability and flow will help fishers to adapt.

Data Quality: Not found.

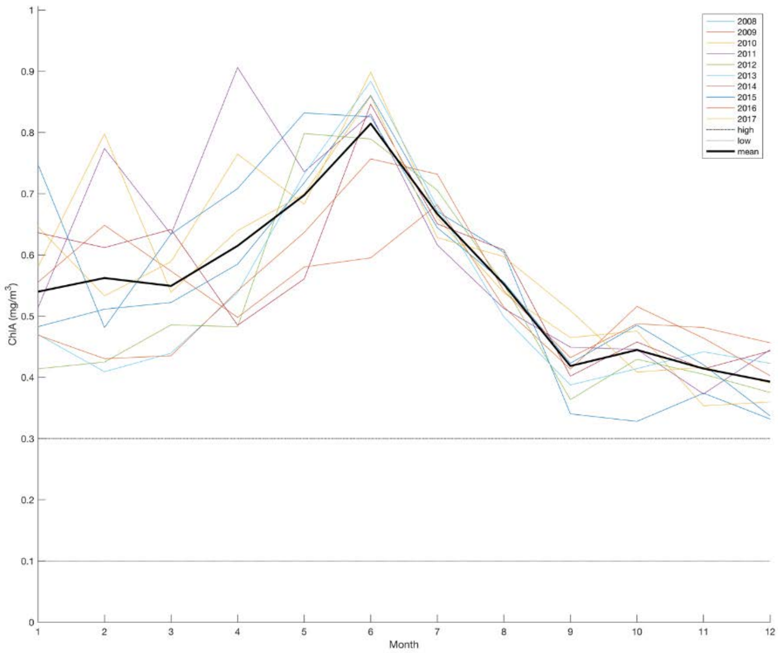
Social and Ethical > Climate-related > Access to networks > Level of membership of industry association

This metric assesses the presence or absence of a dedicated social media or social network group for the fishery. The fishery may still have a strong social network without a social media presence.

Data Quality: Not found.

External > Environmental Context > Productivity > Mean chlorophyll

A measure of environmental productivity is the biomass of phytoplankton, which in oceanic waters can be approximated by chlorophyll a concentration, as estimated from satellite (MODIS, oceandata.sci.gsfc.nasa.gov). Monthly chlorophyll values for a representative area of the fishery are shown with the mean productivity shown in solid black and references levels of low chlorophyll at 0.1 mg $m^{-3}$and high chlorophyll levels at 0.3 mg m^{-3}. This indicator shows the mean chlorophyll by month for the years 2008-2017. These data provide information on the relative environmental productivity in the fishery area. Missing data for some months can be due to ice cover. Variability in chlorophyll a concentration between years can indicate high environmental variability, while similar seasonal patterns indicate relative environmental stability.



Data Quality: Gold

External > Environmental Context > Environmental character > Description of the ecosystems

This metric provides a qualitative description of the ecosystem(s) in which the fishery occurs. The goal is to provide a general overview of these environments. The knowledge about which ecosystems are encountered during fishing activity is the indicator (rather than the response of the ecosystems to fishing).

Marine ecosystems are defined for the purposes of this indicator as the composition of plants, animals, and the marine environment (water masses, geomorphology). Types of marine ecosystems include estuaries, the sea floor, the mesopelagic zone, the pelagic zone, the inter-tidal zones, coral reefs, lagoons, and mangroves. A pelagic zone ecosystem for example, is defined by physical, chemical and biological features of the marine water column of the open ocean[189].

Description of the ecosystems: High

The fishery takes place in offshore waters, where a range of ecosystems are encountered.

Data Quality: Silver

External > Climate related > Susceptibility of target species > Impacts on target species

Climate change directly affects the distribution, abundance and phenology of individual species. These changes then affect the fisheries that harvest these species, and can be a strong external

[189] Game, E. T., H. S. Grantham, A. J. Hobday, R. L. Pressey, A. T. Lombard, L. E. Beckley, K. Gjerde, R. H. Bustamante, H. P. Possingham and A. J. Richardson (2009). Pelagic protected areas: the missing dimension in ocean conservation. Trends in Ecology and Evolution **24**(7): 360-369 doi:310.1016/j.tree.2009.1001.1011.

influence on the fishery. These impacts can be positive (e.g. increased abundance), or negative (e.g. movements further from fishing ports), and to long-term warming, or short-term extreme events such as marine heatwaves.

Sensitivity of some of the target species to climate change has been assessed[190]. Species in this fishery have sensitivities ranging from low to high.

Common name	Species	Fishery	Score	Sensitivity
Spanish mackerel	Scomberomorus commerson	Off Net and Line Fishery	4.875	LOW
Black jewfish	Protonibea diacanthus	Off Net and Line Fishery	6.125	HIGH
Blacktip shark 1	Carcharhinus tilstoni	Off Net and Line Fishery	5	LOW
Grey mackerel	Scomberomorus semifasciatus	Off Net and Line Fishery	5.5	MODERATE
Spotted mackerel	Scomberomorus munroi	Off Net and Line Fishery	4.625	LOW

Data Quality: Silver

External > Climate related > Susceptibility of key habitats > Habitat Impacts

Habitat impact: Low

Data Quality: Bronze

External > Contaminants in the environment > Detection system for seafood contaminants > Risk of contaminants

Potential risk for contamination from the marine environment combined with monitoring arrangements to be able to address risks needed to ensure food safety. Contaminants include those with maximum levels set for by Food Standards Code Australia: metal contaminants, non-metal contaminants, natural toxicants, and average and maximum levels of mercury in fish. Contaminants from poor handling after landing are not assessed but may be indirectly addressed.

Rubric for risk level:

Low risk	Medium risk	High risk
There are no documented levels of contaminants from	There may be seasonal/area/species/size-	Permanent diet restrictions of species

[190] Fulton EA, Hobday AJ, Pethybridge H, Blanchard J, Bulman C, Butler I, Cheung W, Gorton B, Hutton T, Lozano- Montes H, Matear R, Pecl G, Villanueva C, Zhang X (2018). *Decadal scale projection of changes in Australian fisheries stocks under climate change.* CSIRO Report to FRDC. FRDC Project No: 2016/139 – ONLINE.

the marine environment causing risk/diet restrictions to any consumer group in the fishery.	based risks of contaminants for some species.	caught to vulnerable consumers such as children or pregnant women.

Risk of Contaminants: Medium

No specific monitoring arrangements found for marine contaminants on the fishery webpage: https://nt.gov.au/marine/commercial-fishing/timor-reef-fishery-and-licences, targeted species have medium potential risk for contamination from the marine environment. Warm-water finfish (e.g. snappers, basse, wrasse) may in different seasons, areas and at larger sizes contain natural toxins (such as ciguatera).

Data Quality: Silver

External > Contaminants in the environment > Management arrangements to ensure food safety related to contaminants > Evidence for arrangements

There is evidence of management arrangements to ensure food safety related to contaminants and food safety from the marine environment. No supply chain risks from poor handling are considered. Food standard 4.2.1 requires all seafood business in Australia to identify potential seafood safety hazards and put controls in place that are consistent with the risk.

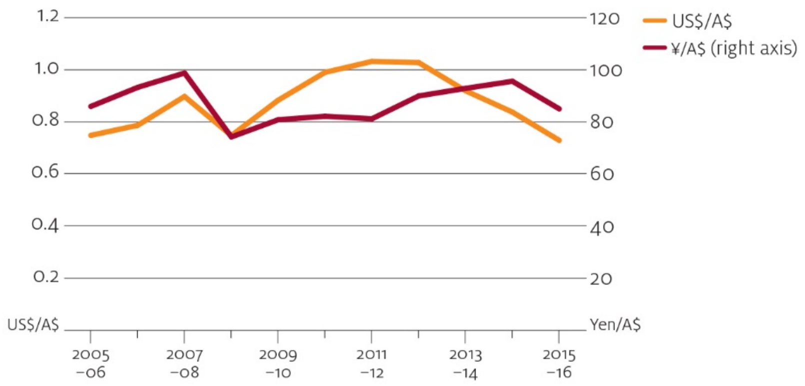
Data Quality: Not found.

External > Market Drivers > Macroeconomic factors > Exchange Rates

A depreciating Australian dollar (or, increasing exchange rate) generally results in producers receiving a higher export price in Australian dollar terms, while an appreciating Australian dollar (or, decreasing exchange rate) results in a lower export price. Domestically, a depreciation of the Australian dollar encourages substitution from imported seafood to domestically produced seafood, as imported products become relatively more expensive. A lower exchange rate also makes Australian exports more competitive in world markets, as exported seafood become relatively cheaper in foreign currency terms.

National export trends are negatively related to exchange rate movements— the Australian dollar declined against the US dollar and Japanese yen from 1990–91 to 2000–01, with exports increasing in volume and value. Exchange rates for the Australian dollar increased against those currencies from 2001–02 to 2015–16. The real export value and volume of Australia's seafood exports decreased between 2005–06 and 2012–13 and then increased between 2012–13 and 2015–16—with a noticeable rise (43 per cent) in volume between 2014–15 and 2015–16.[191]

[191] Mobsby, D and Koduah, A 2017, Australian fisheries and aquaculture statistics 2016, FRDC project 2017-095. ABARES, Canberra, December. CC BY 4.0.



Data Quality: Gold

External > Market Drivers > Consumer Trends > Per person annual apparent consumption of seafood (kg)

Annual apparent consumption is estimated by adding the total edible quantity of seafood supplied domestically—that is, total production plus imported seafood— less exports of seafood. Apparent consumption provides an estimate of the total amount of seafood consumed in Australia assuming zero change in stocks.

The production quantity of Australian fishery and aquaculture products is reported by ABARES on a whole weight basis, whereas trade data are reported on a processed basis. To align the units of measurement between production and trade data, it is necessary to convert production volume to a processed edible equivalent.

Production volumes are adjusted to an edible quantity basis using species-specific conversion rates and excluding species that are known to be predominantly supplied for non-human consumption purposes, such as for aquaculture feed or bait. Imports and exports of seafood are sourced from Australian Bureau of Statistics (ABS) trade data and are reported as edible weight. The apparent consumption per person is calculated as the total apparent consumption divided by the total Australian population in each year. The method applied here is consistent with that used by ABARES to estimate apparent consumption of other agricultural commodities produced in Australia.

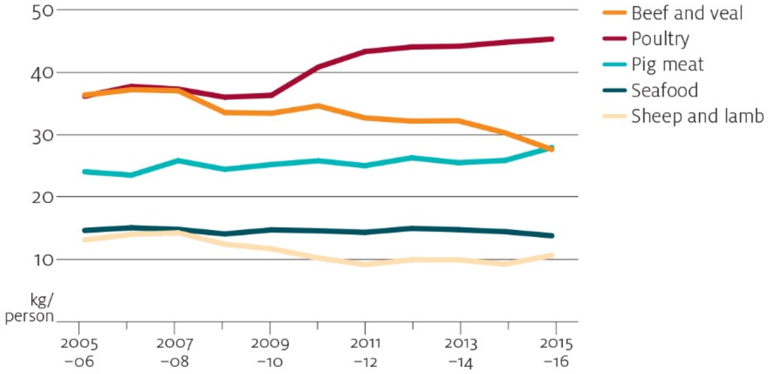
The FAO also compiles statistics on apparent consumption of seafood, applying a consistent method across all countries. FAO estimates indicate that annual consumption of seafood in Australia is around 26 kilograms per person in 2013 (FAO 2016[192]). The discrepancy between FAO and ABARES estimates reflects differences in methodological approaches to estimating consumption. Moreover, ABARES estimates seafood consumption on a processed edible basis, whereas the FAO provides its estimates on a whole weight basis.

In Australia, apparent consumption of seafood per person (edible equivalent) decreased, on average, at an annual rate of 0.6 per cent, from 14.6 kilograms in 2005– 06 to 13.8 kilograms per person in 2015–16. Annual apparent consumption is estimated by the Australian Bureau of Agricultural and

[192] The state of world fisheries and aquaculture 2016—opportunities and challenges, Food and Agriculture Organization of the United Nations, Rome.

Resource Economics and Sciences by adding the total edible quantity of seafood supplied domestically—that is, total production plus imported seafood— less exports of seafood[193]

In comparison, global per capita apparent fish consumption increased from an average of 9.9 kg in the 1960s to 14.4 kg in the 1990s and 20.1 kg in 2014, with preliminary estimates for 2015 indicating further growth, exceeding 20 kg (FAO 2016). Australia's per person seafood consumption in 2013 was estimated by the FAO to be 26kg. The differences in estimates are accounted for by varying methods for calculating consumption. ABARES estimates seafood consumption on a processed edible basis, whereas the FAO provides its estimates on a whole weight basis.



Data quality: Gold

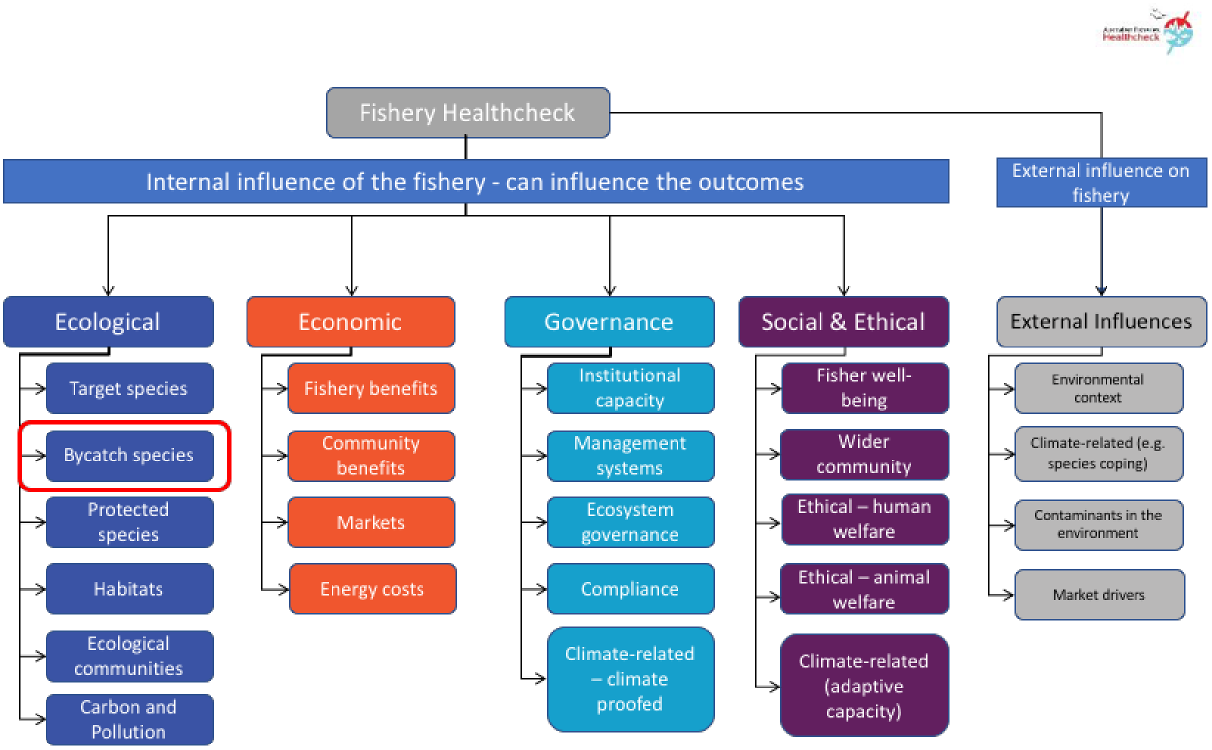
[193] Mobsby, D and Koduah, A 2017, *Australian fisheries and aquaculture statistics 2016*, FRDC 2017-095. ABARES, Canberra, December. CC BY 4.0

Queensland Coral Reef Fin Fish Fishery

The Queensland Coral Reef Fin Fish Fishery (CRFFF) is a predominantly line-only fishery that targets a range of bottom-dwelling reef fish. It consists of a commercial sector, focusing primarily on live coral trout, and recreational and charter sectors. The fishery operates predominantly in the Great Barrier Reef Marine Park (GBRMP). Coral trout refers to a group of seven species, including five Plectropomus and two Variola species. The common coral trout (P. leopardus) makes up the majority of landings. Common coral trout are found throughout the Great Barrier Reef (GBR) in waters to at least 100 m depth and are daytime predators. Commercial fishing operations generally consist of a number of smaller tender boats (dories) and a larger primary fishing vessel used to hold fish. A comprehensive suite of management arrangements, including an Individual Transferable Quota (ITQ) system, is in place for the commercial fishery to ensure its sustainability into the future. A comprehensive set of input and output controls are in place under the Fisheries Regulation 2008 and the Fisheries (Coral Reef Fin Fish) Management Plan 2003 to manage the harvest of coral reef fin fish. (Source: Fisheries Guidelines Project).

Case Study Presentation Format

The case study documents are a collection of metrics, organised by the healthcheck structure:



The presentation of metrics will follow the following heading format:

Ecological > Bycatch species > Bycatch composition > <u>Mean Trophic Level</u>

Understand this to be an indicator (**Bycatch composition**) of the **Ecological** Component, **Bycatch species** subcomponent where the (in the figure and heading example above, is being measured by presenting Mean Trophic Level as the metric.

Ecological > Target species > Stock Status > Status of Australian Fish Stocks (SAFS)

Target species in each fishery are the primary focus for this indicator. Status of these species is ideally assessed with the SAFS approach, however this may not cover all target species for each fishery. In that case, we indicate the number of unassessed species. These species could also be assessed by individual states or by alternative methods.

SpeciesName	StockName	StockStatus	Year
CORAL TROUTS	Coral Reef Fin Fish Fishery	Sustainable	2016
Crimson Snapper	East Coast Queensland	Undefined	2016
Goldband Snapper	East Coast Queensland	Undefined	2016
Red Emperor	East Coast Queensland	Undefined	2016
Redthroat Emperor	East Coast Queensland	Sustainable	2016
Saddletail Snapper	East Coast Queensland	Undefined	2016
Silver Trevally	Queensland	Undefined	2016

Data Quality: Gold

Ecological > Target Species > Harvest Level > Catch weight

This metric is a proxy for harvest level. The harvested biomass for each species, provides information on the level of the catch. Trends in this metric over time can indicate declining availability of fish, quota restrictions, or changes in market demand. For Australian fisheries, trends are expected to be stable for most species.

This fishery targets Coral trout, red throat emperor and other coral reef fin fish species (including cods, emperors and tropical snappers). Recent retained catch[194] are:

[194] https://www.daf.qld.gov.au/business-priorities/fisheries/monitoring-our-fisheries/commercial-fisheries/data-reports/sustainability-reporting/queensland-fisheries-summary/coral-reef-fin-fish-fishery

	2006–07	2007–08	2008–09	2009–10	2010–11	2011–12	2012–13	2013–14	2014-15	2015-16	2016-17
Total catch (t)	1668	1736	1856	1704	1475	1308	1339	1458	1371	1420	1388
Primary effort (days)12329	13441	13743	14564	14349	12674	11736	11145	11404	12395	13146	10760
Dory effort (days)	37919	38126	41407	44334	40063	38218	36469	35031	38183	37658	27556
Licences (active)	221	236	241	350	227	230	225	230	244	256	251
GVP ($A million)	36.6	39.1	40.9	35.5	30.4	27.4	28.2	31.2	28.5	30.4	31.1
Coral trout (t)	993	1071	1105	938	800	725	749	834	753	816	849
Red throat emperor (t)	328	276	247	269	247	226	218	218	202	164	137
Other species (t)	347	389	504	497	428	357	372	406	416	440	401

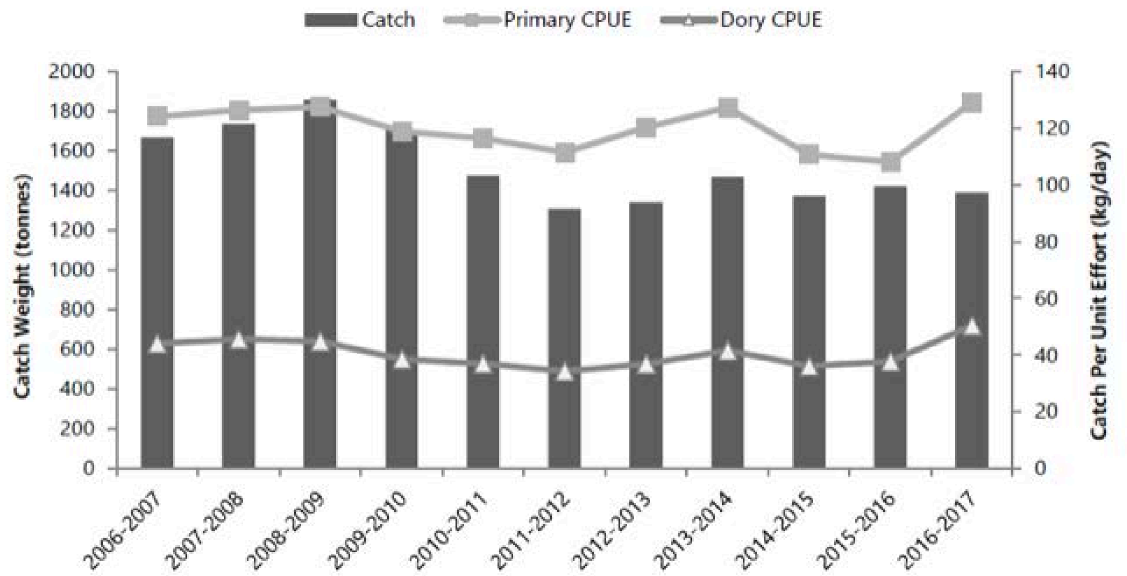


Table 18 – Average annual retained catches and fishing effort (and SE's) in Queensland's commercial fisheries during the 5 year period, 2010-11 to 2014-15. Kennelly (2018)

Fishery	Retained Catch (t)	SE	Fishing Effort (Days)	SE
Coral Reef Finfish	1388.8	33.05	11857.6	284.35

Data quality: Silver

Ecological > Bycatch species > Bycatch composition > Mean Trophic Level

The trophic level is a measure of the position of an organism in a food web, starting at level 1 with primary producers, such as phytoplankton, then moving through the primary consumers at level **2** that eat the primary producers to the secondary consumers at level **3** that eat the primary consumers, and so on. The **bycatch mean trophic level** is an indicator of the mean level of the food chain for bycatch in a fishery.

This fishery has very low bycatch, and so this metric was not calculated

Data Quality: Not applicable

Ecological > Bycatch species > Bycatch amount > Total weight of bycatch

Bycatch weights for fishery are typically developed by specific projects, and require a range of assumptions due to issues with reporting and retention of bycatch. **Bycatch** estimates typically cover species that are not target species, while **discard** rates may also include undersized individuals of the target species. Kennelly (2018) provides estimates of discard rates, which include both target and bycatch species, and when discard rates are used, that information is noted for each fishery. Animals can be returned to the ocean alive or dead. The intention of this metric is to provide information on animals that are dead on return to the ocean.

Reference:

Kennelly, S.J., 2018. *Developing a National Bycatch Reporting System.* Final FRDC Report, ISBN 978-0-9924930-5-9, March, 2018. 99 pp.

The Coral Reef Fin Fish Fishery is predominantly a line-only fishery that targets a range of bottom-dwelling reef fish. Despite the volume caught in this fishery (Queensland's 4th largest), limited information on bycatches are available (Kennelly 2018)[195]. While Ryan et al (2003) noted that bycatch comprised less than 25% of the total catch, the most comprehensive data comes from Andersen et. al. (2004) who summarised an observer program (Mapstone et al., 2001) where approximately 225 dory days of fishing were observed. This observer program revealed that the discards were dominated by undesired target species (ie usually under the legal size), especially Coral Trout, which was responsible for greater than 50 percent of the bycatch. Other species discarded were Red-Throat Emperor, Grassy Sweetlip, Stripey Seaperch, Hussar, Trevally species and Blacktip Rockcod.

The results indicated that, for dead fishing operations, of 5,376 individuals caught, 4,036 (75.1%) were retained for a discard rate of 24.9% (by number). For live fishing operations, of 4,645 individuals caught, 2,679 (57.7%) were retained for a discard rate of 42.3% (by number). This gives a total discard rate (by number) of 33.0%.

Data Quality: Bronze

Ecological > Protected species > Capture amount > Captures

The number and diversity of TEP species captured by a fishery in the most recent year, provided as annual numbers.

[195] Kennelly, S.J., 2018. *Developing a National Bycatch Reporting System.* Final FRDC Report, ISBN 978-0-9924930-5-9, March, 2018. 99 pp.

None reported for this fishery (Kennelly 2018)[196]. The data obtained from all available sources regarding interactions with TEPs species (or, as they are known in Queensland, Species of Conservation Interest – SOCI) mostly came from self-reported fishers' logbooks (augmented occasionally by data from observer programs). Only 8 of Queensland's 22 fisheries indicated any interactions with TEP species.

Data quality: Bronze

Ecological > Protected species > Reporting > Level of monitoring

This indicator is to provide information on the level of coverage for a fishery. Annual measures are preferred.

Fisheries Queensland has been undertaking routine monitoring of Queensland's fisheries for almost 30 years. Monitoring programs collect a range of data including catch, effort, size and age of fish, social and economic indicators and compliance rates.[197]

Queensland Commercial fishery observer data[198].
Number of days observed by the Observer program for the Queensland commercial Line, Net, Trawl and Pot fisheries from 2006 to 2013.

Method	Year	Number of Days
Net	2006	16
Net	2007	23
Net	2008	109
Net	2009	98
Net	2010	82
Net	2011	125
Net	2012	83
Trawl	2006	95
Trawl	2007	93
Trawl	2008	61
Trawl	2009	35
Trawl	2010	215
Trawl	2011	0
Trawl	2012	0
Line	2006	63
Line	2007	54
Line	2008	33
Line	2009	19
Line	2010	2
Line	2011	72
Line	2012	8

[196] Kennelly, S.J., 2018. *Developing a National Bycatch Reporting System.* Final FRDC Report, ISBN 978-0-9924930-5-9, March, 2018. 99 pp.
[197] State of Queensland (2017) Sustainable Fisheries Strategy 2017-2027. Fisheries Queensland Monitoring and Research Plan. Queensland Government CC BY 4.0.
[198] https://data.qld.gov.au/dataset/queensland-commercial-fishery-observer-data

Data quality: Silver

Ecological > Habitats > Habitat impact > Impact score

The habitat impact is an indicator of the effect the fishing gear has on the habitat. Different gear types have different impacts. See the scoring rubric.

Habitat Impact: Negligible, based on the gear type used in this fishery.

Data quality: Bronze

Ecological > Habitats > Habitat impact > Habitat status

The status of the habitat types is a measure of the condition relative to a pristine state. Fishing may not be responsible for that habitat status, but it is important to note if fishing is taking place in pristine or disturbed habitats.

Habitat status: Moderate – impacts due to coral bleaching, rather than fishing activity.

Data quality: Bronze

Ecological > Ecological communities > Ecosystem status > Ecosystem status

This metric reports the ecosystem status in the region of the fishery.

Ecosystem Status: Moderate

Recent bleaching events have impacted large sections of the Great Barrier Reef with loss of healthy corals[199]. These losses compound past changes in ecosystem quality due to declines in water quality, crown of thorns outbreaks and cyclone damage[200].

Data Quality: Silver

Ecological > Ecological communities > Ecosystem status > Species diversity

The measure of species diversity as a ratio between fished and unfished states.

Data quality: Not found

Ecological > Carbon and Pollution > Macro-plastics > Plastic code of conduct

Macro-plastics are plastics that are visible to the naked eye, such as food containers and wrapping, equipment packaging, and fishing equipment. The metric notes a commitment to a zero waste overboard code of conduct to assess attempts to reduce accidental or intentional introduction of

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[199] Hughes, T. P., A. H. B. James T. Kerry1, Sean R. Connolly1,2, Andreas Dietzel1, C. Mark Eakin3, Scott F. Heron3,4,5,, M. O. H. Andrew S. Hoey1, 2, Gang Liu3,4, Michael J. McWilliam1, Rachel J. Pears6, Morgan S. Pratchett1, and William J. Skirving3, Jessica S. Stella6 & Gergely Torda1 (2018). Global warming transforms coral reef assemblages. Nature: https://doi.org/10.1038/s41586-41018-40041-41582.

[200] De'ath, G., K. E. Fabricius, H. Sweatman and M. Puotinen (2012). The 27-year decline of coral cover on the Great Barrier Reef and its causes. Proceedings of the National Academy of Science U.S.A. **109**: 17995-17999.

macro-plastics to the ocean. There are stated guidelines detailing Australia's guidelines regarding marine pollution from the Australian Maritime Safety Authority[201]:

Pollution of the marine environment by ships, including fishing vessels, is strictly controlled by the International Convention for the Prevention of Pollution from Ships (known as MARPOL).

To minimise pollution, MARPOL prohibits ships from discharging garbage into the sea except in very limited circumstances.

Australian MARPOL regulations apply to Australian fishing vessels wherever they are operating.

Data Quality: Bronze

Ecological > Carbon and Pollution > Carbon footprint > CO$_2$-equivalents

The emissions of climate forcing gases in kg CO_2-equivalents (CO_2e) per kg live weight fish caught, not including the supply chain after landing.

Data Quality	Gear	Target species	Min (kg CO_2e/kg)	Average (kg CO_2e/kg)	Max (kg CO_2e/kg)	Reference	Description
Gold							
Silver							
Bronze	Hooks and lines	Finfish	0.3		10.7	Parker and Tyedmers 2015	Global, year and fuel type not specified, unclear if bait fishing is included, no refrigerants included.

Economic > Fishery Benefits > Net Economic Returns > Economic Rent

Net Economic Returns (NER) is equal to fishing revenue less fishing costs and measures the economic profit that is derived from fishing activity, it is measured by the Commonwealth as Net Economic Returns and by some States as Economic Rent. **Data Quality:** Not found

Economic > Fishery Benefits > Gross Value of Production > Gross Value of Production

GVP calculated as the volume of catch multiplied by the average per unit beach price (AUD$).

Data Quality	**Species/Fishery**	**Year**	**Amount**	**Reference**	**Note/Comment**
Gold	Coral Reef Finfish	2016-2017	$31.1 million	State of Queensland (2017). Queensland Fisheries Summary October 2017. Department of Agriculture and Fisheries, CC BY 3.0	

[201] https://www.amsa.gov.au/marine-environment/marine-pollution/pollution-fishing-vessels
https://www.amsa.gov.au/marine-environment/marine-pollution/marpol-and-its-implementation-australia

Gold	Coral Reef Finfish	2015-2016	$30.4 million	State of Queensland (2017). Queensland Fisheries Summary October 2017. Department of Agriculture and Fisheries, CC BY 3.0	
Gold	Coral Reef Finfish	2014-2015	$28.5 million	State of Queensland (2017). Queensland Fisheries Summary October 2017. Department of Agriculture and Fisheries, CC BY 3.0	
Gold	Coral Reef Finfish	2013-2014	$31.2 million	State of Queensland (2017). Queensland Fisheries Summary October 2017. Department of Agriculture and Fisheries, CC BY 3.0	
Gold	Coral Reef Finfish	2012-2013	$28.2 million	State of Queensland (2017). Queensland Fisheries Summary October 2017. Department of Agriculture and Fisheries, CC BY 3.0	
Gold	Coral Reef Finfish	2011-2012	$27.4 million	State of Queensland (2017). Queensland Fisheries Summary October 2017. Department of Agriculture and Fisheries, CC BY 3.0	
Gold	Coral Reef Finfish	2010-2011	$30.4 million	State of Queensland (2017). Queensland Fisheries Summary October 2017. Department of Agriculture and Fisheries, CC BY 3.0	
Gold	Coral Reef Finfish	2009-2010	$35.5 million	State of Queensland (2017). Queensland Fisheries Summary October 2017. Department of Agriculture and Fisheries, CC BY 3.0	
Gold	Coral Reef Finfish	2008-2009	$40.1 million	State of Queensland (2017). Queensland Fisheries Summary October 2017. Department of Agriculture and Fisheries, CC BY 3.0	
Gold	Coral Reef Finfish	2007-2008	$39.1 million	State of Queensland (2017). Queensland Fisheries Summary October 2017. Department of Agriculture and Fisheries, CC BY 3.0	

Economic > Fishery Benefits > Profitability > Financial Performance

Economic health of a fishery can be measured by the financial performance of the operators in the fleet. Fleet wide averages or distributions of levels of profitability indicate the extent to which the fishery is generating economic benefits for fishers.

Data Quality: Not found

Economic > Fishery Benefits > Latency > Underutilised Effort

Latency is fishery concessions that are not being fully utilised by fishers, for example, often the annual total allowable catch is left partially or largely uncaught for a fishery. Latency may appear as effort or uncaught TAC or inactive licences.

Data Quality	Indicator used	Year	Amount	Reference	Note
Gold	Uncaught TAC	2015-2016	3% of TAC	State of Queensland (2017) Queensland Fisheries Summary April 2017. Department of Agriculture and Fisheries, CC BY 3.0	Coral Trout
Gold	Uncaught TAC	2015-216	74% of TAC	State of Queensland (2017) Queensland Fisheries Summary April 2017. Department of Agriculture and Fisheries, CC BY 3.0	Red throat emperor
Gold	Uncaught TAC	2015-2016	51% of TAC	State of Queensland (2017) Queensland Fisheries Summary April 2017. Department of Agriculture and Fisheries, CC BY 3.0	Other species
Gold	Inactive licences	2015-2016	91	State of Queensland (2017) Queensland Fisheries Summary April 2017. Department of Agriculture and Fisheries, CC BY 3.0	

Economic > Community benefits > Value to community > GDP or GSP value

A fisheries contribution to Gross Domestic Production (GDP)/Gross State Product (GSP) is the total economic value that it generates directly, plus the indirect contribution made to other industries, which is also measured in value-add terms.

Data Quality	Indicator used	Year	Amount	Reference	Note

Bronze	GSP	2016-2017	$10,851,000	Queensland Government (2017) Gross state product at factor cost by industry and main components, Queensland, 2006-07 to 2016-17 (current prices) http://www.qgso.qld.gov.au/products/tables/gsp-factor-cost-industry-components/index.php	Agriculture, forestry and fishing combined
Bronze	GSP	2015-2016	$9,062,000	Queensland Government (2017) Gross state product at factor cost by industry and main components, Queensland, 2006-07 to 2016-17 (current prices) http://www.qgso.qld.gov.au/products/tables/gsp-factor-cost-industry-components/index.php	Agriculture, forestry and fishing combined
Bronze	GSP	2014-2015	$7,623,000	Queensland Government (2017) Gross state product at factor cost by industry and main components, Queensland, 2006-07 to 2016-17 (current prices) http://www.qgso.qld.gov.au/products/tables/gsp-factor-cost-industry-components/index.php	Agriculture, forestry and fishing combined
Bronze	GSP	2013-2014	$6,641,000	Queensland Government (2017) Gross state product at factor cost by industry and main components, Queensland, 2006-07 to 2016-17 (current prices) http://www.qgso.qld.gov.au/products/tables/gsp-factor-cost-industry-components/index.php	Agriculture, forestry and fishing combined
Bronze	GSP	2012-2013	$7,328,000	Queensland Government (2017) Gross state product at factor cost by industry and main components, Queensland, 2006-07 to 2016-17 (current prices)	Agriculture, forestry and fishing combined

				http://www.qgso.qld.gov.au/products/tables/gsp-factor-cost-industry-components/index.php	
Bronze	GSP	2011-2012	$7,513,000	Queensland Government (2017) Gross state product at factor cost by industry and main components, Queensland, 2006-07 to 2016-17 (current prices) http://www.qgso.qld.gov.au/products/tables/gsp-factor-cost-industry-components/index.php	Agriculture, forestry and fishing combined
Bronze	GSP	2010-2012	$6,601,000	Queensland Government (2017) Gross state product at factor cost by industry and main components, Queensland, 2006-07 to 2016-17 (current prices) http://www.qgso.qld.gov.au/products/tables/gsp-factor-cost-industry-components/index.php	Agriculture, forestry and fishing combined

Economic > Community benefits > Wealth Spread > Distribution of fishing firm size

The spread of profits to owners and crew members indicates how widely benefits of fishing are distributed across the fishing community. A wide spread of benefits may be important to some fishery stakeholders. A narrow spread may not indicate a lack of distribution of benefits in the case where all participating businesses are the same size, or if other mechanisms are present to capture and distribute benefits such as high levels of employment of crew. The number of large business versus small business, classified by turnover (direct measure) or catch volume (proxy) may provide an indirect indicator: i.e. are economic returns from commercial fishing gained by one or two large businesses or a spread over many smaller businesses? **Data Quality:** Not released

Economic > Markets > Fish distribution > Fish receivers

One way of measuring benefits from a fishery is by assessing the flow of seafood through the supply chain. In many fishery jurisdictions, the first step in the supply chain is via licensed fish receivers who are allowed to receive fish for sale. They can also trade fish with other receivers. In some jurisdictions, commercial fishers must sell their catch to a receiver (although they can sell small amounts on wharves). While this restricts fishers' options for landing their catch, it means that fish can be tracked, reduces illegal fish trading and ensures that the Quota Management Systems (QMS) work effectively by ensuring catches do not exceed the total allowable catch or quota amounts for individual species. Receivers of fish may be fish processors, wholesalers or retailers.

In some jurisdictions, the fishers and fish receivers are integrated, such that they are effectively the same "business". In Commonwealth fisheries, the total number of fish receivers per year may differ to the sum of the fish receivers per fishery because some receivers operate in more than one fishery.

Queensland does not have a fish receiver system for its fisheries.

Data Quality: Not found

Economic > Markets > Volatility in market price > Price volatility

Price volatility is the mean beach price for the target species (top one or five depending on price) over the given period (most recent ten years). The level of volatility is the standard deviation in mean price over this period. **Data Quality:** Not found

Economics > Energy costs > Energy Use > Fuel use per kg of fish harvested

Fuel use varies over time and between stocks and are best collected from industry on a yearly basis. Estimates for different fisheries should be compared with caution, and in particular comparing energy use between fisheries with different data quality which is not recommended (different data availability, may be e.g. old or not fisheries-specific). Estimates are provided for all levels of data quality if available and are given in L per kg live-weight.

Data Quality	Gear	Target species	Min (L/kg)	Average (L/kg)	Max (L/kg)	Reference	Description
Gold							
Silver							
Bronze	Hooks and lines	Finfish	0.1		4.2	Parker and Tyedmers 2015	Global, unclear if bait fishing is included

Economic > Energy costs > Fossil fuel subsidies > Fuel subsidies directed to the fishery

Fossil fuel subsidies (fuel rebates) illustrate to which extent the fuel cost is reduced in the fishery, measured in AUD/kg live weight fish. Note that this form of tax exemption for fisheries is in Australia motivated from the sector not using roads (i.e. costs embedded in fuel price for road construction and maintenance), and are not formally reported as fuel subsidies in Australia.

Data Quality	Gear	Target species	Subsidy (AUD/kg)	Reference	Description
Gold					
Silver					
Bronze	All QLD	All QLD	0.87	Total tax claims per total landings in QLD	2015-16 (2016-17 also available), state level figures on landings are preliminary for 2015-16

Governance > Ecosystem governance > Bycatch mitigation > Description of the bycatch mitigation measures

Bycatch measures can be spatial (e.g. area closure), temporal (time closure, e.g. night setting only) or technical (bycatch reduction devices, hook size). This indicator describes the measures that are in place for a fishery – but not the rates of compliance. For example, spatial closures for different gear types are shown here for AFMA fisheries http://www.afma.gov.au/sustainability-environment/fishing-closures/.

All species caught in the fishery are permitted to be retained (apart from protected species), therefore the only discarded fish are those that do not meet size limits. There is limited data available on discarded species. Given most bycatch is undersized target and secondary target species, measures are in place to reduce catch of these fish through spatial and temporal closures, gear restrictions and education schemes to improve post-release survival.[202]

Data Quality: Silver

Governance > Ecosystem governance > Protected species mitigation > Description of the protected species mitigation measures

TEP mitigation measures can be spatial (e.g. area closure), temporal (time closure, e.g. night setting only) or technical (bycatch reduction devices, hook size). This indicator describes the measures that are in place for a fishery – but not the rates of compliance. **Data Quality:** Not found

Governance > Management system > Harvest strategy > Scope of the harvest strategy

Assessment can be based on scoring presence of the following: a harvest strategy designed to achieve management objectives; harvest control rules and tools; collection of relevant information to support the harvest strategy; and, assessment of stock status or the presence of the following key elements: Defined operational objectives for the fishery; Indicators of fishery performance related to the objectives; Reference points for performance indicators; A statement defining acceptable levels of risk to meeting objectives; A monitoring strategy to collect relevant data to assess fishery performance; A process for conducting assessment of fishery performance relative to objectives; and; Decision rules that control the intensity of fishing activity and/or catch.

Queensland will use a harvest strategy to set out pre-determined management actions in a fishery for defined species (at the stock or management unit level) necessary to achieve the agreed ecological, economic and/or social management objectives. Harvest strategies will address the fishing activities of all sectors (commercial, recreational (including charter) and traditional) and will apply to target and by product species primarily. While in most jurisdictions harvest strategies only apply to target species, Queensland's harvest strategies will also cover bycatch, protected species where an ecological risk assessment generates a high risk. This removes the need to have separate policies for these components because the management principles are the same for all these resources in terms of ensuring risks to all these components are kept at acceptable levels.[203].
The fishery had a period of public consultation (closed 20 May 2018) on the proposed amendments for the Coral Reef Finfish fishery[204]

Data Quality: Bronze

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[202] Assessment of the Queensland Coral Reef Fin Fish Fishery 2017, Commonwealth of Australia 2017
[203] Department of Agriculture and Fisheries (2017). Queensland Harvest Strategy Policy
[204] https://www.daf.qld.gov.au/business-priorities/fisheries/sustainable-fisheries-strategy/fisheries-reforms

Governance > Management system > Management plans > Scope of management plan

Management plans can be assessed by evaluating the presence of minimum requirements, as follows: a description of the fishery, especially its current status and any established user rights: the management objectives; how these objectives are to be achieved; how the plan is to be reviewed and/or appealed, as well as the consultation process for review and appeal.

The Queensland Coral Reef Finfish Fishery is managed under the Fisheries (Coral Reef Fin Fish) Management Plan 2003[205], as well as the Fisheries Act 1994[206] and Fisheries Regulation 2008[207], which contains the following minimum requirements

a description of the fishery
user rights
the management objectives;
how the objectives are to be achieved

Data Quality: Gold

Governance > Institutional capacity > Accountability of decision making bodies > Level of Accountability

Accountability of Decision-making bodies. Performance of a fisheries management agency is based on the degree to which decision-making processes are consultative, the basis for decisions are fully explained, and information about decision making is publicly available. The assessment applied the three tiers of Principle 3.2.2 (d) 'Decision-making process' of the MSC Fisheries Standard v2.0 (2014) to determine whether the level of accountability was low, medium or high.

High level of accountability. This is demonstrated by publicly-available fishery assessment reports, register of authorisations (license and quota unit holdings), and overview information about fisheries management arrangements. Information about decision-making procedures and outcomes, including proceedings of the Coral Reef Fin Fish and Spanish Mackerel Fishery Working Group, are publicly available online.

Data Quality: Silver

Governance > Institutional capacity > Uncertainty management > Extent of incorporation of uncertainty in management of the targeted stock

This metric reports on the explicit incorporation of uncertainties in decision support processes used to inform and make appropriate choices of management actions. We recognise three levels of uncertainty: Low level of incorporation of uncertainty; Medium level of incorporation of uncertainty; High level of incorporation of uncertainty. These are based on: Major sources of uncertainty are identified; Assessment takes uncertainty into account; Frequency of monitoring of indicators is high; Monitoring of more than one indicator to support management decisions; Assessment evaluates stock status relative to reference points in a probabilistic way; Robustness of assessments are tested, Alternative hypotheses and assessment approaches are rigorously explored.

[205] https://www.legislation.qld.gov.au/view/pdf/2013-12-06/sl-2003-0212
[206] https://www.legislation.qld.gov.au/view/html/inforce/current/act-1994-037
[207] https://www.legislation.qld.gov.au/view/html/inforce/current/sl-2008-0083

Medium level of incorporation of uncertainty in management of the targeted stock, noting that this is a multi species multi gear fishery and the extent of incorporation of uncertainty varies across species.	The assessment applied Principle 1.2.4 (c & d) 'Assessment of stock status: Uncertainty in the Assessment' of the MSC Fisheries Standard v2.0 (2014) to assess extent of incorporation of uncertainty in management of the targeted stock.

Data Quality: Silver

Governance > Compliance > Compliance regime > Level of Compliance

Level of compliance with rules and regulations controlling catch can be assessed by audits that measure the agreement between 1) logbook and observer records; 2) catch disposal records submitted by fishers and fish receivers. It might also be assessed by counting the annual number of breaches/observed offences or enforcement actions, preferably scaled to the level of enforcement effort (e.g. $). This indicator can be scored on the basis of the presence of key monitoring, control and surveillance elements and capacities.

Commercial fishers operating in Queensland's state-managed fisheries are required to complete daily catch and effort logbooks. These logbooks detail where, when and how fishing took place, and what was caught.[208]

Queensland's commercial fishers and seafood exporters are required by law to report information based on their fishing activities. A commercial fisher or harvester - from a trawler operator to beachworm collector - must contribute data about that day's catch, the location fished and the time spent fishing. Fishers are legally obliged to record this information in a daily logbook. If the fisher works in quota-based fisheries, they must also report their catch through Fisheries Queensland's automated interactive voice response (AIVR) system.[209]

Data Quality: Bronze

Governance > Compliance > Surveillance > Surveillance Effort

Regulatory controls include logs and catch reporting, on-board observer programs, vessel inspections, vessel monitoring systems, and visual or electronic surveillance using radar or satellite by boat or by air. Higher degrees of surveillance, or coverage using multiple methods, provide greater levels of certainty in estimates of effort, fishing mortality, bycatch and discard levels, and interactions with protected/listed species. Report on the surveillance carried out on the fishery, as reported by the compliance branch responsible for the fishery

Surveillance effort score: undefined
Fisheries compliance activities include monitoring and inspection of fishing activities, investigations into causes of alleged infringement and enforcement in the form of cautions, infringement notices or prosecution (if necessary).

[208] https://www.daf.qld.gov.au/business-priorities/fisheries/monitoring-our-fisheries/commercial-fisheries/logbooks
[209] https://www.business.qld.gov.au/industries/farms-fishing-forestry/fisheries/monitoring-reporting/requirements

Actions identified as part of the Queensland Sustainable Fishery Strategy 2017-2027 include: Require installation of vessel monitoring system (VMS) on all commercial boats by 2020, with a priority to install VMS on net, line and crab boats by 2018.[210]

Certain fisheries have controls on total allowable catch and effort units. The Coral Reef Finfish Fishery is monitored by a combination of:

Vessel Monitoring System (VMS0
Automate Integrated Voice Response (AIVR)
Logbook data
Compliance checks by Queensland Boating and Fisheries Patrol (QBFP).[211]

Data Quality: Bronze

Governance > Adaptive capacity > Governance arrangements > Climate change recognition

Governance arrangements relevant to the fishery consider the impact of climate change on the fishery, as evidenced by documentation, policies and plans that describe how management is addressing climate change impacts. Does the fishery management plan, harvest strategy or research activity suggest that climate change is recognised, and integrated into management planning?

Fishery-specific plans do not yet propose management responses to climate change.

The need for sector responses and governance to climate change are recognised in government strategy documents[212]. Peer-reviewed publications are showing the need for management responses[213].

The National Harvest Strategy also recognizes that "*Variability in ocean conditions, due to natural variability, climate change or other factors, can affect the productivity of stocks. Fisheries should seek to account for that variability when developing and implementing harvest strategies*"[214]. The Guidelines for the Harvest Strategy provide explicit approaches for fisheries[215]. This strategy and guideline do not explicitly apply to state fisheries, but will provide guidance.
Data quality: Bronze

Governance > Adaptive capacity > Coping strategies > Climate responses

The fishery has initiated coping strategies (directed) to reduce the impacts of climate change. Evidence of strategies that have been specifically implemented for the fishery might include codes of practice, restocking programs, early warning systems, and so on. The coping strategies may be for

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[210] State of Queensland (2017) Queensland Sustainable Fisheries Strategy 2017-2017. Fisheries Queensland, Department of Agriculture and Fisheries. CC BY 4.0
[211] https://www.business.qld.gov.au/industries/farms-fishing-forestry/fisheries/monitoring-reporting/requirements/catch-reporting
[212] Moran, C. and Boulter, S. (2018). *Biodiversity and Ecosystems Climate Adaptation Plan*. Brisbane, Australia. Available at https://www.nccarf.edu.au/.
[213] Pratchett, M. S., D. Cameron, J. Donelson, L. Evans, A. J. Frisch, A. J. Hobday, A. S. Hoey, N. A. Marshall, V. Messmer, P. L. Munday, R. Pears, G. Pecl, A. Reynolds, M. Scott, A. Tobin, R. Tobin, D. J. Welch and D. H. Williamson (2017). Effects of climate change on coral grouper (Plectropomus spp.) and possible adaptation options. Reviews in Fish Biology and Fisheries **27**: 297-316.
[214] Department of Agriculture and Water Resources 2018, *Commonwealth Fisheries Harvest Strategy Policy*, Canberra, June. CC BY 4.0.
[215] Department of Agriculture and Water Resources 2018, *Guidelines for the Implementation of the Commonwealth Fisheries Harvest Strategy Policy*, Canberra, June. CC BY 4.0.

long-term change or for extreme events. A description of the climate change responses that have been implemented or explored in research or application are provided.

Research on the fishery[216] has suggested a range of options that are being explored to offset the impacts from environmental extreme events, and to long term climate change.

Data quality: Silver

Social and Ethical > Fishers wellbeing > Fisher satisfaction > Satisfaction scores

If available, fishery specific surveys of well-being or satisfaction, with interpretation required for the types of questions and sample. When surveys are not available other sources of data may need to include broader surveys (e.g. not fishery specific) or discussions with industry representatives, managers or fishers about the industry and their opinion of general fisher-wellbeing (note this will be subjective).

Data Quality: Not found

Social and Ethical > Fishers wellbeing > Age Structure > Proportion of fishers in standard age cohorts

Proportion of fishers in standard age cohorts that were involved in the fishery at any point in the previous 5 years. If the fishery is not attractive or difficult to enter, the age distribution will be skewed to older ages. **Data Quality:** Not released

Social and Ethical > Wider community > Community satisfaction with fishery > Community feedback

Evidence of processes in place to gather direct engagement with the community (diversely represented) to listen and respond to feedback. This may be through a range of means including formal and informal processes and may not be appropriate to all fisheries in the same way. In some cases Marine Stewardship Council accreditation may demonstrate some evidence of community engagement.

Community feedback: Medium.

There is a reef fish management advisory committee, which could oversee a feedback process. Based on general FRDC community perception surveys, satisfaction with Australian fisheries is rated at 42%.

Data quality: Bronze.

Social and Ethical > Wider Community > Level of local employment > Percentage of local employment

The communities surrounding and supporting fisheries benefit from those fisheries when the majority of employees (direct and indirect) associated with the fishery activity are local. Can be reported as direct, indirect and downstream levels.

[216] Pratchett, M. S., D. Cameron, J. Donelson, L. Evans, A. J. Frisch, A. J. Hobday, A. S. Hoey, N. A. Marshall, V. Messmer, P. L. Munday, R. Pears, G. Pecl, A. Reynolds, M. Scott, A. Tobin, R. Tobin, D. J. Welch and D. H. Williamson (2017). Effects of climate change on coral grouper (Plectropomus spp.) and possible adaptation options. Reviews in Fish Biology and Fisheries **27**: 297-316.

Indicator	Year	Amount	Reference	Note
Estimated employment	2016	12 people	Mobsby, D & Koduah, A (2017) Australian fisheries and aquaculture statistics 2016, Fisheries Research and Development Corporation project 2017-095. ABARES, Canberra, December. CC BY 4.0.	Line fishing for QLD

Data Quality: Silver

Social and Ethical > Ethical - Human welfare > Protections in place > Legislation exists

Although all workers are automatically operating under legislation according to their state or territory to a safe work place, the extent to which there is awareness of the relevant Acts, and use of these if required, is highly variable and may be different for each business or individual operation within each fishery. See http://workplaceohs.com.au/legislation for a list of state acts and regulations.

Protections in Place: Low

The Coral Reef Finfish fishery operates under Queensland (Workplace Health and Safety Queensland) – WHS Act 2011 and WHS Regulation 2011. Recent safety incidents in this fishery indicate a need for more protections which are being actively considered.

Data Quality: Silver

Social and Ethical > Ethical > Human welfare > Levels of compliance

Levels of compliance (or violations of) with Workplace Health and Safety. If references to Workplace Health and Safety exist in relation to the specific fishery, determine whether these are voluntary or recorded in anyway. If they are recorded, note the level of compliance. As they are likely to be voluntary, there will not likely be a record of compliance, but this may become more readily available in the future. **Data Quality:** Not found

Social and Ethical > Ethical-animal welfare > Animal welfare protections > Protections in place

At this early stage of development of animal welfare, any type of mention of animal welfare exists, it is probably the most appropriate. As this develops in to the future, assessments as to the level of engagement may become more relevant. **Data Quality:** Not found.

Social and Ethical > Ethical-animal welfare > Level of Compliance > Levels of compliance or violations of animal welfare

If there are any references to animal welfare protections or guidelines in fishery management plans and if reports exist, the indicator reports on the level of compliance or violations with welfare provisions.

Data Quality: Not found.

Social and Ethical > Climate-related > Access to information > Availability of information

This indicator describes available information that will help participants in the fishery adapt to changes. The assumption behind this indicator is that good information availability and flow will help fishers to adapt.

Data Quality: Not found.

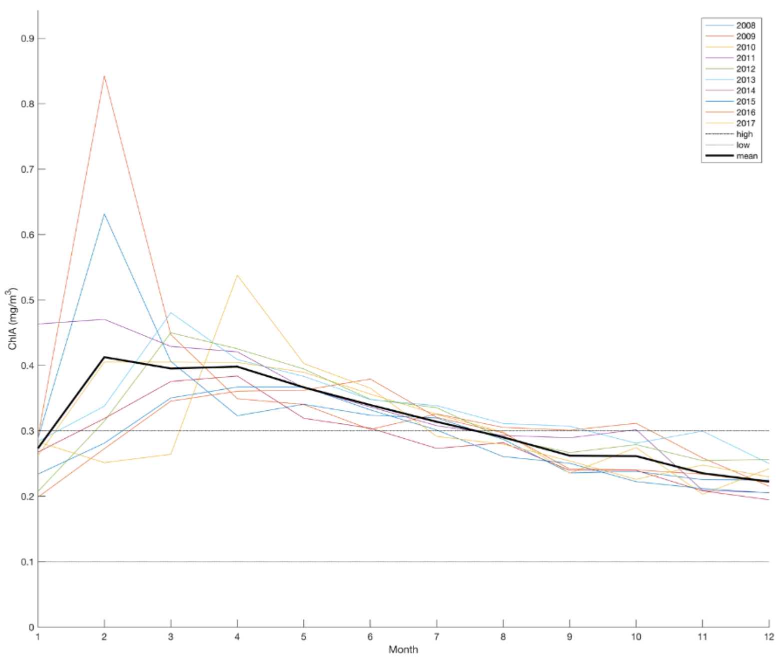
Social and Ethical > Climate-related > Access to networks > Level of membership of industry association

This metric assesses the presence or absence of a dedicated social media or social network group for the fishery. The fishery may still have a strong social network without a social media presence.

Data Quality: Not found.

External > Environmental Context > Productivity > Mean chlorophyll

A measure of environmental productivity is the biomass of phytoplankton, which in oceanic waters can be approximated by chlorophyll a concentration, as estimated from satellite (MODIS, oceandata.sci.gsfc.nasa.gov). Monthly chlorophyll values for a representative area of the fishery are shown with the mean productivity shown in solid black and references levels of low chlorophyll at 0.1 mg $m^{-3}$and high chlorophyll levels at 0.3 mg m^{-3}. This indicator shows the mean chlorophyll by month for the years 2008-2017. These data provide information on the relative environmental productivity in the fishery area. Missing data for some months can be due to ice cover. Variability in chlorophyll a concentration between years can indicate high environmental variability, while similar seasonal patterns indicate relative environmental stability.



Data Quality: Gold

External > Environmental Context > Environmental character > Description of the ecosystems

This metric provides a qualitative description of the ecosystem(s) in which the fishery occurs. The goal is to provide a general overview of these environments. The knowledge about which ecosystems are encountered during fishing activity is the indicator (rather than the response of the ecosystems to fishing).

Marine ecosystems are defined for the purposes of this indicator as the composition of plants, animals, and the marine environment (water masses, geomorphology). Types of marine ecosystems include estuaries, the sea floor, the mesopelagic zone, the pelagic zone, the inter-tidal zones, coral reefs, lagoons, and mangroves. A pelagic zone ecosystem for example, is defined by physical, chemical and biological features of the marine water column of the open ocean[217].

Description of the ecosystems: High

The Coral Reef Finfish fishery operates predominantly in the Great Barrier Reef Marine Park, and fish are captured over coral reefs, rocky bottom, and at the interface with sandy bottoms[218]. Additional spatial data available at QFish[219]

Data Quality: Gold

External > Climate related > Susceptibility of target species > Impacts on target species

Climate change directly affects the distribution, abundance and phenology of individual species. These changes then affect the fisheries that harvest these species, and can be a strong external influence on the fishery. These impacts can be positive (e.g. increased abundance), or negative (e.g. movements further from fishing ports), and to long-term warming, or short-term extreme events such as marine heatwaves.

Sensitivity of some of the target species to climate change has been assessed[220]. Species in this fishery have sensitivities ranging from moderately high to high.

Common name	Species	Fishery	Score	Sensitivity
Goldband snapper	Pristipomoides multidens	Coral Reef Fin Fish Fishery	5.625	MODERATELY HIGH
Red emperor	Lutjanus sebae	Coral Reef Fin Fish Fishery	5.92	MODERATELY HIGH

[217] Game, E. T., H. S. Grantham, A. J. Hobday, R. L. Pressey, A. T. Lombard, L. E. Beckley, K. Gjerde, R. H. Bustamante, H. P. Possingham and A. J. Richardson (2009). Pelagic protected areas: the missing dimension in ocean conservation. Trends in Ecology and Evolution **24**(7): 360-369 doi:310.1016/j.tree.2009.1001.1011.

[218] https://www.daf.qld.gov.au/business-priorities/fisheries/monitoring-our-fisheries/commercial-fisheries/data-reports/sustainability-reporting/queensland-fisheries-summary/coral-reef-fin-fish-fishery

[219] http://qfish.fisheries.qld.gov.au/

[220] Fulton EA, Hobday AJ, Pethybridge H, Blanchard J, Bulman C, Butler I, Cheung W, Gorton B, Hutton T, Lozano- Montes H, Matear R, Pecl G, Villanueva C, Zhang X (2018). *Decadal scale projection of changes in Australian fisheries stocks under climate change.* CSIRO Report to FRDC. FRDC Project No: 2016/139 – ONLINE.

Coral trout	Plectropomus spp. & Variola spp.	Coral Reef Fin Fish Fishery	6.125	HIGH
Crimson snapper	Lutjanus erythropterus	Coral Reef Fin Fish Fishery	5.75	MODERATELY HIGH
Saddle tail snapper	Lutjanus malabaricus	Coral Reef Fin Fish Fishery	5.75	MODERATELY HIGH
Red throat emperor	Lethrinus miniatus	Coral Reef Fin Fish Fishery	6.375	HIGH

Data Quality: Silver

External > Climate related > Susceptibility of key habitats > Habitat Impacts

Habitat impact: High

Recent bleaching events are reducing coral cover[221] across the region of the fishery and are projected to worsen in future.

Data Quality: Gold

External > Contaminants in the environment > Detection system for seafood contaminants > Risk of contaminants

Potential risk for contamination from the marine environment combined with monitoring arrangements to be able to address risks needed to ensure food safety. Contaminants include those with maximum levels set for by Food Standards Code Australia: metal contaminants, non-metal contaminants, natural toxicants, and average and maximum levels of mercury in fish. Contaminants from poor handling after landing are not assessed but may be indirectly addressed.

Rubric for risk level:

Low risk	Medium risk	High risk
There are no documented levels of contaminants from the marine environment causing risk/diet restrictions to any consumer group in the fishery.	There may be seasonal/area/species/size-based risks of contaminants for some species.	Permanent diet restrictions of species caught to vulnerable consumers such as children or pregnant women.

Risk of Contaminants: Medium

No specific monitoring arrangements found for marine contaminants on the fishery webpage: https://www.daf.qld.gov.au/business-priorities/fisheries/monitoring-our-fisheries/commercial-fisheries/data-reports/sustainability-reporting/queensland-fisheries-summary/coral-reef-fin-fish-fishery, targeted species have medium potential risk for contamination from the marine

[221] Hughes, T. P., J. T. Kerry, M. Álvarez-Noriega, J. G. Álvarez-Romero, K. D. Anderson, A. H. Baird, R. C. Babcock, M. Beger, D. R. Bellwood, R. Berkelmans, T. C. Bridge, I. R. Butler, M. Byrne, N. E. Cantin, S. Comeau, S. R. Connolly, G. S. Cumming, S. J. Dalton, G. Diaz-Pulido, C. M. Eakin, W. F. Figueira, J. P. Gilmour, H. B. Harrison, S. F. Heron, A. S. Hoey and e. al. (2017). Global warming and recurrent mass bleaching of corals. Nature **543**: 373-377.

environment. Warm-water finfish (e.g. snappers, basse, wrasse) may in different seasons, areas and at larger sizes contain natural toxins (such as ciguatera).

Data Quality: Silver

External > Contaminants in the environment > Management arrangements to ensure food safety related to contaminants > Evidence for arrangements

There is evidence of management arrangements to ensure food safety related to contaminants and food safety from the marine environment. No supply chain risks from poor handling are considered. Food standard 4.2.1 requires all seafood business in Australia to identify potential seafood safety hazards and put controls in place that are consistent with the risk.

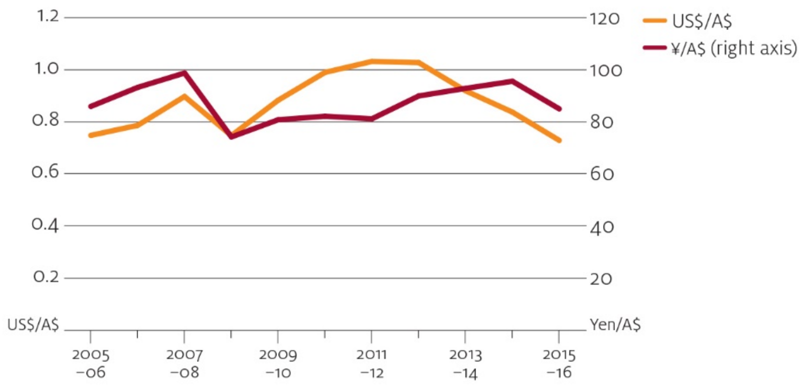
Data Quality	
GOLD	
SILVER	Follows national standards but fisheries-specific arrangements not found. https://www.business.qld.gov.au/industries/farms-fishing-forestry/agriculture/land-management/chemical-controls/using-chemicals/residue-limits
BRONZE	

External > Market Drivers > Macroeconomic factors > Exchange Rates

A depreciating Australian dollar (or, increasing exchange rate) generally results in producers receiving a higher export price in Australian dollar terms, while an appreciating Australian dollar (or, decreasing exchange rate) results in a lower export price. Domestically, a depreciation of the Australian dollar encourages substitution from imported seafood to domestically produced seafood, as imported products become relatively more expensive. A lower exchange rate also makes Australian exports more competitive in world markets, as exported seafood become relatively cheaper in foreign currency terms.

National export trends are negatively related to exchange rate movements— the Australian dollar declined against the US dollar and Japanese yen from 1990–91 to 2000–01, with exports increasing in volume and value. Exchange rates for the Australian dollar increased against those currencies from 2001–02 to 2015–16. The real export value and volume of Australia's seafood exports decreased between 2005–06 and 2012–13 and then increased between 2012–13 and 2015–16—with a noticeable rise (43 per cent) in volume between 2014–15 and 2015–16.[222]

[222] Mobsby, D and Koduah, A 2017, Australian fisheries and aquaculture statistics 2016, FRDC project 2017-095. ABARES, Canberra, December. CC BY 4.0.



Data Quality: Gold

External > Market Drivers > Consumer Trends > Per person annual apparent consumption of seafood (kg)

Annual apparent consumption is estimated by adding the total edible quantity of seafood supplied domestically—that is, total production plus imported seafood— less exports of seafood. Apparent consumption provides an estimate of the total amount of seafood consumed in Australia assuming zero change in stocks.

The production quantity of Australian fishery and aquaculture products is reported by ABARES on a whole weight basis, whereas trade data are reported on a processed basis. To align the units of measurement between production and trade data, it is necessary to convert production volume to a processed edible equivalent.

Production volumes are adjusted to an edible quantity basis using species-specific conversion rates and excluding species that are known to be predominantly supplied for non-human consumption purposes, such as for aquaculture feed or bait. Imports and exports of seafood are sourced from Australian Bureau of Statistics (ABS) trade data and are reported as edible weight. The apparent consumption per person is calculated as the total apparent consumption divided by the total Australian population in each year. The method applied here is consistent with that used by ABARES to estimate apparent consumption of other agricultural commodities produced in Australia.

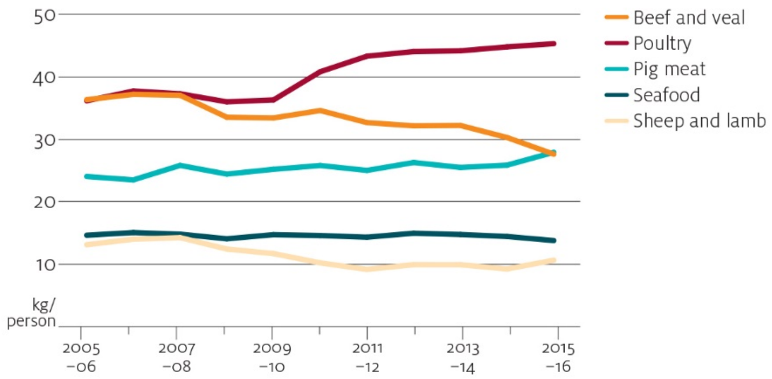
The FAO also compiles statistics on apparent consumption of seafood, applying a consistent method across all countries. FAO estimates indicate that annual consumption of seafood in Australia is around 26 kilograms per person in 2013 (FAO 2016[223]). The discrepancy between FAO and ABARES estimates reflects differences in methodological approaches to estimating consumption. Moreover, ABARES estimates seafood consumption on a processed edible basis, whereas the FAO provides its estimates on a whole weight basis.

In Australia, apparent consumption of seafood per person (edible equivalent) decreased, on average, at an annual rate of 0.6 per cent, from 14.6 kilograms in 2005– 06 to 13.8 kilograms per person in 2015–16. Annual apparent consumption is estimated by the Australian Bureau of Agricultural and

[223] The state of world fisheries and aquaculture 2016—opportunities and challenges, Food and Agriculture Organization of the United Nations, Rome.

Resource Economics and Sciences by adding the total edible quantity of seafood supplied domestically—that is, total production plus imported seafood— less exports of seafood[224]

In comparison, global per capita apparent fish consumption increased from an average of 9.9 kg in the 1960s to 14.4 kg in the 1990s and 20.1 kg in 2014, with preliminary estimates for 2015 indicating further growth, exceeding 20 kg (FAO 2016). Australia's per person seafood consumption in 2013 was estimated by the FAO to be 26kg. The differences in estimates are accounted for by varying methods for calculating consumption. ABARES estimates seafood consumption on a processed edible basis, whereas the FAO provides its estimates on a whole weight basis.



Data quality: Gold

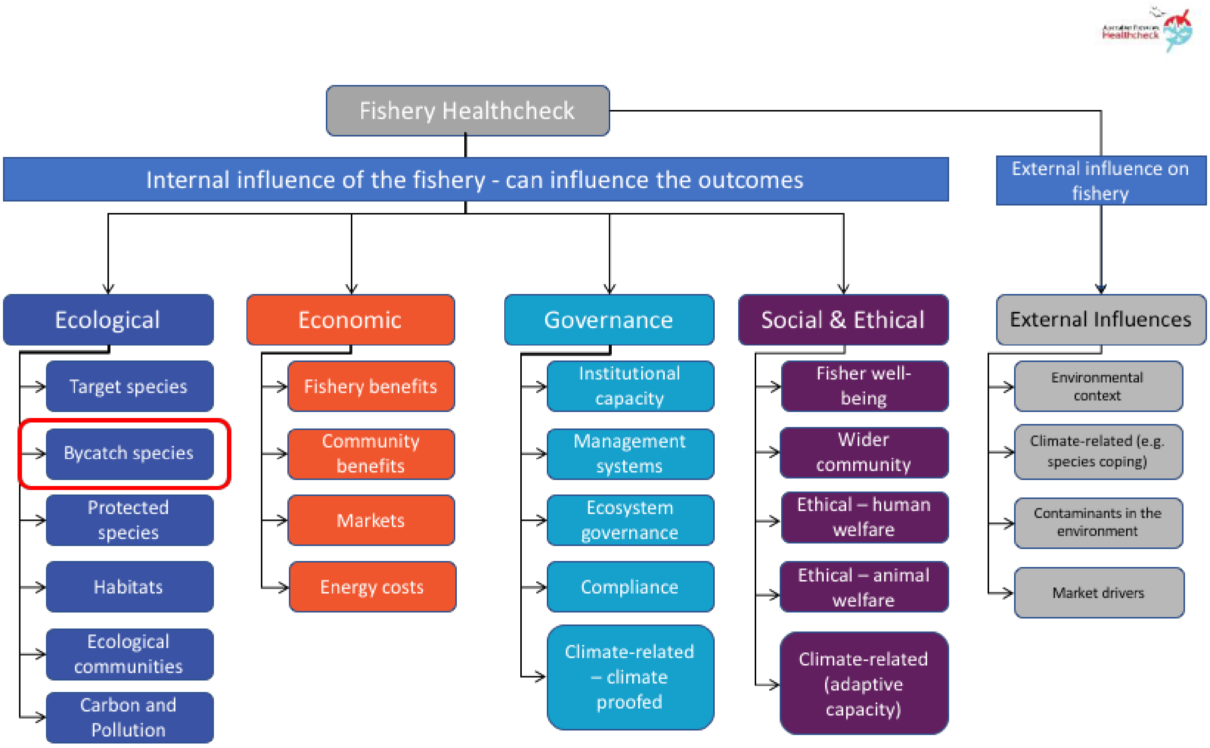
[224] Mobsby, D and Koduah, A 2017, *Australian fisheries and aquaculture statistics 2016*, FRDC 2017-095. ABARES, Canberra, December. CC BY 4.0

Queensland Blue Swimmer Crab Fishery

The commercial Queensland Blue Swimmer Crab Fishery targets blue swimmer crabs (Portunus armatus) using pots, and access is managed by licences, with a total of 350. The fishing area covers the majority of Queensland tidal waters, except closed waters. The species is found in coastal and estuarine waters along the entire Queensland coast but are fished mainly in the southern part of Queensland. Each year Fisheries Queensland assesses the exploitation status (stock status) of Queensland's key fish stocks. [Stock status assessments](https://www.daf.qld.gov.au/business-priorities/fisheries/monitoring-our-fisheries/commercial-fisheries/data-reports/sustainability-reporting/queensland-fisheries-summary/blue-swimmer-crab) are carried out regularly. (Source: https://www.daf.qld.gov.au/business-priorities/fisheries/monitoring-our-fisheries/commercial-fisheries/data-reports/sustainability-reporting/queensland-fisheries-summary/blue-swimmer-crab).

Case Study Presentation Format

The case study documents are a collection of metrics, organised by the healthcheck structure:



The presentation of metrics will follow the following heading format:

Ecological > Bycatch species > Bycatch composition > <u>Mean Trophic Level</u>

Understand this to be an indicator (**Bycatch composition**) of the **Ecological** Component, **Bycatch species** subcomponent where the (in the figure and heading example above, is being measured by presenting <u>Mean Trophic Level</u> as the metric.

Ecological > Target species > Stock Status > Status of Australian Fish Stocks (SAFS)

Target species in each fishery are the primary focus for this indicator. Status of these species is ideally assessed with the SAFS approach, however this may not cover all target species for each fishery. In that case, we indicate the number of unassessed species. These species could also be assessed by individual states or by alternative methods.

SpeciesName	StockName	StockStatus	Year
Blue Swimmer Crab	North-Eastern Australia	Sustainable	2016

Data Quality: Gold

Ecological > Target Species > Harvest Level > Catch weight

This metric is a proxy for harvest level. The harvested biomass for each species, provides information on the level of the catch. Trends in this metric over time can indicate declining availability of fish, quota restrictions, or changes in market demand. For Australian fisheries, trends are expected to be stable for most species.

Table 18 – Average annual retained catches and fishing effort (and SE's) in Queensland's commercial fisheries during the 5 year period, 2010-11 to 2014-15. Kennelly (2018)

Fishery	Retained Catch (t)	SE	Fishing Effort (Days)	SE
Blue Swimmer Crab	361.6	12.27	8711.8	233.24

Data quality: Silver

Ecological > Bycatch species > Bycatch composition > Mean Trophic Level

The trophic level is a measure of the position of an organism in a food web, starting at level 1 with primary producers, such as phytoplankton, then moving through the primary consumers at level **2** that eat the primary producers to the secondary consumers at level **3** that eat the primary consumers, and so on. The **bycatch mean trophic level** is an indicator of the mean level of the food chain for bycatch in a fishery.

This fishery has very low bycatch, and so this metric was not calculated

Data Quality: Not applicable

Ecological > Bycatch species > Bycatch amount > Total weight of bycatch

Bycatch weights for fishery are typically developed by specific projects, and require a range of assumptions due to issues with reporting and retention of bycatch. **Bycatch** estimates typically cover species that are not target species, while **discard** rates may also include undersized individuals of the target species. Kennelly (2018) provides estimates of discard rates, which include both target and bycatch species, and when discard rates are used, that information is noted for each fishery. Animals can be returned to the ocean alive or dead. The intention of this metric is to provide information on animals that are dead on return to the ocean.

Reference:

Kennelly, S.J., 2018. *Developing a National Bycatch Reporting System.* Final FRDC Report, ISBN 978-0-9924930-5-9, March, 2018. 99 pp.

Kennelly (2018)[225] reports "Rigid or collapsible crab pots are the main methods used in the Queensland Blue Swimmer Crab Fishery. DAFF (2012b) notes that bycatch in this fishery is generally low and consists of undersized target or non-permitted species, but no data were available to quantify these discards. In the absence of such data, we use the retained:discard ratio of 1:0.122 (a discard rate of 10.87%) derived for the NSW estuarine Blue Swimmer Crab fishery (Leland et al., 2013)."

Data Quality: Bronze.

Ecological > Protected species > Capture amount > Captures

The number and diversity of TEP species captured by a fishery in the most recent year, provided as annual numbers.

The data obtained from all available sources regarding interactions with TEPs species (or, as they are known in Queensland, Species of Conservation Interest – SOCI) mostly came from self-reported fishers' logbooks (augmented occasionally by data from observer programs). Only 8 of Queensland's 22 fisheries indicated any interactions with TEP species.

For the Blue Swimmer Crab Fishery fishers' logbooks list four interactions with loggerhead turtles in 2003, four in 2004, none during 2005–06 and two in 2007 and Leslie (2014) notes that the fishery did not report interacting with any protected species during 2012. A fishery observer-based study of the Moreton Bay Blue Swimmer Crab pot fishery recorded only one turtle interaction in 220 observed fishing days.[226]

Data quality: Bronze

Ecological > Protected species > Reporting > Level of monitoring

This indicator is to provide information on the level of coverage for a fishery. Annual measures are preferred.

Fisheries Queensland has been undertaking routine monitoring of Queensland's fisheries for almost 30 years. Monitoring programs collect a range of data including catch, effort, size and age of fish, social and economic indicators and compliance rates.[227]

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[225] Kennelly, S.J., 2018. *Developing a National Bycatch Reporting System.* Final FRDC Report, ISBN 978-0-9924930-5-9, March, 2018. 99 pp.
[226] Kennelly, S.J., 2018. *Developing a National Bycatch Reporting System.* Final FRDC Report, ISBN 978-0-9924930-5-9, March, 2018. 99 pp.
[227] State of Queensland (2017) Sustainable Fisheries Strategy 2017-2027. Fisheries Queensland Monitoring and Research Plan. Queensland Government CC BY 4.0.

Queensland Commercial fishery observer data[228].

Number of days observed by the Observer program for the Queensland commercial Line, Net, Trawl and Pot fisheries from 2006 to 2013.

Method	Year	Number of Days
Crab	2006	2
Crab	2007	22
Crab	2008	0
Crab	2009	0
Crab	2010	0
Crab	2011	44
Crab	2012	37

Data quality: Silver

Ecological > Habitats > Habitat impact > Impact score

The habitat impact is an indicator of the effect the fishing gear has on the habitat. Different gear types have different impacts. See the scoring rubric.

Habitat Impact: Minor, based on the gear type used in this fishery.

Data quality: Bronze

Ecological > Habitats > Habitat impact > Habitat status

The status of the habitat types is a measure of the condition relative to a pristine state. Fishing may not be responsible for that habitat status, but it is important to note if fishing is taking place in pristine or disturbed habitats.

Habitat status: Moderate – changing environment as a result of climate change has significantly impacted this system

Data quality: Bronze

Ecological > Ecological communities > Ecosystem status > Ecosystem status

This metric reports the ecosystem status in the region of the fishery.

Ecosystem Status: Moderate

Substantial modification of estuarine and coastal waters has occurred along the southern Queensland coast[229].

Data Quality: Bronze

Ecological > Ecological communities > Ecosystem status > Species diversity

[228] https://data.qld.gov.au/dataset/queensland-commercial-fishery-observer-data

[229] https://soe.environment.gov.au/assessment-summary/marine-environment/state-and-trends-habitats-and-communities

The measure of species diversity as a ratio between fished and unfished states.

Data quality: Not found

Ecological > Carbon and Pollution > Macro-plastics > Plastic code of conduct

Macro-plastics are plastics that are visible to the naked eye, such as food containers and wrapping, equipment packaging, and fishing equipment. The metric notes a commitment to a zero waste overboard code of conduct to assess attempts to reduce accidental or intentional introduction of macro-plastics to the ocean. There are stated guidelines detailing Australia's guidelines regarding marine pollution from the Australian Maritime Safety Authority[230]:

Pollution of the marine environment by ships, including fishing vessels, is strictly controlled by the International Convention for the Prevention of Pollution from Ships (known as MARPOL).

To minimise pollution, MARPOL prohibits ships from discharging garbage into the sea except in very limited circumstances.

Australian MARPOL regulations apply to Australian fishing vessels wherever they are operating.

Data Quality: Bronze

Ecological > Carbon and Pollution > Carbon footprint > CO_2-equivalents

The emissions of climate forcing gases in kg CO_2-equivalents (CO_2e) per kg live weight fish caught, not including the supply chain after landing.

Data Quality	Gear	Target species	Min (kg CO_2e/kg)	Average (kg CO_2e/kg)	Max (kg CO_2e/kg)	Reference	Description
Gold							
Silver							
Bronze	Pots and traps	Crustaceans	2.1	10.4	23.8	Parker and Tyedmers 2015	Oceania region, year and fuel type not specified, unclear if bait fishing is included, no refrigerants included.

Economic > Fishery Benefits > Net Economic Returns > Economic Rent

Net Economic Returns (NER) is equal to fishing revenue less fishing costs and measures the economic profit that is derived from fishing activity, it is measured by the Commonwealth as Net Economic Returns and by some States as Economic Rent. **Data Quality:** Not found

Economic > Fishery Benefits > Gross Value of Production > Gross Value of Production

[230] https://www.amsa.gov.au/marine-environment/marine-pollution/pollution-fishing-vessels
https://www.amsa.gov.au/marine-environment/marine-pollution/marpol-and-its-implementation-australia

GVP calculated as the volume of catch multiplied by the average per unit beach price (AUD$).

Data Quality	Species/Fishery	Year	Amount	Reference	Note/Comment
Gold	Blue Swimmer crab	2016	$3.0 million	State of Queensland (2017). Queensland Fisheries Summary October 2017. Department of Agriculture and Fisheries, CC BY 3.0	
Gold	Blue Swimmer crab	2015	$3.8 million	State of Queensland (2017). Queensland Fisheries Summary October 2017. Department of Agriculture and Fisheries, CC BY 3.0	
Gold	Blue Swimmer crab	2014	$3.2 million	State of Queensland (2017). Queensland Fisheries Summary October 2017. Department of Agriculture and Fisheries, CC BY 3.0	
Gold	Blue Swimmer crab	2013	$3.1 million	State of Queensland (2017). Queensland Fisheries Summary October 2017. Department of Agriculture and Fisheries, CC BY 3.0	
Gold	Blue Swimmer crab	2012	$3.7 million	State of Queensland (2017). Queensland Fisheries Summary October 2017. Department of Agriculture and Fisheries, CC BY 3.0	
Gold	Blue Swimmer crab	2011	$3.0 million	State of Queensland (2017). Queensland Fisheries Summary October 2017. Department of Agriculture and Fisheries, CC BY 3.0	
Gold	Blue Swimmer crab	2010	$4.5 million	State of Queensland (2017). Queensland Fisheries Summary October 2017.	

				Department of Agriculture and Fisheries, CC BY 3.0	
Gold	Blue Swimmer crab	2009	$6.8 million	State of Queensland (2017). Queensland Fisheries Summary October 2017. Department of Agriculture and Fisheries, CC BY 3.0	
Gold	Blue Swimmer crab	2008	$6.0 million	State of Queensland (2017). Queensland Fisheries Summary October 2017. Department of Agriculture and Fisheries, CC BY 3.0	

Economic > Fishery Benefits > Profitability > Financial Performance

Economic health of a fishery can be measured by the financial performance of the operators in the fleet. Fleet wide averages or distributions of levels of profitability indicate the extent to which the fishery is generating economic benefits for fishers.

Data Quality: Not found

Economic > Fishery Benefits > Latency > Underutilised Effort

Latency is fishery concessions that are not being fully utilised by fishers, for example, often the annual total allowable catch is left partially or largely uncaught for a fishery. Latency may appear as effort or uncaught TAC or inactive licences.

Data Quality	Indicator used	Year	Amount	Reference	Note
Gold	Inactive licences	2016	230	State of Queensland (2017) Queensland Fisheries Summary April 2017. Department of Agriculture and Fisheries, CC BY 3.0	

Economic > Community benefits > Value to community > GDP or GSP value

A fisheries contribution to Gross Domestic Production (GDP)/Gross State Product (GSP) is the total economic value that it generates directly, plus the indirect contribution made to other industries, which is also measured in value-add terms.

Data Quality	Indicator used	Year	Amount	Reference	Note
Bronze	GSP	2016-2017	$10,851,000	Queensland Government (2017) Gross state product at factor cost by industry and main components, Queensland, 2006-07 to 2016-17 (current prices) http://www.qgso.qld.gov.au/products/tables/gsp-factor-cost-industry-components/index.php	Agriculture, forestry and fishing combined
Bronze	GSP	2015-2016	$9,062,000	Queensland Government (2017) Gross state product at factor cost by industry and main components, Queensland, 2006-07 to 2016-17 (current prices) http://www.qgso.qld.gov.au/products/tables/gsp-factor-cost-industry-components/index.php	Agriculture, forestry and fishing combined
Bronze	GSP	2014-2015	$7,623,000	Queensland Government (2017) Gross state product at factor cost by industry and main components, Queensland, 2006-07 to 2016-17 (current prices) http://www.qgso.qld.gov.au/products/tables/gsp-factor-cost-industry-components/index.php	Agriculture, forestry and fishing combined
Bronze	GSP	2013-2014	$6,641,000	Queensland Government (2017) Gross state product at factor cost by industry and main components, Queensland, 2006-07 to 2016-17 (current prices) http://www.qgso.qld.gov.au/products/tables/gsp-factor-cost-industry-components/index.php	Agriculture, forestry and fishing combined
Bronze	GSP	2012-2013	$7,328,000	Queensland Government (2017) Gross state product at factor cost by industry and main components, Queensland, 2006-07 to 2016-17 (current prices) http://www.qgso.qld.gov.au/products/tables/gsp-factor-cost-industry-components/index.php	Agriculture, forestry and fishing combined
Bronze	GSP	2011-2012	$7,513,000	Queensland Government (2017) Gross state product at factor cost by industry and main components, Queensland, 2006-07 to 2016-17 (current prices) http://www.qgso.qld.gov.au/products/tables/gsp-factor-cost-industry-components/index.php	Agriculture, forestry and fishing combined

Bronze	GSP	2010-2012	$6,601,000	Queensland Government (2017) Gross state product at factor cost by industry and main components, Queensland, 2006-07 to 2016-17 (current prices) http://www.qgso.qld.gov.au/products/tables/gsp-factor-cost-industry-components/index.php	Agriculture, forestry and fishing combined

Economic > Community benefits > Wealth Spread > Distribution of fishing firm size

The spread of profits to owners and crew members indicates how widely benefits of fishing are distributed across the fishing community. A wide spread of benefits may be important to some fishery stakeholders. A narrow spread may not indicate a lack of distribution of benefits in the case where all participating businesses are the same size, or if other mechanisms are present to capture and distribute benefits such as high levels of employment of crew. The number of large business versus small business, classified by turnover (direct measure) or catch volume (proxy) may provide an indirect indicator: i.e. are economic returns from commercial fishing gained by one or two large businesses or a spread over many smaller businesses? **Data Quality:** Not released

Economic > Markets > Fish distribution > Fish receivers

One way of measuring benefits from a fishery is by assessing the flow of seafood through the supply chain. In many fishery jurisdictions, the first step in the supply chain is via licensed fish receivers who are allowed to receive fish for sale. They can also trade fish with other receivers. In some jurisdictions, commercial fishers must sell their catch to a receiver (although they can sell small amounts on wharves). While this restricts fishers' options for landing their catch, it means that fish can be tracked, reduces illegal fish trading and ensures that the Quota Management Systems (QMS) work effectively by ensuring catches do not exceed the total allowable catch or quota amounts for individual species. Receivers of fish may be fish processors, wholesalers or retailers.

In some jurisdictions, the fishers and fish receivers are integrated, such that they are effectively the same “business”. In Commonwealth fisheries, the total number of fish receivers per year may differ to the sum of the fish receivers per fishery because some receivers operate in more than one fishery.

Queensland does not have a fish receiver system for its fisheries.

Data Quality: Not found

Economic > Markets > Volatility in market price > Price volatility

Price volatility is the mean beach price for the target species (top one or five depending on price) over the given period (most recent ten years). The level of volatility is the standard deviation in mean price over this period.

Data Quality	Species/Fishery	Year/Time period	Amount	Reference	Note
Bronze	QLD crab	2006-07 to 2015-16	$3.55/kg	Mobsby, D and Koduah, A 2017, Australian fisheries and aquaculture statistics 2016,	For whole of QLD

				Fisheries Research and Development Corporation project 2017-095. ABARES, Canberra, December. CC BY 4.0. Supporting data tables	

Economics > Energy costs > Energy Use > Fuel use per kg of fish harvested

Fuel use varies over time and between stocks and are best collected from industry on a yearly basis. Estimates for different fisheries should be compared with caution, and in particular comparing energy use between fisheries with different data quality which is not recommended (different data availability, may be e.g. old or not fisheries-specific). Estimates are provided for all levels of data quality if available and are given in L per kg live-weight.

Data Quality	Gear	Target species	Min (L/kg)	Average (L/kg)	Max (L/kg)	Reference	Description
Gold							
Silver							
Bronze	Pots and traps	Crustaceans	0.8	3.8	9.5	Parker and Tyedmers 2015	Oceania region, unclear if bait use is included

Economic > Energy costs > Fossil fuel subsidies > Fuel subsidies directed to the fishery

Fossil fuel subsidies (fuel rebates) illustrate to which extent the fuel cost is reduced in the fishery, measured in AUD/kg live weight fish. Note that this form of tax exemption for fisheries is in Australia motivated from the sector not using roads (i.e. costs embedded in fuel price for road construction and maintenance), and are not formally reported as fuel subsidies in Australia.

Data Quality	Gear	Target species	Subsidy (AUD/kg)	Reference	Description
Gold					
Silver					
Bronze	All QLD	All QLD	0.87	Total tax claims per total landings in QLD	2015-16 (2016-17 also available), state level figures on landings are preliminary for 2015-16

Governance > Ecosystem governance > Bycatch mitigation > Description of the bycatch mitigation measures

Bycatch measures can be spatial (e.g. area closure), temporal (time closure, e.g. night setting only) or technical (bycatch reduction devices, hook size). This indicator describes the measures that are in place for a fishery – but not the rates of compliance. For example, spatial closures for different gear types are shown here for AFMA fisheries http://www.afma.gov.au/sustainability-environment/fishing-closures/.

Bycatch mitigation information for the Blue Swimmer Crab Fishery is not currently collected by Fisheries Queensland[231]

Data Quality: Bronze

Governance > Ecosystem governance > Protected species mitigation > Description of the protected species mitigation measures

TEP mitigation measures can be spatial (e.g. area closure), temporal (time closure, e.g. night setting only) or technical (bycatch reduction devices, hook size). This indicator describes the measures that are in place for a fishery – but not the rates of compliance. **Data Quality:** Not found

Governance > Management system > Harvest strategy > Scope of the harvest strategy

Assessment can be based on scoring presence of the following: a harvest strategy designed to achieve management objectives; harvest control rules and tools; collection of relevant information to support the harvest strategy; and, assessment of stock status or the presence of the following key elements: Defined operational objectives for the fishery; Indicators of fishery performance related to the objectives; Reference points for performance indicators; A statement defining acceptable levels of risk to meeting objectives; A monitoring strategy to collect relevant data to assess fishery performance; A process for conducting assessment of fishery performance relative to objectives; and; Decision rules that control the intensity of fishing activity and/or catch.

Queensland will use a harvest strategy to set out pre-determined management actions in a fishery for defined species (at the stock or management unit level) necessary to achieve the agreed ecological, economic and/or social management objectives. Harvest strategies will address the fishing activities of all sectors (commercial, recreational (including charter) and traditional) and will apply to target and by product species primarily. While in most jurisdictions harvest strategies only apply to target species, Queensland’s harvest strategies will also cover bycatch, protected species where an ecological risk assessment generates a high risk. This removes the need to have separate policies for these components because the management principles are the same for all these resources in terms of ensuring risks to all these components are kept at acceptable levels.[232].
The fishery had a period of public consultation (closed 20 May 2018) on the proposed amendments for the Queensland crab (mud and blue swimmer crabs) fishery[233]

Data Quality: Bronze

Governance > Management system > Management plans > Scope of management plan

Management plans can be assessed by evaluating the presence of minimum requirements, as follows: a description of the fishery, especially its current status and any established user rights: the management objectives; how these objectives are to be achieved; how the plan is to be reviewed and/or appealed, as well as the consultation process for review and appeal.

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[231] State of Queensland (2012). Performance Measurement System Blue Swimmer Crab Fishery version 2 – August 2012. CC BY 3.0
[232] Department of Agriculture and Fisheries (2017). Queensland Harvest Strategy Policy
[233] https://www.daf.qld.gov.au/business-priorities/fisheries/sustainable-fisheries-strategy/fisheries-reforms

The Queensland Blue Swimmer Crab Fishery is managed under the Fisheries Act 1994[234] and Fisheries Regulation 2008[235], which contains the following minimum requirements

established user rights:
the management objectives;
how these objectives are to be achieved

Data Quality: Gold

Governance > Institutional capacity > Accountability of decision making bodies > Level of Accountability

Accountability of Decision-making bodies. Performance of a fisheries management agency is based on the degree to which decision-making processes are consultative, the basis for decisions are fully explained, and information about decision making is publicly available. The assessment applied the three tiers of Principle 3.2.2 (d) 'Decision-making process' of the MSC Fisheries Standard v2.0 (2014) to determine whether the level of accountability was low, medium or high.

High level of accountability. This is demonstrated by publicly-available fishery assessment reports, and overview information about fisheries management arrangements. Information about decision-making procedures and outcomes, including proceedings of the Crab Fishery Working Group, are publicly available online.

Data Quality: Silver

Governance > Institutional capacity > Uncertainty management > Extent of incorporation of uncertainty in management of the targeted stock

This metric reports on the explicit incorporation of uncertainties in decision support processes used to inform and make appropriate choices of management actions. We recognise three levels of uncertainty: Low level of incorporation of uncertainty; Medium level of incorporation of uncertainty; High level of incorporation of uncertainty. These are based on: Major sources of uncertainty are identified; Assessment takes uncertainty into account; Frequency of monitoring of indicators is high; Monitoring of more than one indicator to support management decisions; Assessment evaluates stock status relative to reference points in a probabilistic way; Robustness of assessments are tested, Alternative hypotheses and assessment approaches are rigorously explored.

Medium level of incorporation of uncertainty in management of the targeted stock.	The assessment applied Principle 1.2.4 (c & d) 'Assessment of stock status: Uncertainty in the Assessment' of the MSC Fisheries Standard v2.0 (2014) to assess extent of incorporation of uncertainty in management of the targeted stock.

Data Quality: Silver

234 https://www.legislation.qld.gov.au/view/html/inforce/current/act-1994-037
235 https://www.legislation.qld.gov.au/view/html/inforce/current/sl-2008-0083

Governance > Compliance > Compliance regime > Level of Compliance

Level of compliance with rules and regulations controlling catch can be assessed by audits that measure the agreement between 1) logbook and observer records; 2) catch disposal records submitted by fishers and fish receivers. It might also be assessed by counting the annual number of breaches/observed offences or enforcement actions, preferably scaled to the level of enforcement effort (e.g. $). This indicator can be scored on the basis of the presence of key monitoring, control and surveillance elements and capacities.

Commercial fishers have a legal obligation to report information about their fishing activities in a compulsory daily logbook. All crab fishers must contribute data about their day's catch, the location fished, the gear used and any interactions with species of conservation interest. Fisheries Queensland uses this data to assess and monitor the status of individual species and fisheries in Queensland.[236]

Data Quality: Bronze

Governance > Compliance > Surveillance > Surveillance Effort

Regulatory controls include logs and catch reporting, on-board observer programs, vessel inspections, vessel monitoring systems, and visual or electronic surveillance using radar or satellite by boat or by air. Higher degrees of surveillance, or coverage using multiple methods, provide greater levels of certainty in estimates of effort, fishing mortality, bycatch and discard levels, and interactions with protected/listed species. Report on the surveillance carried out on the fishery, as reported by the compliance branch responsible for the fishery

Surveillance effort score: undefined
Fisheries compliance activities include monitoring and inspection of fishing activities, investigations into causes of alleged infringement and enforcement in the form of cautions, infringement notices or prosecution (if necessary).

Actions identified as part of the Queensland Sustainable Fishery Strategy 2017-2027 include:
Require installation of vessel monitoring system (VMS) on all commercial boats by 2020, with a priority to install VMS on net, line and crab boats by 2018. [237]

Units inspected by Queensland Boating and Fisheries Patrol in 2012: 767 including the Gulf of Carpentaria (Commercial vessels: 85, majority of remainder were recreational fishers (private or charter)).
Offences detected in 2012: 37. This equates to compliance rates of 95.3% for commercial fishers and 94.6% for recreational fishers corresponding to an overall compliance rate of 95.2%. These offences do not include incorrectly marked crab pots.
Incorrectly marked crab pots seized from tidal waters in Queensland: 708[238].

Data Quality: Silver

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[236] https://www.business.qld.gov.au/industries/farms-fishing-forestry/fisheries/fisheries-profiles/crab-fisheries/regulations
[237] State of Queensland (2017) Queensland Sustainable Fisheries Strategy 2017-2017. Fisheries Queensland, Department of Agriculture and Fisheries. CC BY 4.0
[238] https://www.daf.qld.gov.au/__data/assets/pdf_file/0005/248126/Blue-Swimmer-Crab-Fishery-2012-Fishing-Year-Report.pdf

Governance > Adaptive capacity > Governance arrangements > Climate change recognition

Governance arrangements relevant to the fishery consider the impact of climate change on the fishery, as evidenced by documentation, policies and plans that describe how management is addressing climate change impacts. Does the fishery management plan, harvest strategy or research activity suggest that climate change is recognised, and integrated into management planning?

Fishery-specific plans do not yet propose management responses to climate change.

The need for sector responses and governance to climate change are recognised in government strategy documents[239].

The National Harvest Strategy also recognizes that "*Variability in ocean conditions, due to natural variability, climate change or other factors, can affect the productivity of stocks. Fisheries should seek to account for that variability when developing and implementing harvest strategies.*"[240]. The Guidelines for the Harvest Strategy provide explicit approaches for fisheries[241]. The strategy and guidelines do not explicitly apply to state fisheries, but will provide guidance.
Data quality: Bronze

Governance > Adaptive capacity > Coping strategies > Climate responses

The fishery has initiated coping strategies (directed) to reduce the impacts of climate change. Evidence of strategies that have been specifically implemented for the fishery might include codes of practice, restocking programs, early warning systems, and so on. The coping strategies may be for long-term change or for extreme events. A description of the climate change responses that have been implemented or explored in research or application are provided.

There are no management actions currently implemented that address climate change impacts in the fishery.

Data quality: Bronze

Social and Ethical > Fishers wellbeing > Fisher satisfaction > Satisfaction scores

If available, fishery specific surveys of well-being or satisfaction, with interpretation required for the types of questions and sample. When surveys are not available other sources of data may need to include broader surveys (e.g. not fishery specific) or discussions with industry representatives, managers or fishers about the industry and their opinion of general fisher-wellbeing (note this will be subjective).

Data Quality: Not found

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[239] Moran, C. and Boulter, S. (2018). *Biodiversity and Ecosystems Climate Adaptation Plan*. Brisbane, Australia. Available at https://www.nccarf.edu.au/.
[240] Department of Agriculture and Water Resources 2018, *Commonwealth Fisheries Harvest Strategy Policy*, Canberra, June. CC BY 4.0.
[241] Department of Agriculture and Water Resources 2018, *Guidelines for the Implementation of the Commonwealth Fisheries Harvest Strategy Policy*, Canberra, June. CC BY 4.0.

Social and Ethical > Fishers wellbeing > Age Structure > Proportion of fishers in standard age cohorts

Proportion of fishers in standard age cohorts that were involved in the fishery at any point in the previous 5 years. If the fishery is not attractive or difficult to enter, the age distribution will be skewed to older ages. **Data Quality:** Not released

Social and Ethical > Wider community > Community satisfaction with fishery > Community feedback

Evidence of processes in place to gather direct engagement with the community (diversely represented) to listen and respond to feedback. This may be through a range of means including formal and informal processes and may not be appropriate to all fisheries in the same way. In some cases Marine Stewardship Council accreditation may demonstrate some evidence of community engagement.

Community feedback: Medium.

There is a crab management advisory committee, which could oversee a feedback process. Based on general FRDC community perception surveys, satisfaction with Australian fisheries is rated at 42%.

Data quality: Bronze.

Social and Ethical > Wider Community > Level of local employment > Percentage of local employment

The communities surrounding and supporting fisheries benefit from those fisheries when the majority of employees (direct and indirect) associated with the fishery activity are local. Can be reported as direct, indirect and downstream levels.

Indicator	Year	Amount	Reference	Note
Estimated employment	2016	81 people	Mobsby, D & Koduah, A (2017) Australian fisheries and aquaculture statistics 2016, Fisheries Research and Development Corporation project 2017-095. ABARES, Canberra, December. CC BY 4.0.	Rock lobster and crab potting for QLD

Data Quality: Silver

Social and Ethical > Ethical - Human welfare > Protections in place > Legislation exists

Although all workers are automatically operating under legislation according to their state or territory to a safe work place, the extent to which there is awareness of the relevant Acts, and use of these if required, is highly variable and may be different for each business or individual operation within each fishery. See http://workplaceohs.com.au/legislation for a list of state acts and regulations.

Protections in Place: Low

The Blue Swimmer Crab fishery operates under Queensland (Workplace Health and Safety Queensland) – WHS Act 2011 and WHS Regulation 2011.

Data Quality: Silver

Social and Ethical > Ethical > Human welfare > Levels of compliance

Levels of compliance (or violations of) with Workplace Health and Safety. If references to Workplace Health and Safety exist in relation to the specific fishery, determine whether these are voluntary or recorded in anyway. If they are recorded, note the level of compliance. As they are likely to be voluntary, there will not likely be a record of compliance, but this may become more readily available in the future. **Data Quality:** Not found

Social and Ethical > Ethical-animal welfare > Animal welfare protections > Protections in place

At this early stage of development of animal welfare, any type of mention of animal welfare exists, it is probably the most appropriate. As this develops in to the future, assessments as to the level of engagement may become more relevant. **Data Quality:** Not found.

Social and Ethical > Ethical-animal welfare > Level of Compliance > Levels of compliance or violations of animal welfare

If there are any references to animal welfare protections or guidelines in fishery management plans and if reports exist, the indicator reports on the level of compliance or violations with welfare provisions.

Data Quality: Not found.

Social and Ethical > Climate-related > Access to information > Availability of information

This indicator describes available information that will help participants in the fishery adapt to changes. The assumption behind this indicator is that good information availability and flow will help fishers to adapt.

Data Quality: Not found.

Social and Ethical > Climate-related > Access to networks > Level of membership of industry association

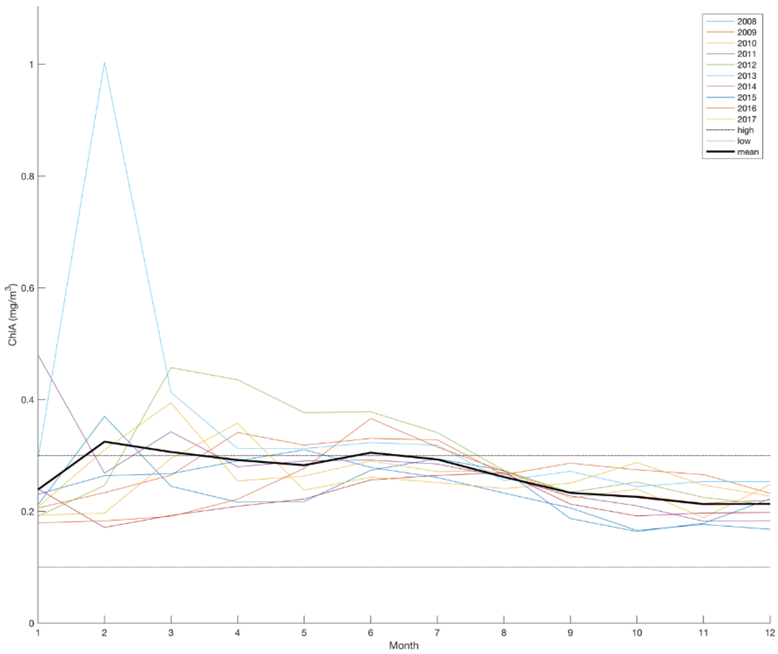
This metric assesses the presence or absence of a dedicated social media or social network group for the fishery. The fishery may still have a strong social network without a social media presence.

Data Quality: Not found.

External > Environmental Context > Productivity > Mean chlorophyll

A measure of environmental productivity is the biomass of phytoplankton, which in oceanic waters can be approximated by chlorophyll a concentration, as estimated from satellite (MODIS,

oceandata.sci.gsfc.nasa.gov). Monthly chlorophyll values for a representative area of the fishery are shown with the mean productivity shown in solid black and references levels of low chlorophyll at 0.1 mg m^{-3}and high chlorophyll levels at 0.3 mg m^{-3}. This indicator shows the mean chlorophyll by month for the years 2008-2017. These data provide information on the relative environmental productivity in the fishery area. Missing data for some months can be due to ice cover. Variability in chlorophyll a concentration between years can indicate high environmental variability, while similar seasonal patterns indicate relative environmental stability.



Data Quality: Gold

External > Environmental Context > Environmental character > Description of the ecosystems

This metric provides a qualitative description of the ecosystem(s) in which the fishery occurs. The goal is to provide a general overview of these environments. The knowledge about which ecosystems are encountered during fishing activity is the indicator (rather than the response of the ecosystems to fishing).

Marine ecosystems are defined for the purposes of this indicator as the composition of plants, animals, and the marine environment (water masses, geomorphology). Types of marine ecosystems include estuaries, the sea floor, the mesopelagic zone, the pelagic zone, the inter-tidal zones, coral reefs, lagoons, and mangroves. A pelagic zone ecosystem for example, is defined by physical, chemical and biological features of the marine water column of the open ocean[242].

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[242] Game, E. T., H. S. Grantham, A. J. Hobday, R. L. Pressey, A. T. Lombard, L. E. Beckley, K. Gjerde, R. H. Bustamante, H. P. Possingham and A. J. Richardson (2009). Pelagic protected areas: the missing dimension in ocean conservation. Trends in Ecology and Evolution **24**(7): 360-369 doi:310.1016/j.tree.2009.1001.1011.

Description of the ecosystems: Medium

The fishery occurs in a wide range of ecosystems from Moreton Bay in the south, to the Gulf of Carpentaria in northwest Queensland. Additional spatial data available at QFish[243]

Data Quality: Gold

External > Climate related > Susceptibility of target species > Impacts on target species

Climate change directly affects the distribution, abundance and phenology of individual species. These changes then affect the fisheries that harvest these species, and can be a strong external influence on the fishery. These impacts can be positive (e.g. increased abundance), or negative (e.g. movements further from fishing ports), and to long-term warming, or short-term extreme events such as marine heatwaves.

Sensitivity of the target species to climate change has been assessed[244]. Species in this fishery have a sensitivity of low.

Common name	Species	Fishery	Score	Sensitivity
Blue swimmer crab	Portunus armatus	Blue Swimmer Crab Fishery	5	LOW

Data Quality: Silver

External > Climate related > Susceptibility of key habitats > Habitat Impacts

Habitat impact: Moderate

Changes in rainfall and the impact of extreme events (e.g. cyclones) may affect inshore recruitment habitats.

Data Quality: Bronze

External > Contaminants in the environment > Detection system for seafood contaminants > Risk of contaminants

Potential risk for contamination from the marine environment combined with monitoring arrangements to be able to address risks needed to ensure food safety. Contaminants include those with maximum levels set for by Food Standards Code Australia: metal contaminants, non-metal contaminants, natural toxicants, and average and maximum levels of mercury in fish. Contaminants from poor handling after landing are not assessed but may be indirectly addressed.

Rubric for risk level:

Low risk	Medium risk	High risk

[243] http://qfish.fisheries.qld.gov.au/

[244] Fulton EA, Hobday AJ, Pethybridge H, Blanchard J, Bulman C, Butler I, Cheung W, Gorton B, Hutton T, Lozano- Montes H, Matear R, Pecl G, Villanueva C, Zhang X (2018). *Decadal scale projection of changes in Australian fisheries stocks under climate change.* CSIRO Report to FRDC. FRDC Project No: 2016/139 – ONLINE.

There are no documented levels of contaminants from the marine environment causing risk/diet restrictions to any consumer group in the fishery.	There may be seasonal/area/species/size-based risks of contaminants for some species.	Permanent diet restrictions of species caught to vulnerable consumers such as children or pregnant women.

Risk of Contaminants: Low

No specific monitoring arrangements found for marine contaminants on the fishery webpage: https://www.daf.qld.gov.au/business-priorities/fisheries/monitoring-our-fisheries/commercial-fisheries/data-reports/sustainability-reporting/queensland-fisheries-summary/blue-swimmer-crab, but targeted species have low potential risk for contamination from the marine environment.

Data Quality: Silver

External > Contaminants in the environment > Management arrangements to ensure food safety related to contaminants > Evidence for arrangements

There is evidence of management arrangements to ensure food safety related to contaminants and food safety from the marine environment. No supply chain risks from poor handling are considered. Food standard 4.2.1 requires all seafood business in Australia to identify potential seafood safety hazards and put controls in place that are consistent with the risk.

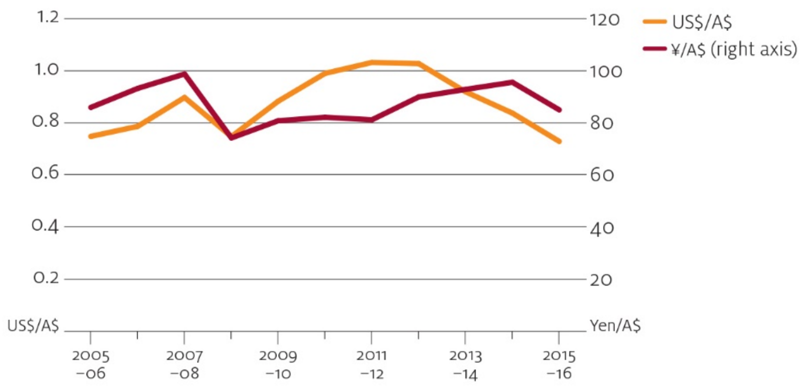
Data Quality	
GOLD	
SILVER	Follows national standards but fisheries-specific arrangements not found. https://www.business.qld.gov.au/industries/farms-fishing-forestry/agriculture/land-management/chemical-controls/using-chemicals/residue-limits
BRONZE	

External > Market Drivers > Macroeconomic factors > Exchange Rates

A depreciating Australian dollar (or, increasing exchange rate) generally results in producers receiving a higher export price in Australian dollar terms, while an appreciating Australian dollar (or, decreasing exchange rate) results in a lower export price. Domestically, a depreciation of the Australian dollar encourages substitution from imported seafood to domestically produced seafood, as imported products become relatively more expensive. A lower exchange rate also makes Australian exports more competitive in world markets, as exported seafood become relatively cheaper in foreign currency terms.

National export trends are negatively related to exchange rate movements— the Australian dollar declined against the US dollar and Japanese yen from 1990–91 to 2000–01, with exports increasing in volume and value. Exchange rates for the Australian dollar increased against those currencies from 2001–02 to 2015–16. The real export value and volume of Australia's seafood exports decreased

between 2005–06 and 2012–13 and then increased between 2012–13 and 2015–16—with a noticeable rise (43 per cent) in volume between 2014–15 and 2015–16.[245]



Data Quality: Gold

External > Market Drivers > Consumer Trends > Per person annual apparent consumption of seafood (kg)

Annual apparent consumption is estimated by adding the total edible quantity of seafood supplied domestically—that is, total production plus imported seafood— less exports of seafood. Apparent consumption provides an estimate of the total amount of seafood consumed in Australia assuming zero change in stocks.

The production quantity of Australian fishery and aquaculture products is reported by ABARES on a whole weight basis, whereas trade data are reported on a processed basis. To align the units of measurement between production and trade data, it is necessary to convert production volume to a processed edible equivalent.

Production volumes are adjusted to an edible quantity basis using species-specific conversion rates and excluding species that are known to be predominantly supplied for non-human consumption purposes, such as for aquaculture feed or bait. Imports and exports of seafood are sourced from Australian Bureau of Statistics (ABS) trade data and are reported as edible weight. The apparent consumption per person is calculated as the total apparent consumption divided by the total Australian population in each year. The method applied here is consistent with that used by ABARES to estimate apparent consumption of other agricultural commodities produced in Australia.

The FAO also compiles statistics on apparent consumption of seafood, applying a consistent method across all countries. FAO estimates indicate that annual consumption of seafood in Australia is around 26 kilograms per person in 2013 (FAO 2016[246]). The discrepancy between FAO and ABARES estimates reflects differences in methodological approaches to estimating consumption. Moreover, ABARES estimates seafood consumption on a processed edible basis, whereas the FAO provides its estimates on a whole weight basis.

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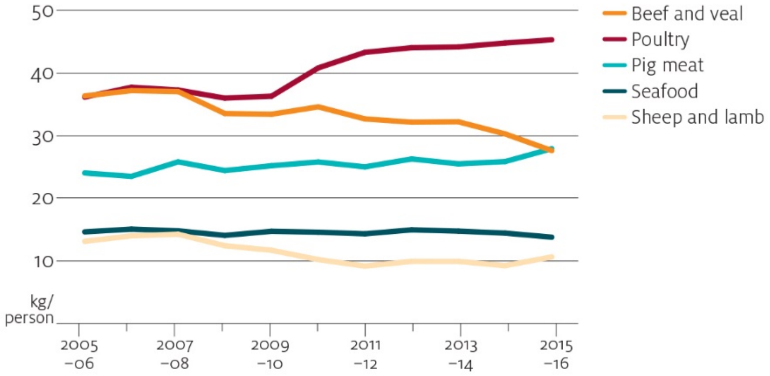
[245] Mobsby, D and Koduah, A 2017, Australian fisheries and aquaculture statistics 2016, FRDC project 2017-095. ABARES, Canberra, December. CC BY 4.0.

[246] The state of world fisheries and aquaculture 2016—opportunities and challenges, Food and Agriculture Organization of the United Nations, Rome.

In Australia, apparent consumption of seafood per person (edible equivalent) decreased, on average, at an annual rate of 0.6 per cent, from 14.6 kilograms in 2005– 06 to 13.8 kilograms per person in 2015–16. Annual apparent consumption is estimated by the Australian Bureau of Agricultural and Resource Economics and Sciences by adding the total edible quantity of seafood supplied domestically—that is, total production plus imported seafood— less exports of seafood[247]

In comparison, global per capita apparent fish consumption increased from an average of 9.9 kg in the 1960s to 14.4 kg in the 1990s and 20.1 kg in 2014, with preliminary estimates for 2015 indicating further growth, exceeding 20 kg (FAO 2016). Australia's per person seafood consumption in 2013 was estimated by the FAO to be 26kg. The differences in estimates are accounted for by varying methods for calculating consumption. ABARES estimates seafood consumption on a processed edible basis, whereas the FAO provides its estimates on a whole weight basis.



Data quality: Gold

[247] Mobsby, D and Koduah, A 2017, *Australian fisheries and aquaculture statistics 2016*, FRDC 2017-095. ABARES, Canberra, December. CC BY 4.0

South Australia Spencer Gulf Prawn Fishery

South Australia's Spencer Gulf Prawn Fishery is the largest of three commercial prawn fisheries occur within the state in terms of production and number of licence holders. It is a single-species prawn fishery, based on the capture of the King Prawn (*Melicertus latisulcatus*). Fishing is permitted in all waters greater than 10 m in depth within the Gulf, which is divided into 125 prawn fishing blocks. There are currently 39 commercial fishery licences issued for the SGPF. Any boat used in the SGPF must be registered must not have an overall length exceeding 22 m. Commercial fishing is undertaken using the demersal otter trawl technique. Trawling is undertaken during the night between sunset and sunrise, and generally between the last quarter of the moon – through the phase of the new moon to the first quarter. Major home ports for Spencer Gulf boats are Port Lincoln and Wallaroo, with minor activity at Port Adelaide and Port Pirie. This is the first prawn fishery in Australia to gain certification by the Marine Stewardship Council (MSC).

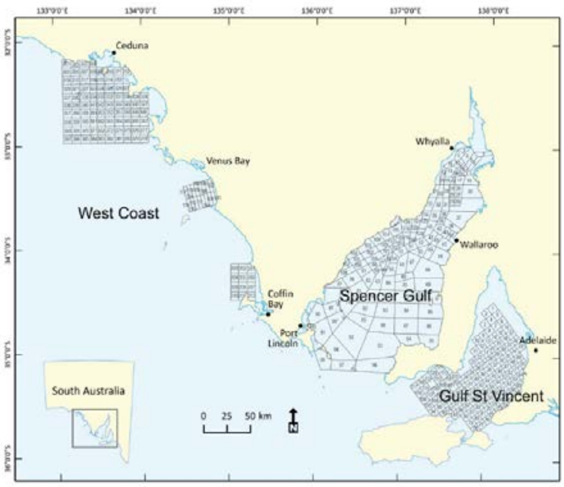
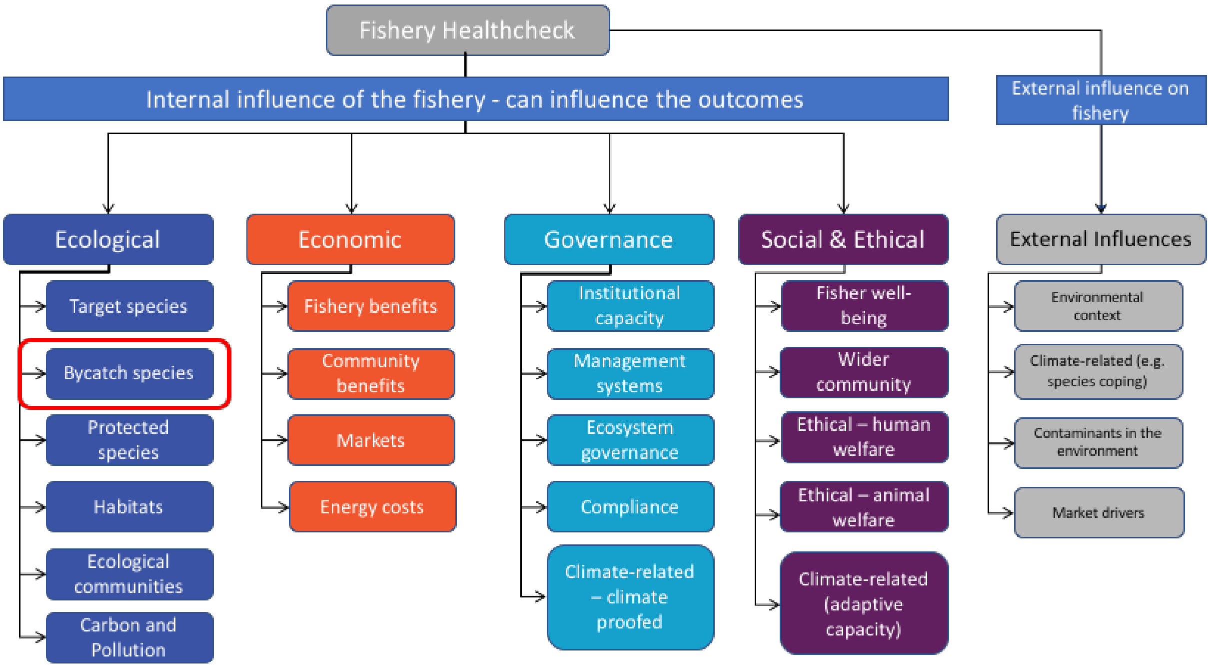


Figure 1: Map of fishing blocks in the three commercial prawn fisheries of South Australia.

Case Study Presentation Format

The case study documents are a collection of metrics, organised by the healthcheck structure:



The presentation of metrics will follow the following heading format:

Ecological > Bycatch species > Bycatch composition > Mean Trophic Level

Understand this to be an indicator (**Bycatch composition**) of the **Ecological** Component, **Bycatch species** subcomponent where the (in the figure and heading example above, is being measured by presenting Mean Trophic Level as the metric.

Ecological > Target species > Stock Status > Status of Australian Fish Stocks (SAFS)

Target species in each fishery are the primary focus for this indicator. Status of these species is ideally assessed with the SAFS approach, however this may not cover all target species for each fishery. In that case, we indicate the number of unassessed species. These species could also be assessed by individual states or by alternative methods.

SpeciesName	StockName	StockStatus	Year
Western King Prawn	Spencer Gulf Prawn Fishery	Sustainable	2016

Data Quality: Gold

Ecological > Target Species > Harvest Level > Catch weight

This metric is a proxy for harvest level. The harvested biomass for each species, provides information on the level of the catch. Trends in this metric over time can indicate declining availability of fish, quota restrictions, or changes in market demand. For Australian fisheries, trends are expected to be stable for most species.

The data are available from the Econsearch report[248].

Table 3-2 Catch and value of catch of the Spencer Gulf Prawn Fishery, 2001/02 to 2015/16

	Catch (tonnes)	Value of catch	
		Nominal ($'000)	Real (2015/16) ($'000)
2001/02	2,182	39,873	56,623
2002/03	1,479	27,681	37,859
2003/04	1,943	40,171	53,379
2004/05	1,939	31,759	41,283
2005/06	1,870	33,610	42,110
2006/07	2,024	39,386	48,499
2007/08	2,028	32,163	37,870
2008/09	1,821	29,549	34,267
2009/10	2,361	27,450	30,964
2010/11	1,979	30,335	32,940
2011/12	1,675	24,460	26,242
2012/13	1,699	27,361	28,752
2013/14	1,675	27,694	28,219
2014/15	1,664	28,663	28,851
2015/16	2,180	38,452	38,452

Source: SARDI Aquatic Sciences

Data quality: Gold

Ecological > Bycatch species > Bycatch composition > Mean Trophic Level

The trophic level is a measure of the position of an organism in a food web, starting at level 1 with primary producers, such as phytoplankton, then moving through the primary consumers at level **2** that eat the primary producers to the secondary consumers at level **3** that eat the primary consumers, and so on. The **bycatch mean trophic level** is an indicator of the mean level of the food chain for bycatch in a fishery. **Data Quality:** Not organised/analysed.

Ecological > Bycatch species > Bycatch amount > Total weight of bycatch

248 http://www.econsearch.com.au/media/Documents/Fishing/201516_Economic_Indicator_Reports/SG_Prawn_Final_170913.pdf

Bycatch weights for fishery are typically developed by specific projects, and require a range of assumptions due to issues with reporting and retention of bycatch. **Bycatch** estimates typically cover species that are not target species, while **discard** rates may also include undersized individuals of the target species. Kennelly (2018) provides estimates of discard rates, which include both target and bycatch species, and when discard rates are used, that information is noted for each fishery. Animals can be returned to the ocean alive or dead. The intention of this metric is to provide information on animals that are dead on return to the ocean.

Reference:

Kennelly, S.J., 2018. *Developing a National Bycatch Reporting System.* Final FRDC Report, ISBN 978-0-9924930-5-9, March, 2018. 99 pp.

These data are available for the fishery, but the project team has not compiled data. A continuation of Kennelly (2018) is underway and will provide these data shortly.

Data Quality: Not organised/analysed

Ecological > Protected species > Capture amount > Captures

The number and diversity of TEP species captured by a fishery in the most recent year, provided as annual numbers.

The ERA report for the fishery is based on a bycatch survey conducted in 2007 with the report published in 2009. A further by-catch survey was completed in February 2013, however, the results were not located by the project team.

Data quality: Not found

Ecological > Protected species > Reporting > Level of monitoring

This indicator is to provide information on the level of coverage for a fishery. Annual measures are preferred.

All commercial fishery are required to report in wildlife interactions logbooks for interactions with TEPS. Interaction rates for TEPS from wildlife interaction logbooks and SASs monitored annually.[249]

Data quality: Bronze

Ecological > Habitats > Habitat impact > Impact score

The habitat impact is an indicator of the effect the fishing gear has on the habitat. Different gear types have different impacts. See the scoring rubric.

Habitat Impact: Moderate

Impacts are seen in the fished areas, not the whole gulf as the fished areas are small compared to whole gulf. A risk assessment [250] showed a moderate risk ranking for habitat impacts (Consequence: 2, Likelihood: 6, Risk rating: 12 (Moderate).

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[249] http://www.pir.sa.gov.au/__data/assets/pdf_file/0003/57954/Prawn-Spencer_Gulf-Fishery-Management_Plan.pdf

[250] http://pir.sa.gov.au/__data/assets/pdf_file/0007/232477/FINAL_ESD_risk_assessment_of_South_Australias_SGPF_July_2014.pdf

Data quality: Silver

Ecological > Habitats > Habitat impact > Habitat status

The status of the habitat types is a measure of the condition relative to a pristine state. Fishing may not be responsible for that habitat status, but it is important to note if fishing is taking place in pristine or disturbed habitats.

Habitat status: Moderate

The highest impacts of bottom trawling have been on benthic communities in the Spencer Gulf in South Australia (Evans et al. 2016, p79). New marinas are being constructed which results in the physical destruction of habitat, and there are concerns for critical juvenile habitats in northern gulfs where much of the coastal/industrial development is taking place. An ESD assessment[251] noted a moderate risk ranking with regard to habitat status.

Data quality: Silver

Ecological > Ecological communities > Ecosystem status > Ecosystem status

This metric reports the ecosystem status in the region of the fishery.

Ecosystem Status: Moderate

Trawling occurs over large areas of the Spencer Gulf, and the modification to coastal environments is significant around towns.

Data Quality: Bronze

Ecological > Ecological communities > Ecosystem status > Species diversity

The measure of species diversity as a ratio between fished and unfished states.

Data quality: Not organised/analysed

Ecological > Carbon and Pollution > Macro-plastics > Plastic code of conduct

Macro-plastics are plastics that are visible to the naked eye, such as food containers and wrapping, equipment packaging, and fishing equipment. The metric notes a commitment to a zero waste overboard code of conduct to assess attempts to reduce accidental or intentional introduction of macro-plastics to the ocean. There are stated guidelines detailing Australia's guidelines regarding marine pollution from the Australian Maritime Safety Authority[252]:

Pollution of the marine environment by ships, including fishing vessels, is strictly controlled by the International Convention for the Prevention of Pollution from Ships (known as MARPOL).

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[251] http://pir.sa.gov.au/__data/assets/pdf_file/0007/232477/FINAL_ESD_risk_assessment_of_South_Australias_SGPF_July_2014.pdf

[252] https://www.amsa.gov.au/marine-environment/marine-pollution/pollution-fishing-vessels
https://www.amsa.gov.au/marine-environment/marine-pollution/marpol-and-its-implementation-australia

To minimise pollution, MARPOL prohibits ships from discharging garbage into the sea except in very limited circumstances.

Australian MARPOL regulations apply to Australian fishing vessels wherever they are operating.

Data Quality: Bronze

Ecological > Carbon and Pollution > Carbon footprint > CO_2-equivalents

The emissions of climate forcing gases in kg CO_2-equivalents (CO_2e) per kg live weight fish caught, not including the supply chain after landing.

Data Quality	Gear	Target species	Min (kg CO_2e/kg)	Average (kg CO_2e/kg)	Max (kg CO_2e/kg)	Reference	Description
Gold							
Silver	Bottom trawl	King prawn		4.3		PIRSA 2017	Spencer Gulf Prawn (SA), 2014/15, diesel, refrigerants not included.
Bronze	Bottom trawl	Crustaceans	3.2	11.2	29.6	Parker and Tyedmers 2015	Oceania region, year not specified, assume diesel, no refrigerants included.

Economic > Fishery Benefits > Net Economic Returns > Economic Rent

Net Economic Returns (NER) is equal to fishing revenue less fishing costs and measures the economic profit that is derived from fishing activity, it is measured by the Commonwealth as Net Economic Returns and by some States as Economic Rent.

Data Quality	**Indicator**	**Year**	**Amount**	**Reference**	**Note**
Silver	Economic rent	2015-2016	$1,566,000	EconSearch (2017) Economic Indicators for the Spencer Gulf Prawn Fishery 2015/16. A report to PIRSA Fisheries and Aquaculture, September 2017 Appendix Table 4-2	Adjusted for sample bias. Values are in nominal terms
Silver	Economic rent	2014-2015	$4,016,000	EconSearch (2017) Economic Indicators for the Spencer Gulf Prawn Fishery 2015/16. A report to PIRSA Fisheries and Aquaculture, September	Adjusted for sample bias. Values are in nominal terms

				2017 Appendix Table 4-2	
Silver	Economic rent	2013-2014	$1,422,000	EconSearch (2017) Economic Indicators for the Spencer Gulf Prawn Fishery 2015/16. A report to PIRSA Fisheries and Aquaculture, September 2017 Appendix Table 4-2	Adjusted for sample bias. Values are in nominal terms
Silver	Economic rent	2012-2013	$595,000	EconSearch (2017) Economic Indicators for the Spencer Gulf Prawn Fishery 2015/16. A report to PIRSA Fisheries and Aquaculture, September 2017 Appendix Table 4-2	Adjusted for sample bias. Values are in nominal terms
Silver	Economic rent	2011-2012	-$9,313,000	EconSearch (2017) Economic Indicators for the Spencer Gulf Prawn Fishery 2015/16. A report to PIRSA Fisheries and Aquaculture, September 2017 Appendix Table 4-2	Adjusted for sample bias. Values are in nominal terms
Silver	Economic rent	2010-2011	-$6,151,000	EconSearch (2017) Economic Indicators for the Spencer Gulf Prawn Fishery 2015/16. A report to PIRSA Fisheries and Aquaculture, September 2017 Appendix Table 4-2	Adjusted for sample bias. Values are in nominal terms
Silver	Economic rent	2009-2010	-$7,325,000	EconSearch (2017) Economic Indicators for the Spencer Gulf Prawn Fishery 2015/16. A report to PIRSA Fisheries and Aquaculture, September 2017 Appendix Table 4-2	Adjusted for sample bias. Values are in nominal terms
Silver	Economic rent	2008-2009	-$5,469,000	EconSearch (2017) Economic Indicators for the Spencer Gulf Prawn Fishery 2015/16. A report to PIRSA Fisheries and Aquaculture, September 2017 Appendix Table 4-2	Adjusted for sample bias. Values are in nominal terms

Economic > Fishery Benefits > Gross Value of Production > Gross Value of Production

GVP calculated as the volume of catch multiplied by the average per unit beach price (AUD$).

Data Quality	Species/Fishery	Year	Amount	Reference	Note/Comment
Gold	Spencer Gulf Prawn	2013-2014	$28 million	EconSearch (2016) Economic Indicators for the Spencer Gulf Prawn Fishery 2014/15 report prepared for Primary Industries and Regions South Australia Fisheries and Aquaculture, August	
Gold	Spencer Gulf Prawn	2012-2013	$28 million	EconSearch (2016) Economic Indicators for the Spencer Gulf Prawn Fishery 2014/15 report prepared for Primary Industries and Regions South Australia Fisheries and Aquaculture, August	
Gold	Spencer Gulf Prawn	2011-2012	$26 million	EconSearch (2016) Economic Indicators for the Spencer Gulf Prawn Fishery 2014/15 report prepared for Primary Industries and Regions South Australia Fisheries and Aquaculture, August	
Gold	Spencer Gulf Prawn	2010-2011	$32 million	EconSearch (2016) Economic Indicators for the Spencer Gulf Prawn Fishery 2014/15 report prepared for Primary Industries and Regions South Australia Fisheries and Aquaculture, August	
Gold	Spencer Gulf Prawn	2009-2010	$30 million	EconSearch (2016) Economic Indicators for the Spencer Gulf Prawn Fishery 2014/15 report prepared for Primary Industries and Regions South Australia Fisheries and Aquaculture, August	
Gold	Spencer Gulf Prawn	2008-2009	$34 million	EconSearch (2016) Economic Indicators for the Spencer Gulf Prawn Fishery 2014/15 report prepared	

				for Primary Industries and Regions South Australia Fisheries and Aquaculture, August	
Gold	Spencer Gulf Prawn	2007-2008	$37 million	EconSearch (2016) Economic Indicators for the Spencer Gulf Prawn Fishery 2014/15 report prepared for Primary Industries and Regions South Australia Fisheries and Aquaculture, August	

Economic > Fishery Benefits > Profitability > Financial Performance

Economic health of a fishery can be measured by the financial performance of the operators in the fleet. Fleet wide averages or distributions of levels of profitability indicate the extent to which the fishery is generating economic benefits for fishers.

Data Quality	**Indicator used**	**Year**	**Amount**	**Reference**	**Note**
Gold	Boat gross margin	2015-2016	$374,538	EconSearch (2017) Economic Indicators for the Spencer Gulf Prawn Fishery 2015/16. A report to PIRSA Fisheries and Aquaculture, September	average per licence
Gold	Boat gross margin	2014-2015	$372,689	EconSearch (2017) Economic Indicators for the Spencer Gulf Prawn Fishery 2015/16. A report to PIRSA Fisheries and Aquaculture, September	average per licence
Gold	Boat gross margin	2013-2014	$332,711	EconSearch (2017) Economic Indicators for the Spencer Gulf Prawn Fishery 2015/16. A report to PIRSA Fisheries and Aquaculture, September	average per licence
Gold	Boat gross margin	2012-2011	$326,858	EconSearch (2017) Economic Indicators for the Spencer Gulf Prawn Fishery 2015/16. A report to PIRSA Fisheries and Aquaculture, September	average per boat
Gold	Boat gross margin	2011-2010	$180,536	EconSearch (2017) Economic Indicators for the Spencer Gulf Prawn Fishery 2015/16. A report	average per boat

				to PIRSA Fisheries and Aquaculture, September	
Gold	Boat gross margin	2010-2011	$278,314	EconSearch (2017) Economic Indicators for the Spencer Gulf Prawn Fishery 2015/16. A report to PIRSA Fisheries and Aquaculture, September	average per boat
Gold	Boat gross margin	2009-2010	$241,641	EconSearch (2017) Economic Indicators for the Spencer Gulf Prawn Fishery 2015/16. A report to PIRSA Fisheries and Aquaculture, September	average per boat
Gold	Boat gross margin	2008-2009	$276,022	EconSearch (2017) Economic Indicators for the Spencer Gulf Prawn Fishery 2015/16. A report to PIRSA Fisheries and Aquaculture, September	average per boat

Economic > Fishery Benefits > Latency > Underutilised Effort

Latency is fishery concessions that are not being fully utilised by fishers, for example, often the annual total allowable catch is left partially or largely uncaught for a fishery. Latency may appear as effort or uncaught TAC or inactive licences.

Data Quality: Not found

Economic > Community benefits > Value to community > GDP or GSP value

A fisheries contribution to Gross Domestic Production (GDP)/Gross State Product (GSP) is the total economic value that it generates directly, plus the indirect contribution made to other industries, which is also measured in value-add terms.

Data Quality	Indicator used	Year	Amount	Reference	Note
Gold	GSP	2015-2016	$27,200,000	EconSearch (2017) Economic Indicators for the Spencer Gulf Prawn Fishery 2015/16. A report to PIRSA Fisheries and Aquaculture, September	Generated by fishing direct
Gold	GSP	2014-2015	$19,000,000	EconSearch (2017) Economic Indicators for the Spencer Gulf Prawn Fishery 2015/16. A report	Generated by fishing direct

				to PIRSA Fisheries and Aquaculture, September	

Economic > Community benefits > Wealth Spread > Distribution of fishing firm size

The spread of profits to owners and crew members indicates how widely benefits of fishing are distributed across the fishing community. A wide spread of benefits may be important to some fishery stakeholders. A narrow spread may not indicate a lack of distribution of benefits in the case where all participating businesses are the same size, or if other mechanisms are present to capture and distribute benefits such as high levels of employment of crew. The number of large business versus small business, classified by turnover (direct measure) or catch volume (proxy) may provide an indirect indicator: i.e. are economic returns from commercial fishing gained by one or two large businesses or a spread over many smaller businesses? **Data Quality:** Not released

Economic > Markets > Fish distribution > Fish receivers

One way of measuring benefits from a fishery is by assessing the flow of seafood through the supply chain. In many fishery jurisdictions, the first step in the supply chain is via licensed fish receivers who are allowed to receive fish for sale. They can also trade fish with other receivers. In some jurisdictions, commercial fishers must sell their catch to a receiver (although they can sell small amounts on wharves). While this restricts fishers' options for landing their catch, it means that fish can be tracked, reduces illegal fish trading and ensures that the Quota Management Systems (QMS) work effectively by ensuring catches do not exceed the total allowable catch or quota amounts for individual species. Receivers of fish may be fish processors, wholesalers or retailers.

In some jurisdictions, the fishers and fish receivers are integrated, such that they are effectively the same “business”. In Commonwealth fisheries, the total number of fish receivers per year may differ to the sum of the fish receivers per fishery because some receivers operate in more than one fishery.

Data were not available, but may exist.

South Australia divides its fish processing into 3 categories:

Selling straight from the boat for immediate consumption
Selling to restaurants and clubs (no on-selling other than as part of a meal) - a restricted fish processor
Selling to a processor who can then process and sell to retail - a full fish processor.
Fish processors are managed pursuant to the South Australian Fisheries Management (Fish Processor) Regulations.

SA also collects economic data as a part of its administration of the FMA. Reports on this fishery are at: http://www.econsearch.com.au/pages/completed-projects/fishing-aquaculture/fish10.php

Data Quality: Not released

Economic > Markets > Volatility in market price > Price volatility

Price volatility is the mean beach price for the target species (top one or five depending on price) over the given period (most recent ten years). The level of volatility is the standard deviation in mean price over this period.

Data Quality	**Species/Fishery**	**Year/Time period**	**Amount**	**Reference**	**Note**
Silver		2006-07 to 2015-16	$5.81/kg	EconSearch (2017) Economic Indicators for the Spencer Gulf Prawn Fishery 2015/16. A report to PIRSA Fisheries and Aquaculture, September	

Economics > Energy costs > Energy Use > Fuel use per kg of fish harvested

Fuel use varies over time and between stocks and are best collected from industry on a yearly basis. Estimates for different fisheries should be compared with caution, and in particular comparing energy use between fisheries with different data quality which is not recommended (different data availability, may be e.g. old or not fisheries-specific). Estimates are provided for all levels of data quality if available and are given in L per kg live-weight.

Data Quality	Gear	Target species	Min (L/kg)	Average (L/kg)	Max (L/kg)	Reference	Description
Gold	Bottom trawl	King prawn		1.6		PIRSA 2017	2014/15, average per boat
Silver	Bottom trawl	King prawn		2.1		Parker et al 2015	Spencer Gulf prawn, average 2006-2009
Bronze	Bottom trawl	Crustaceans	1.2	4.1	10.9	Parker and Tyedmers 2015	Oceania region

Economic > Energy costs > Fossil fuel subsidies > Fuel subsidies directed to the fishery

Fossil fuel subsidies (fuel rebates) illustrate to which extent the fuel cost is reduced in the fishery, measured in AUD/kg live weight fish. Note that this form of tax exemption for fisheries is in Australia motivated from the sector not using roads (i.e. costs embedded in fuel price for road construction and maintenance), and are not formally reported as fuel subsidies in Australia.

Data Quality	Gear	Target species	Subsidy (AUD/kg)	Reference	Description
Gold	Bottom trawl	King prawn	0.63	PIRSA 2017	Fuel use from 2014/15, average per boat
Silver	Bottom trawl	King prawn	0.84	Parker et al 2015	Fuel use from Spencer Gulf prawn, average 2006-2009
Bronze	All SA	All SA	0.10	Total tax claims per total landings in SA	2015-16 (2016-17 also available), state level figures on landings are preliminary for 2015-16

Governance > Ecosystem governance > Bycatch mitigation > Description of the bycatch mitigation measures

Bycatch measures can be spatial (e.g. area closure), temporal (time closure, e.g. night setting only) or technical (bycatch reduction devices, hook size). This indicator describes the measures that are in place for a fishery – but not the rates of compliance. For example, spatial closures for different gear types are shown here for AFMA fisheries http://www.afma.gov.au/sustainability-environment/fishing-closures/.

All vessels in Spencer Gulf are fitted with a grid and 'hopper', into which the contents of the cod ends are spilt. The grid separates out the megafauna, which is immediately returned to the water to maximise species' survival. The hopper is flooded with water to increase the survival of by-catch. The contents of the hopper trickle onto a conveyer-belt system where the retained catch is sorted from the by-catch and discarded by-catch is returned directly to the water.[253]

Data Quality: Gold

Governance > Ecosystem governance > Protected species mitigation > Description of the protected species mitigation measures

TEP mitigation measures can be spatial (e.g. area closure), temporal (time closure, e.g. night setting only) or technical (bycatch reduction devices, hook size). This indicator describes the measures that are in place for a fishery – but not the rates of compliance.

TEPS Mitigation measures undertaken by the fishery include closed areas e.g. waters < 10m depth and management measures to avoid TEPS are developed.[254]

Data Quality: Silver

Governance > Management system > Harvest strategy > Scope of the harvest strategy

Assessment can be based on scoring presence of the following: a harvest strategy designed to achieve management objectives; harvest control rules and tools; collection of relevant information to support the harvest strategy; and, assessment of stock status or the presence of the following key elements: Defined operational objectives for the fishery; Indicators of fishery performance related to the objectives; Reference points for performance indicators; A statement defining acceptable levels of risk to meeting objectives; A monitoring strategy to collect relevant data to assess fishery performance; A process for conducting assessment of fishery performance relative to objectives; and; Decision rules that control the intensity of fishing activity and/or catch.

This Harvest Strategy provides a structured framework for decision making that specifies pre-determined management actions necessary for the Spencer Gulf Prawn Fishery (SGPF) to achieve the ecologically sustainable development (ESD) objectives of the Fisheries Management Act. Consistent with national guidelines (Sloan et al. 2014), this Harvest Strategy brings together all of the key scientific monitoring, assessment and management elements to form an integrated package to make decisions about the level of fishing intensity that should be applied to the King Prawn stock in

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[253] http://www.pir.sa.gov.au/__data/assets/pdf_file/0003/57954/Prawn-Spencer_Gulf-Fishery-Management_Plan.pdf
[254] http://www.pir.sa.gov.au/__data/assets/pdf_file/0003/57954/Prawn-Spencer_Gulf-Fishery-Management_Plan.pdf

Spencer Gulf. Monitoring of the fishery is achieved through three fishery independent stock assessment surveys (SASs) as well as industry at-sea monitoring of fishing catch and effort through a co-management arrangement with the Spencer Gulf and West Coast Prawn Fishermen's Association (SGWCPFA). The fishery is assessed against the sustainability and economic aims described in this Harvest Strategy. Consistent with the Fisheries Management Act, the principle of ecological sustainability has priority over the other principles of ESD; hence the sustainability aim is the primary assessment focus for the Harvest Strategy. Assessment outcomes lead to an annual stock status being determined for the fishery, which is reported in the annual stock assessment report. Biological performance indicators (PIs) provide information about the biological state of the fishery. A performance indicator (PI) can be measured and monitored to assess if an objective is being met. Reference levels are established for PIs as a reference against which performance of the indicator can be assessed. A reference level establishes a benchmark for sustainable fishery performance. PIs can be a direct measure of performance (e.g., total biomass of a stock) or a proxy considered an appropriate indicator of a direct measure (e.g., catch rates for indicating relative biomass). The management plan applies from 23 October 2014 for a period of five years. [255]

Data quality: Gold

Governance > Management system > Management plans > Scope of management plan

Management plans can be assessed by evaluating the presence of minimum requirements, as follows: a description of the fishery, especially its current status and any established user rights: the management objectives; how these objectives are to be achieved; how the plan is to be reviewed and/or appealed, as well as the consultation process for review and appeal.

The South Australian Spencer Gulf Prawn Fishery is managed under the Fisheries Management Act 2007[256] and the Management Plan for the South Australian Commercial Spencer Gulf Prawn Fishery[257], which contains the following minimum requirements:

a description of the fishery
established user rights
management objectives
how these objectives are to be achieved
how the plan is to be reviewed

Data Quality: Gold

Governance > Institutional capacity > Accountability of decision making bodies > Level of Accountability

Accountability of Decision-making bodies. Performance of a fisheries management agency is based on the degree to which decision-making processes are consultative, the basis for decisions are fully explained, and information about decision making is publicly available. The assessment applied the three tiers of Principle 3.2.2 (d) 'Decision-making process' of the MSC Fisheries Standard v2.0 (2014) to determine whether the level of accountability was low, medium or high.

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[255] The South Australian Fisheries Management Series Paper number 67: Management Plan for the South Australian Commercial Spencer Gulf Prawn Fishery
[256] https://www.legislation.sa.gov.au/LZ/C/A/FISHERIES%20MANAGEMENT%20ACT%202007.aspx
[257] http://www.pir.sa.gov.au/__data/assets/pdf_file/0003/57954/Prawn-Spencer_Gulf-Fishery-Management_Plan.pdf

High level of accountability. This is demonstrated by the public availability of a management plan, fishery assessment report and harvest strategy and the availability of information on decision-making documentation on request. The King Prawn fishery has achieved and maintained MSC certification since 2011, and this includes assessment of Principle 3 and 3.2.2 at the highest level.

Data Quality: Silver

Governance > Institutional capacity > Uncertainty management > Extent of incorporation of uncertainty in management of the targeted stock

This metric reports on the explicit incorporation of uncertainties in decision support processes used to inform and make appropriate choices of management actions. We recognise three levels of uncertainty: Low level of incorporation of uncertainty; Medium level of incorporation of uncertainty; High level of incorporation of uncertainty. These are based on: Major sources of uncertainty are identified; Assessment takes uncertainty into account; Frequency of monitoring of indicators is high; Monitoring of more than one indicator to support management decisions; Assessment evaluates stock status relative to reference points in a probabilistic way; Robustness of assessments are tested, Alternative hypotheses and assessment approaches are rigorously explored.

High level of incorporation of uncertainty in management of the targeted stock.	MSC Certification by MRAG (2016). The fishery has achieved and maintained MSC Certification since 2016, and this includes assessment of Principle 1.2.4 at the highest level.

Data Quality: Gold

Governance > Compliance > Compliance regime > Level of Compliance

Level of compliance with rules and regulations controlling catch can be assessed by audits that measure the agreement between 1) logbook and observer records; 2) catch disposal records submitted by fishers and fish receivers. It might also be assessed by counting the annual number of breaches/observed offences or enforcement actions, preferably scaled to the level of enforcement effort (e.g. $). This indicator can be scored on the basis of the presence of key monitoring, control and surveillance elements and capacities.

Each year a report is to be prepared assessing the compliance status of the Spencer Gulf Prawn Fishery. This report will:

Describe the compliance program for the previous three years, including an overview of activities and relevant statistics.
Describe how the program has been implemented to achieve both voluntary compliance and create effective deterrence.
Describe the risks that have been addressed as a priority over that period.
Comment on any changes to the risk profile of the fishery during that period.
Analyse the compliance status of the fishery (including information about intelligence reports received).

Make suggestions for future compliance planning. [258]

Data Quality: Silver

Governance > Compliance > Surveillance > Surveillance Effort

Regulatory controls include logs and catch reporting, on-board observer programs, vessel inspections, vessel monitoring systems, and visual or electronic surveillance using radar or satellite by boat or by air. Higher degrees of surveillance, or coverage using multiple methods, provide greater levels of certainty in estimates of effort, fishing mortality, bycatch and discard levels, and interactions with protected/listed species. Report on the surveillance carried out on the fishery, as reported by the compliance branch responsible for the fishery **Data Quality:** Not found

Governance > Adaptive capacity > Governance arrangements > Climate change recognition

Governance arrangements relevant to the fishery consider the impact of climate change on the fishery, as evidenced by documentation, policies and plans that describe how management is addressing climate change impacts. Does the fishery management plan, harvest strategy or research activity suggest that climate change is recognised, and integrated into management planning?

Fishery-specific plans do not yet propose management responses to climate change.

South Australian government documents recognise the need for industry responses to be planned and implemented, but recommendations are not specific to fisheries[259]. Some regional adaptation plans adjacent to the fishery recognize the need for adaptation to warming oceans[260].

The National Harvest Strategy also recognizes that "*Variability in ocean conditions, due to natural variability, climate change or other factors, can affect the productivity of stocks. Fisheries should seek to account for that variability when developing and implementing harvest strategies*"[261]. The Guidelines for the Harvest Strategy provide explicit approaches for fisheries[262]. The strategy and guidelines do not explicitly apply to state fisheries, but will provide guidance.

Data quality: Bronze

Governance > Adaptive capacity > Coping strategies > Climate responses

The fishery has initiated coping strategies (directed) to reduce the impacts of climate change. Evidence of strategies that have been specifically implemented for the fishery might include codes of practice, restocking programs, early warning systems, and so on. The coping strategies may be for long-term change or for extreme events. A description of the climate change responses that have been implemented or explored in research or application are provided.

[258] http://www.pir.sa.gov.au/__data/assets/pdf_file/0003/57954/Prawn-Spencer_Gulf-Fishery-Management_Plan.pdf
[259] https://www.environment.sa.gov.au/files/sharedassets/public/climate-change/prospering-in-a-changing-climate-adaptation-framework-sa.pdf
[260] Siebentritt, M., Halsey, N. and Stafford-Smith, M. (2014). Regional Climate Change Adaptation Plan for the Eyre Peninsula. Prepared for the Eyre Peninsula Integrated Climate Change Agreement Committee.
[261] Department of Agriculture and Water Resources 2018, *Commonwealth Fisheries Harvest Strategy Policy*, Canberra, June. CC BY 4.0.
[262] Department of Agriculture and Water Resources 2018, *Guidelines for the Implementation of the Commonwealth Fisheries Harvest Strategy Policy*, Canberra, June. CC BY 4.0.

There are no management actions currently implemented that address climate change impacts in the fishery.

Data quality: Bronze

Social and Ethical > Fishers wellbeing > Fisher satisfaction > Satisfaction scores

If available, fishery specific surveys of well-being or satisfaction, with interpretation required for the types of questions and sample. When surveys are not available other sources of data may need to include broader surveys (e.g. not fishery specific) or discussions with industry representatives, managers or fishers about the industry and their opinion of general fisher-wellbeing (note this will be subjective).

Satisfaction score: Medium
The fishery is managed in a collaborative way and fishers take responsibility for developing the annual harvesting strategy. The South Australian Government provides advice on prawn biology, abundance and spawning biomass, but the fishers make all the management decisions about where to fish, when to fish and how much fish will be taken during a fishing period. This level of agency over key fishing decisions is likely to increase fisher satisfaction. (Report of the FRDC's national working group for the Fisheries Co-management Initiative — project no. 2006/068).

Data Quality: Silver

Social and Ethical > Fishers wellbeing > Age Structure > Proportion of fishers in standard age cohorts

Proportion of fishers in standard age cohorts that were involved in the fishery at any point in the previous 5 years. If the fishery is not attractive or difficult to enter, the age distribution will be skewed to older ages.

In 2017 61 per cent of respondents to a survey of license holders in Spencer Gulf Prawn Fishery were aged between 51 and 60. A number of survey participants were licence holders who primarily filled a role of shore management rather than skippers. It is likely that the average age of skippers is lower than the average age of survey participants. The average age of Spencer Gulf Prawn Fishery licence holders was 54 in 2017 (52 in 2014)[263].

[263] Carlin, L. and Morison, J. 2017. Economic Indicators for the South Australian Spencer Gulf Prawn Fishery, 2015/16. EconSearch and PIRSA. Adelaide.

Table 4-10 Age of Spencer Gulf Prawn licence holders, 2014 and 2017

Age Bracket (years)	2014 Number from survey sample	2014 Proportion	2017 Number from survey sample	2017 Proportion
Under 25	0	0%	0	0%
26-30	0	0%	0	0%
31-35	0	0%	0	0%
36-40	3	14%	2	11%
41-45	3	14%	1	6%
46-50	4	18%	1	6%
51-55	4	18%	6	33%
56-60	4	18%	5	28%
61-65	1	5%	1	6%
Over 65	3	14%	2	11%
Total	22	100%	18	100%

Source: 2014 and 2017 licence holder survey

Data Quality: Gold

Social and Ethical > Wider community > Community satisfaction with fishery > Community feedback

Evidence of processes in place to gather direct engagement with the community (diversely represented) to listen and respond to feedback. This may be through a range of means including formal and informal processes and may not be appropriate to all fisheries in the same way. In some cases Marine Stewardship Council accreditation may demonstrate some evidence of community engagement.

Community feedback: Medium.

Community wellbeing is potentially good for this fishery, although fishery operations may be considered 'out of sight/out of mind'. The fishery is Marine Stewardship Council certified. There is a management advisory committee, which could oversee a feedback process. Based on general FRDC community perception surveys, satisfaction with Australian fisheries is rated at 42%.

Data quality: Bronze.

Social and Ethical > Wider Community > Level of local employment > Percentage of local employment

The communities surrounding and supporting fisheries benefit from those fisheries when the majority of employees (direct and indirect) associated with the fishery activity are local. Can be reported as direct, indirect and downstream levels.

Indicator	Year	Amount	Reference	Note
Fishing (direct)	2013-2014	88 fte	EconSearch (2016) Economic Indicators for the Spencer Gulf Prawn Fishery 2014/15 report prepared for Primary Industries and Resources	

			South Australia, Adelaide, August	
Downstream (direct)	2013-2014	30 fte	EconSearch (2016) Economic Indicators for the Spencer Gulf Prawn Fishery 2014/15 report prepared for Primary Industries and Resources South Australia, Adelaide, August	Downstream activities include net value of processing, transport services and retail/food services trade
All other sectors (indirect)	2013-2014	252 fte	EconSearch (2016) Economic Indicators for the Spencer Gulf Prawn Fishery 2014/15 report prepared for Primary Industries and Resources South Australia, Adelaide, August	
Fishing (direct)	2014-2015	88 fte	EconSearch (2017) Ecomonic and Social Indicators for the Lakes and Coorong Fishery 2015/16 report prepared for Primary Industries and Regions South Australia Fisheries and Aquaculture, July	
Downstream (direct)	2014-2015	181 fte	EconSearch (2017) Ecomonic and Social Indicators for the Lakes and Coorong Fishery 2015/16 report prepared for Primary Industries and Regions South Australia Fisheries and Aquaculture, July	Downstream activities include net value of processing, transport services and retail/food services trade

Data Quality: Gold

Social and Ethical > Ethical - Human welfare > Protections in place > Legislation exists

Although all workers are automatically operating under legislation according to their state or territory to a safe work place, the extent to which there is awareness of the relevant Acts, and use of these if required, is highly variable and may be different for each business or individual operation within each fishery. See http://workplaceohs.com.au/legislation for a list of state acts and regulations.

Protections in Place: Medium

The Spencer Gulf Prawn fishery is operates under South Australia (SafeWork SA) – WHS Act 2012 and WHS Regulations 2012. Safety training has been widely implemented in this fishery.

Data Quality: Silver

Social and Ethical > Ethical > Human welfare > Levels of compliance

Levels of compliance (or violations of) with Workplace Health and Safety. If references to Workplace Health and Safety exist in relation to the specific fishery, determine whether these are voluntary or recorded in anyway. If they are recorded, note the level of compliance. As they are likely to be voluntary, there will not likely be a record of compliance, but this may become more readily available in the future. **Data Quality:** Not found

Social and Ethical > Ethical-animal welfare > Animal welfare protections > Protections in place

At this early stage of development of animal welfare, any type of mention of animal welfare exists, it is probably the most appropriate. As this develops in to the future, assessments as to the level of engagement may become more relevant.

Animal welfare is not considered.

Data Quality: Bronze

Social and Ethical > Ethical-animal welfare > Level of Compliance > Levels of compliance or violations of animal welfare

If there are any references to animal welfare protections or guidelines in fishery management plans and if reports exist, the indicator reports on the level of compliance or violations with welfare provisions.

Animal welfare is not considered in any documents covered.

Data Quality: Not found

Social and Ethical > Climate-related > Access to information > Availability of information

This indicator describes available information that will help participants in the fishery adapt to changes. The assumption behind this indicator is that good information availability and flow will help fishers to adapt.

Data Quality: Not found.

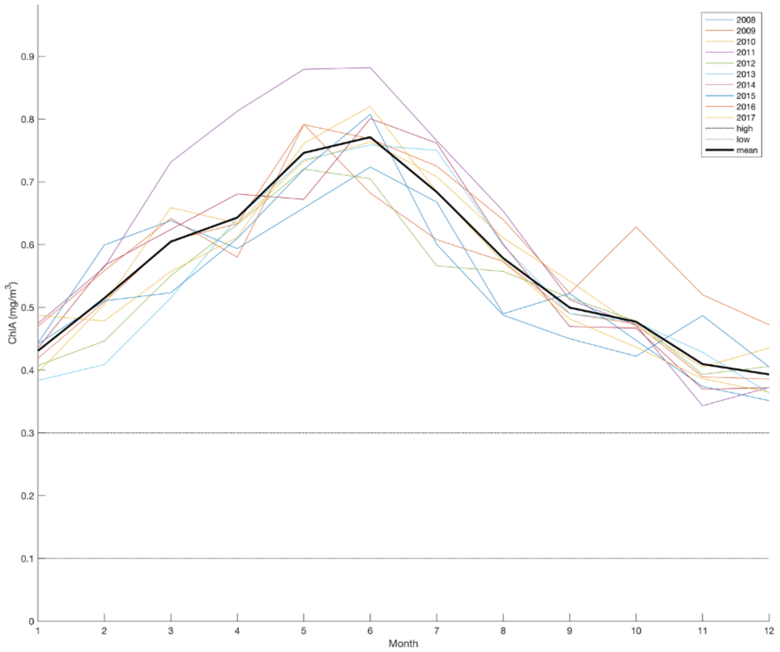
Social and Ethical > Climate-related > Access to networks > Level of membership of industry association

This metric assesses the presence or absence of a dedicated social media or social network group for the fishery. The fishery may still have a strong social network without a social media presence.

Data Quality: Not found.

External > Environmental Context > Productivity > Mean chlorophyll

A measure of environmental productivity is the biomass of phytoplankton, which in oceanic waters can be approximated by chlorophyll a concentration, as estimated from satellite (MODIS, oceandata.sci.gsfc.nasa.gov). Monthly chlorophyll values for a representative area of the fishery are shown with the mean productivity shown in solid black and references levels of low chlorophyll at 0.1 mg $m^{-3}$and high chlorophyll levels at 0.3 mg m^{-3}. This indicator shows the mean chlorophyll by month for the years 2008-2017. These data provide information on the relative environmental productivity in the fishery area. Missing data for some months can be due to ice cover. Variability in chlorophyll a concentration between years can indicate high environmental variability, while similar seasonal patterns indicate relative environmental stability.



Data Quality: Gold

External > Environmental Context > Environmental character > Description of the ecosystems

This metric provides a qualitative description of the ecosystem(s) in which the fishery occurs. The goal is to provide a general overview of these environments. The knowledge about which ecosystems are encountered during fishing activity is the indicator (rather than the response of the ecosystems to fishing).

Marine ecosystems are defined for the purposes of this indicator as the composition of plants, animals, and the marine environment (water masses, geomorphology). Types of marine ecosystems include estuaries, the sea floor, the mesopelagic zone, the pelagic zone, the inter-tidal zones, coral reefs, lagoons, and mangroves. A pelagic zone ecosystem for example, is defined by physical, chemical and biological features of the marine water column of the open ocean[264].

Description of the ecosystems: High

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[264] Game, E. T., H. S. Grantham, A. J. Hobday, R. L. Pressey, A. T. Lombard, L. E. Beckley, K. Gjerde, R. H. Bustamante, H. P. Possingham and A. J. Richardson (2009). Pelagic protected areas: the missing dimension in ocean conservation. Trends in Ecology and Evolution **24**(7): 360-369 doi:310.1016/j.tree.2009.1001.1011.

The fishery occurs in the Spencer Gulf which is a shallow embayment, with depths reaching a maximum of 60 m in its southern regions. Due to its shallow nature and temperate location, water temperatures vary markedly throughout the year. A paucity of freshwater influx combined with high levels of evaporation during summer leads to increased levels of salinity, particularly in the shallow northern reaches. This unique 'hyper-saline' environment, along with the vast areas of tidal flat and mangrove habitat, creates ideal breeding conditions for the King Prawns[265].

Data Quality: Gold

External > Climate related > Susceptibility of target species > Impacts on target species

Climate change directly affects the distribution, abundance and phenology of individual species. These changes then affect the fisheries that harvest these species, and can be a strong external influence on the fishery. These impacts can be positive (e.g. increased abundance), or negative (e.g. movements further from fishing ports), and to long-term warming, or short-term extreme events such as marine heatwaves.

Sensitivity of the target species to climate change has been assessed[266]. Species in this fishery have a sensitivity of moderately high.

Common name	Species	Fishery	Score	Sensitivity
Western king prawn	Melicertus latisulcatus	Spencer Gulf Prawn Fishery	5.5	MODERATELY HIGH

Data Quality: Silver

External > Climate related > Susceptibility of key habitats > Habitat Impacts

Habitat impact: Low

Data Quality: Bronze

External > Contaminants in the environment > Detection system for seafood contaminants > Risk of contaminants

Potential risk for contamination from the marine environment combined with monitoring arrangements to be able to address risks needed to ensure food safety. Contaminants include those with maximum levels set for by Food Standards Code Australia: metal contaminants, non-metal contaminants, natural toxicants, and average and maximum levels of mercury in fish. Contaminants from poor handling after landing are not assessed but may be indirectly addressed.

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[265] http://www.pir.sa.gov.au/fishing/commercial_fishing/fisheries/prawn_fishery_-_spencer_gulf_and_west_coast

[266] Fulton EA, Hobday AJ, Pethybridge H, Blanchard J, Bulman C, Butler I, Cheung W, Gorton B, Hutton T, Lozano- Montes H, Matear R, Pecl G, Villanueva C, Zhang X (2018). *Decadal scale projection of changes in Australian fisheries stocks under climate change.* CSIRO Report to FRDC. FRDC Project No: 2016/139 – ONLINE.

Rubric for risk level:

Low risk	Medium risk	High risk
There are no documented levels of contaminants from the marine environment causing risk/diet restrictions to any consumer group in the fishery.	There may be seasonal/area/species/size-based risks of contaminants for some species.	Permanent diet restrictions of species caught to vulnerable consumers such as children or pregnant women.

Risk of Contaminants: Low

All harvesters are required to follow the Seafood Food Safety Scheme established in the Primary Produce (Food Safety Schemes) (Seafood) Regulations 2017. Growers and harvesters of seafood are required to produce safe and suitable food and conform to the requirements of the Food Standards Code including the Seafood Standard 4.2.1.

Data Quality: Gold

External > Contaminants in the environment > Management arrangements to ensure food safety related to contaminants > Evidence for arrangements

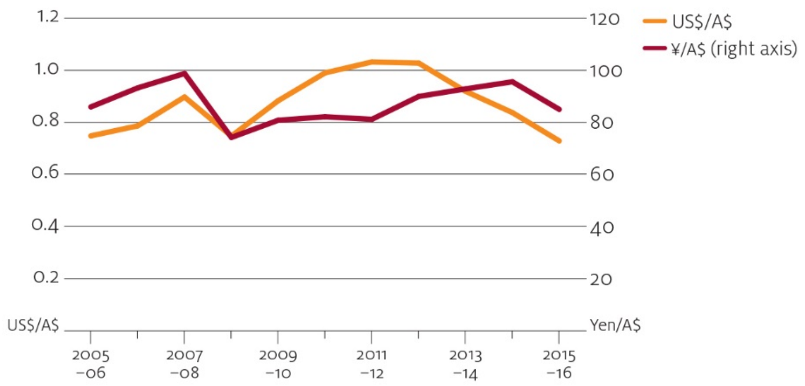
There is evidence of management arrangements to ensure food safety related to contaminants and food safety from the marine environment. No supply chain risks from poor handling are considered. Food standard 4.2.1 requires all seafood business in Australia to identify potential seafood safety hazards and put controls in place that are consistent with the risk.

Data Quality	
GOLD	
SILVER	Follows national standards but fisheries-specific arrangements not found. http://www.pir.sa.gov.au/biosecurity/food_safety/seafood There is a industry code of practise: http://australianwildprawns.com.au/wp-content/uploads/2017/02/2009-787-Food-safety-risks-for-prawns.pdf ; http://www.spencergulfkingprawns.com.au/about/sgwcpfa-inc/
BRONZE	

External > Market Drivers > Macroeconomic factors > Exchange Rates

A depreciating Australian dollar (or, increasing exchange rate) generally results in producers receiving a higher export price in Australian dollar terms, while an appreciating Australian dollar (or, decreasing exchange rate) results in a lower export price. Domestically, a depreciation of the Australian dollar encourages substitution from imported seafood to domestically produced seafood, as imported products become relatively more expensive. A lower exchange rate also makes Australian exports more competitive in world markets, as exported seafood become relatively cheaper in foreign currency terms.

National export trends are negatively related to exchange rate movements— the Australian dollar declined against the US dollar and Japanese yen from 1990–91 to 2000–01, with exports increasing in volume and value. Exchange rates for the Australian dollar increased against those currencies from 2001–02 to 2015–16. The real export value and volume of Australia's seafood exports decreased between 2005–06 and 2012–13 and then increased between 2012–13 and 2015–16—with a noticeable rise (43 per cent) in volume between 2014–15 and 2015–16.[267]



Data Quality: Gold

External > Market Drivers > Consumer Trends > Per person annual apparent consumption of seafood (kg)

Annual apparent consumption is estimated by adding the total edible quantity of seafood supplied domestically—that is, total production plus imported seafood— less exports of seafood. Apparent consumption provides an estimate of the total amount of seafood consumed in Australia assuming zero change in stocks.

The production quantity of Australian fishery and aquaculture products is reported by ABARES on a whole weight basis, whereas trade data are reported on a processed basis. To align the units of measurement between production and trade data, it is necessary to convert production volume to a processed edible equivalent.

Production volumes are adjusted to an edible quantity basis using species-specific conversion rates and excluding species that are known to be predominantly supplied for non-human consumption purposes, such as for aquaculture feed or bait. Imports and exports of seafood are sourced from Australian Bureau of Statistics (ABS) trade data and are reported as edible weight. The apparent consumption per person is calculated as the total apparent consumption divided by the total Australian population in each year. The method applied here is consistent with that used by ABARES to estimate apparent consumption of other agricultural commodities produced in Australia.

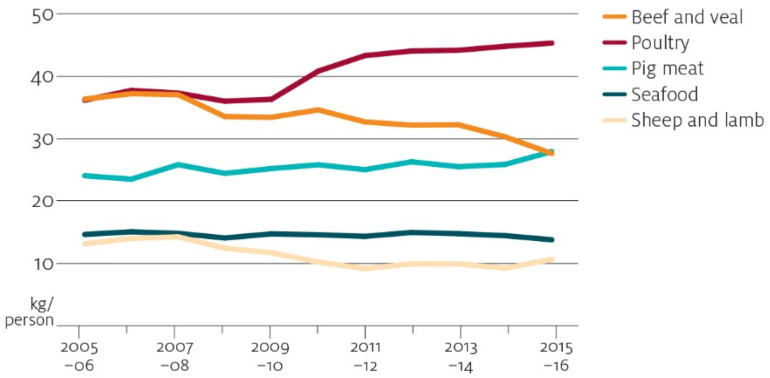
The FAO also compiles statistics on apparent consumption of seafood, applying a consistent method across all countries. FAO estimates indicate that annual consumption of seafood in Australia is around 26 kilograms per person in 2013 (FAO 2016[268]). The discrepancy between FAO and ABARES estimates reflects differences in methodological approaches to estimating consumption. Moreover,

[267] Mobsby, D and Koduah, A 2017, Australian fisheries and aquaculture statistics 2016, FRDC project 2017-095. ABARES, Canberra, December. CC BY 4.0.
[268] The state of world fisheries and aquaculture 2016—opportunities and challenges, Food and Agriculture Organization of the United Nations, Rome.

ABARES estimates seafood consumption on a processed edible basis, whereas the FAO provides its estimates on a whole weight basis.

In Australia, apparent consumption of seafood per person (edible equivalent) decreased, on average, at an annual rate of 0.6 per cent, from 14.6 kilograms in 2005– 06 to 13.8 kilograms per person in 2015–16. Annual apparent consumption is estimated by the Australian Bureau of Agricultural and Resource Economics and Sciences by adding the total edible quantity of seafood supplied domestically—that is, total production plus imported seafood— less exports of seafood[269]

In comparison, global per capita apparent fish consumption increased from an average of 9.9 kg in the 1960s to 14.4 kg in the 1990s and 20.1 kg in 2014, with preliminary estimates for 2015 indicating further growth, exceeding 20 kg (FAO 2016). Australia's per person seafood consumption in 2013 was estimated by the FAO to be 26kg. The differences in estimates are accounted for by varying methods for calculating consumption. ABARES estimates seafood consumption on a processed edible basis, whereas the FAO provides its estimates on a whole weight basis.



Data quality: Gold

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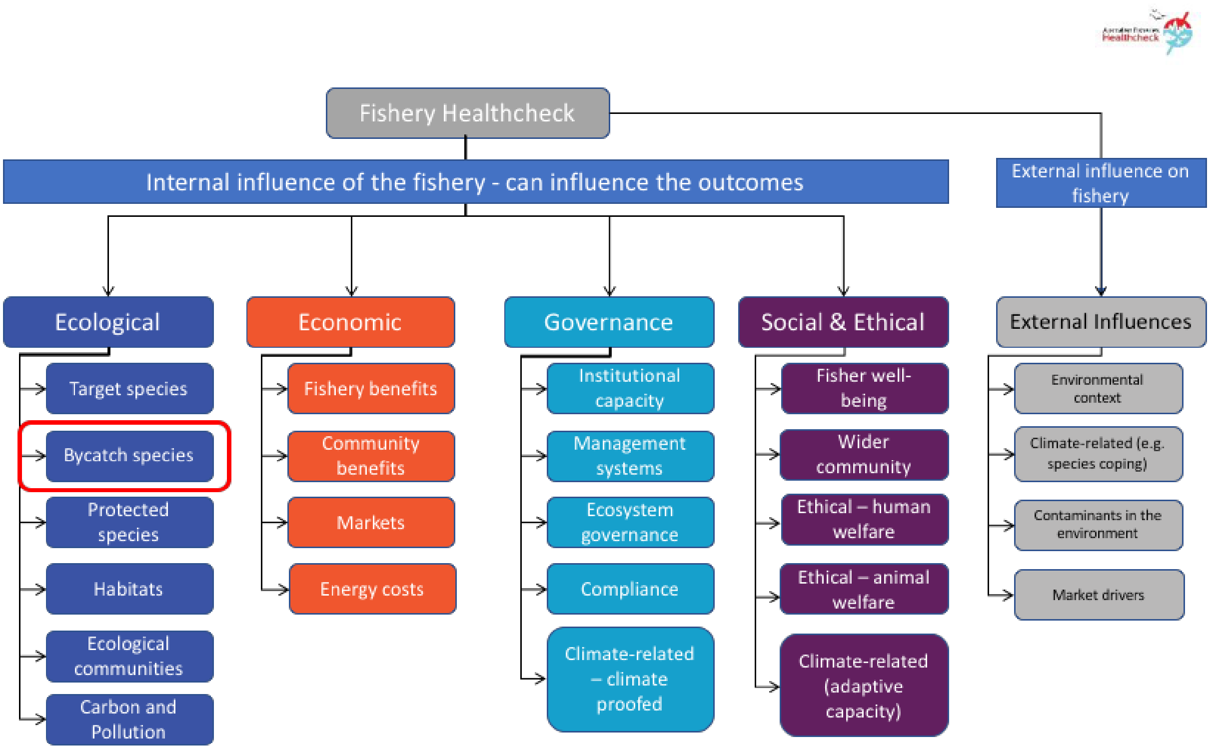
[269] Mobsby, D and Koduah, A 2017, *Australian fisheries and aquaculture statistics 2016*, FRDC 2017-095. ABARES, Canberra, December. CC BY 4.0

South Australian Turbo fishery

The South Australian Turbo Fishery is a small emerging fishery that harvests the Turbo shell (sea snail) from rocky reefs by hand while diving. A small number of fishers had been given exemptions to harvest Turbo shells since 2000 which supply a year-round small niche market with approximately eight tonne per year. Management of Turbo harvest has recently been reviewed to allow Exploratory Fishery and Developmental Fishery permits to be granted. Following an Ecologically Sustainable Development (ESD) risk assessment of the activity, permit conditions for the harvesting of turbo limit the risk of overfishing and localised depletion while providing support for the development of the fishery and its' market. A total of two Developmental Fishery permits and one Exploratory permit have recently been offered to applicants and due to the cultural importance and development potential of the species, a further Developmental Fishing permit has also been offered to the Narungga people. Fishers must provide monthly reporting on their harvesting activities to allow for a comprehensive review. (Source: Fisheries Guidelines Project).

Case Study Presentation Format

The case study documents are a collection of metrics, organised by the healthcheck structure:



The presentation of metrics will follow the following heading format:

Ecological > Bycatch species > Bycatch composition > <u>Mean Trophic Level</u>

Understand this to be an indicator (**Bycatch composition**) of the **Ecological** Component, **Bycatch species** subcomponent where the (in the figure and heading example above, is being measured by presenting Mean Trophic Level as the metric.

Ecological > Target species > Stock Status > Status of Australian Fish Stocks (SAFS)

Target species in each fishery are the primary focus for this indicator. Status of these species is ideally assessed with the SAFS approach, however this may not cover all target species for each fishery. In that case, we indicate the number of unassessed species. These species could also be assessed by individual states or by alternative methods. **Data Quality:** Not Found

Ecological > Target Species > Harvest Level > Catch weight

This metric is a proxy for harvest level. The harvested biomass for each species, provides information on the level of the catch. Trends in this metric over time can indicate declining availability of fish, quota restrictions, or changes in market demand. For Australian fisheries, trends are expected to be stable for most species.

An online report[270] from 2007 reporting data to 2005 was located. This notes 25.9 tonnes total landed weight harvested between 1 July 2001 and 30 June 2005 (averages at ~6.5

tonnes per year). It is considered an experimental fishery – limited number of participants hand collecting snails.

Data quality: Bronze

Ecological > Bycatch species > Bycatch composition > Mean Trophic Level

The trophic level is a measure of the position of an organism in a food web, starting at level 1 with primary producers, such as phytoplankton, then moving through the primary consumers at level **2** that eat the primary producers to the secondary consumers at level **3** that eat the primary consumers, and so on. The **bycatch mean trophic level** is an indicator of the mean level of the food chain for bycatch in a fishery.

This fishery has very low bycatch, and so this metric was not calculated

Data Quality: Not applicable

Ecological > Bycatch species > Bycatch amount > Total weight of bycatch

Bycatch weights for fishery are typically developed by specific projects, and require a range of assumptions due to issues with reporting and retention of bycatch. **Bycatch** estimates typically cover species that are not target species, while **discard** rates may also include undersized individuals of the target species. Kennelly (2018) provides estimates of discard rates, which include both target and bycatch species, and when discard rates are used, that information is noted for each fishery. Animals can be returned to the ocean alive or dead. The intention of this metric is to provide information on animals that are dead on return to the ocean.

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[270] https://www.environment.gov.au/system/files/pages/7b6655ed-9172-471f-9d78-037c180f2827/files/report-07.pdf

Reference:

Kennelly, S.J., 2018. *Developing a National Bycatch Reporting System.* Final FRDC Report, ISBN 978-0-9924930-5-9, March, 2018. 99 pp.

This fishery is by hand collection, and so this metric was not calculated.

Data Quality: Not applicable

Ecological > Protected species > Capture amount > Captures

The number and diversity of TEP species captured by a fishery in the most recent year, provided as annual numbers.

Few to no interactions expected from this fishery, due to nature of the fishery.

Data quality: Bronze

Ecological > Protected species > Reporting > Level of monitoring

This indicator is to provide information on the level of coverage for a fishery. Annual measures are preferred.

Data quality: Not found

Ecological > Habitats > Habitat impact > Impact score

The habitat impact is an indicator of the effect the fishing gear has on the habitat. Different gear types have different impacts. See the scoring rubric.

Habitat Impact: Minor, based on the gear type used in this fishery.

Data quality: Bronze

Ecological > Habitats > Habitat impact > Habitat status

The status of the habitat types is a measure of the condition relative to a pristine state. Fishing may not be responsible for that habitat status, but it is important to note if fishing is taking place in pristine or disturbed habitats.

Habitat status: Good

Data quality: Bronze

Ecological > Ecological communities > Ecosystem status > Ecosystem status

This metric reports the ecosystem status in the region of the fishery.

Ecosystem Status: Good

Rocky reefs in southern Australia have been impacted by coastal runoff and environmental change. The 2016 SOE report notes the 0-25 m inner shelf as being in good condition[271].

Data Quality: Bronze

[271] https://soe.environment.gov.au/assessment-summary/marine-environment/state-and-trends-habitats-and-communities

Ecological > Ecological communities > Ecosystem status > Species diversity

The measure of species diversity as a ratio between fished and unfished states.

Data quality: Not found

Ecological > Carbon and Pollution > Macro-plastics > Plastic code of conduct

Macro-plastics are plastics that are visible to the naked eye, such as food containers and wrapping, equipment packaging, and fishing equipment. The metric notes a commitment to a zero waste overboard code of conduct to assess attempts to reduce accidental or intentional introduction of macro-plastics to the ocean. There are stated guidelines detailing Australia's guidelines regarding marine pollution from the Australian Maritime Safety Authority[272]:

Pollution of the marine environment by ships, including fishing vessels, is strictly controlled by the International Convention for the Prevention of Pollution from Ships (known as MARPOL).

To minimise pollution, MARPOL prohibits ships from discharging garbage into the sea except in very limited circumstances.

Australian MARPOL regulations apply to Australian fishing vessels wherever they are operating.

Data Quality: Bronze

Ecological > Carbon and Pollution > Carbon footprint > CO_2-equivalents

The emissions of climate forcing gases in kg CO_2-equivalents (CO_2e) per kg live weight fish caught, not including the supply chain after landing.

Data Quality	Gear	Target species	Min (kg CO_2e/kg)	Average (kg CO_2e/kg)	Max (kg CO_2e/kg)	Reference	Description
Gold							
Silver							
Bronze	Dive	Molluscs	1.5	2.6	3.7	Parker and Tyedmers 2015	Oceania region, year and fuel type not specified, refrigerants not included.

Economic > Fishery Benefits > Net Economic Returns > Economic Rent

Net Economic Returns (NER) is equal to fishing revenue less fishing costs and measures the economic profit that is derived from fishing activity, it is measured by the Commonwealth as Net Economic Returns and by some States as Economic Rent.
Data Quality: Not found

Economic > Fishery Benefits > Gross Value of Production > Gross Value of Production

[272] https://www.amsa.gov.au/marine-environment/marine-pollution/pollution-fishing-vessels
https://www.amsa.gov.au/marine-environment/marine-pollution/marpol-and-its-implementation-australia

GVP calculated as the volume of catch multiplied by the average per unit beach price (AUD$).

Data Quality	Species/Fishery	Year	Amount	Reference	Note/Comment
Not released	Turbo			Government of South Australia (2017) Policy for the Management of the South Australian Commercial Miscellaneous Dive Fishing Activities. Primary Industries and Regions South Australia, December	Due to the limited size and diverse nature of miscellaneous commercial dive fishing activities, details about the economic characteristics of these activities are limited, and are not able to be published consistent with confidentiality requirements set out in section 124 of the *Fisheries Management Act 2007*

Economic > Fishery Benefits > Profitability > Financial Performance

Economic health of a fishery can be measured by the financial performance of the operators in the fleet. Fleet wide averages or distributions of levels of profitability indicate the extent to which the fishery is generating economic benefits for fishers.

Due to the limited size and diverse nature of miscellaneous commercial dive fishing activities, details about the economic characteristics of these activities are limited, and are not able to be published consistent with confidentiality requirements set out in section 124 of the *Fisheries Management Act 2007*

Government of South Australia (2017) Policy for the Management of the South Australian Commercial Miscellaneous Dive Fishing Activities. Primary Industries and Regions South Australia, December

Data Quality: Not released

Economic > Fishery Benefits > Latency > Underutilised Effort

Latency is fishery concessions that are not being fully utilised by fishers, for example, often the annual total allowable catch is left partially or largely uncaught for a fishery. Latency may appear as effort or uncaught TAC or inactive licences.

Data Quality: Not found

Economic > Community benefits > Value to community > GDP or GSP value

A fisheries contribution to Gross Domestic Production (GDP)/Gross State Product (GSP) is the total economic value that it generates directly, plus the indirect contribution made to other industries, which is also measured in value-add terms.

Data Quality: Not found

Due to the limited size and diverse nature of miscellaneous commercial dive fishing activities, details about the economic characteristics of these activities are limited, and are not able to be published consistent with confidentiality requirements set out in section 124 of the *Fisheries Management Act 2007*

Reference: Government of South Australia (2017) Policy for the Management of the South Australian Commercial Miscellaneous Dive Fishing Activities. Primary Industries and Regions South Australia, December

Economic > Community benefits > Wealth Spread > Distribution of fishing firm size

The spread of profits to owners and crew members indicates how widely benefits of fishing are distributed across the fishing community. A wide spread of benefits may be important to some fishery stakeholders. A narrow spread may not indicate a lack of distribution of benefits in the case where all participating businesses are the same size, or if other mechanisms are present to capture and distribute benefits such as high levels of employment of crew. The number of large business versus small business, classified by turnover (direct measure) or catch volume (proxy) may provide an indirect indicator: i.e. are economic returns from commercial fishing gained by one or two large businesses or a spread over many smaller businesses? **Data Quality:** Not organised/analysed

Economic > Markets > Fish distribution > Fish receivers

One way of measuring benefits from a fishery is by assessing the flow of seafood through the supply chain. In many fishery jurisdictions, the first step in the supply chain is via licensed fish receivers who are allowed to receive fish for sale. They can also trade fish with other receivers. In some jurisdictions, commercial fishers must sell their catch to a receiver (although they can sell small amounts on wharves). While this restricts fishers' options for landing their catch, it means that fish can be tracked, reduces illegal fish trading and ensures that the Quota Management Systems (QMS) work effectively by ensuring catches do not exceed the total allowable catch or quota amounts for individual species. Receivers of fish may be fish processors, wholesalers or retailers.

In some jurisdictions, the fishers and fish receivers are integrated, such that they are effectively the same “business”. In Commonwealth fisheries, the total number of fish receivers per year may differ to the sum of the fish receivers per fishery because some receivers operate in more than one fishery.

Data were not available, but may exist.

South Australia divides its fish processing into 3 categories:

Selling straight from the boat for immediate consumption
Selling to restaurants and clubs (no on-selling other than as part of a meal) - a restricted fish processor
Selling to a processor who can then process and sell to retail - a full fish processor.
Fish processors are managed pursuant to the South Australian Fisheries Management (Fish Processor) Regulations.

SA also collects economic data as a part of its administration of the FMA. Reports on this fishery are at: http://www.econsearch.com.au/pages/completed-projects/fishing-aquaculture/fish10.php

Data Quality: Not released

Economic > Markets > Volatility in market price > Price volatility

Price volatility is the mean beach price for the target species (top one or five depending on price) over the given period (most recent ten years). The level of volatility is the standard deviation in mean price over this period.

Data Quality: Not released

Due to the limited size and diverse nature of miscellaneous commercial dive fishing activities, details about the economic characteristics of these activities are limited, and are not able to be published consistent with confidentiality requirements set out in section 124 of the *Fisheries Management Act 2007.*

Reference: Government of South Australia (2017) Policy for the Management of the South Australian Commercial Miscellaneous Dive Fishing Activities. Primary Industries and Regions South Australia, December

Economics > Energy costs > Energy Use > Fuel use per kg of fish harvested

Fuel use varies over time and between stocks and are best collected from industry on a yearly basis. Estimates for different fisheries should be compared with caution, and in particular comparing energy use between fisheries with different data quality which is not recommended (different data availability, may be e.g. old or not fisheries-specific). Estimates are provided for all levels of data quality if available and are given in L per kg live-weight.

Data Quality	Gear	Target species	Min (L/kg)	Average (L/kg)	Max (L/kg)	Reference	Description
Gold							
Silver							
Bronze	Divers	Mollusc	0.6	1.0	1.5	Parker and Tyedmers 2015	Oceania region

Economic > Energy costs > Fossil fuel subsidies > Fuel subsidies directed to the fishery

Fossil fuel subsidies (fuel rebates) illustrate to which extent the fuel cost is reduced in the fishery, measured in AUD/kg live weight fish. Note that this form of tax exemption for fisheries is in Australia motivated from the sector not using roads (i.e. costs embedded in fuel price for road construction and maintenance), and are not formally reported as fuel subsidies in Australia.

Data Quality	Gear	Target species	Subsidy (AUD/kg)	Reference	Description
Gold					
Silver					

Bronze	All SA	All SA	0.10	Total tax claims per total landings in SA	2015-16 (2016-17 also available), state level figures on landings are preliminary for 2015-16

Governance > Ecosystem governance > Bycatch mitigation > Description of the bycatch mitigation measures

Bycatch measures can be spatial (e.g. area closure), temporal (time closure, e.g. night setting only) or technical (bycatch reduction devices, hook size). This indicator describes the measures that are in place for a fishery – but not the rates of compliance. For example, spatial closures for different gear types are shown here for AFMA fisheries http://www.afma.gov.au/sustainability-environment/fishing-closures/.

None

Data Quality: Bronze – based on no bycatch species captured

Governance > Ecosystem governance > Protected species mitigation > Description of the protected species mitigation measures

TEP mitigation measures can be spatial (e.g. area closure), temporal (time closure, e.g. night setting only) or technical (bycatch reduction devices, hook size). This indicator describes the measures that are in place for a fishery – but not the rates of compliance.

None

Data Quality: Bronze – based on no interactions with TEPS

Governance > Management system > Harvest strategy > Scope of the harvest strategy

Assessment can be based on scoring presence of the following: a harvest strategy designed to achieve management objectives; harvest control rules and tools; collection of relevant information to support the harvest strategy; and, assessment of stock status or the presence of the following key elements: Defined operational objectives for the fishery; Indicators of fishery performance related to the objectives; Reference points for performance indicators; A statement defining acceptable levels of risk to meeting objectives; A monitoring strategy to collect relevant data to assess fishery performance; A process for conducting assessment of fishery performance relative to objectives; and; Decision rules that control the intensity of fishing activity and/or catch.
The South Australian Turbo fishery is part of the South Australian Miscellaneous dive fishery. Miscellaneous dive fishing activities target multiple species harvested by hand using SCUBA, hookah and/or snorkelling gear including scallops, sea urchins, turbo, native oysters. In the future these activities may also apply to collection of specimen shells. Fishers may be assisted by hand held implements. Miscellaneous dive fishing activities are not formally identified as a discrete fishery under the Fisheries Management Act 2007. Rather the activity forms part of the broader Miscellaneous Fishery, noting that some species including native oysters and scallops, are also included as prescribed species in the Marine Scalefish Fishery. Miscellaneous dive fishing activities are mainly regulated under the:
Fisheries Management (Miscellaneous Fishery) Regulations 2015
Fisheries Management (General) Regulations 2017

At the time of developing this policy, PIRSA was considering a number of applications for Exploratory and Developmental fishing permits related to miscellaneous dive fishing activities under the Fisheries Management (Miscellaneous Developmental Fishery) Regulations 2013.[273]

Data Quality: Bronze

Governance > Management system > Management plans > Scope of management plan

Management plans can be assessed by evaluating the presence of minimum requirements, as follows: a description of the fishery, especially its current status and any established user rights: the management objectives; how these objectives are to be achieved; how the plan is to be reviewed and/or appealed, as well as the consultation process for review and appeal.

The South Australian Turbo Fishery is part of the South Australia Commercial Miscellaneous Dive Fishing Activities, which are managed under Fisheries Management Act (2007)[274], the Fisheries Management (General) Regulations 2007[275], and the Fisheries Management (Miscellaneous Fisheries) Regulations 2015[276]. Together they contain the following minimum requirements:

established user rights:
the management objectives

Data Quality: Gold

Governance > Institutional capacity > Accountability of decision making bodies > Level of Accountability

Accountability of Decision-making bodies. Performance of a fisheries management agency is based on the degree to which decision-making processes are consultative, the basis for decisions are fully explained, and information about decision making is publicly available. The assessment applied the three tiers of Principle 3.2.2 (d) 'Decision-making process' of the MSC Fisheries Standard v2.0 (2014) to determine whether the level of accountability was low, medium or high.

Medium level accountability. This is demonstrated by the public availability of rules and regulations, policy statement, harvest strategy and ESD risk assessment for the miscellaneous fishery. No information is publicly available online regarding recent harvest level setting decisions or catch and effort.

Data Quality: Silver

Governance > Institutional capacity > Uncertainty management > Extent of incorporation of uncertainty in management of the targeted stock

[273] Primary Industries and Regions SA (2018). Ecological Assessment of South Australian Commercial Miscellaneous Dive Fishing Activities.
[274] https://www.legislation.sa.gov.au/LZ/C/A/FISHERIES%20MANAGEMENT%20ACT%202007.aspx
[275] https://www.legislation.sa.gov.au/LZ/C/R/Fisheries%20Management%20(General)%20Regulations%202007.aspx
[276] https://www.legislation.sa.gov.au/LZ/C/R/Fisheries%20Management%20(Miscellaneous%20Fishery)%20Regulations%202015.aspx

This metric reports on the explicit incorporation of uncertainties in decision support processes used to inform and make appropriate choices of management actions. We recognise three levels of uncertainty: Low level of incorporation of uncertainty; Medium level of incorporation of uncertainty; High level of incorporation of uncertainty. These are based on: Major sources of uncertainty are identified; Assessment takes uncertainty into account; Frequency of monitoring of indicators is high; Monitoring of more than one indicator to support management decisions; Assessment evaluates stock status relative to reference points in a probabilistic way; Robustness of assessments are tested, Alternative hypotheses and assessment approaches are rigorously explored.

Low level of incorporation of uncertainty in management of the targeted stock.	The assessment applied Principle 1.2.4 (c & d) 'Assessment of stock status: Uncertainty in the Assessment' of the MSC Fisheries Standard v2.0 (2014) to assess extent of incorporation of uncertainty in management of the targeted stock.

Data Quality: Silver

Governance > Compliance > Compliance regime > Level of Compliance

Level of compliance with rules and regulations controlling catch can be assessed by audits that measure the agreement between 1) logbook and observer records; 2) catch disposal records submitted by fishers and fish receivers. It might also be assessed by counting the annual number of breaches/observed offences or enforcement actions, preferably scaled to the level of enforcement effort (e.g. $). This indicator can be scored on the basis of the presence of key monitoring, control and surveillance elements and capacities. **Data Quality:** Not found

Governance > Compliance > Surveillance > Surveillance Effort

Regulatory controls include logs and catch reporting, on-board observer programs, vessel inspections, vessel monitoring systems, and visual or electronic surveillance using radar or satellite by boat or by air. Higher degrees of surveillance, or coverage using multiple methods, provide greater levels of certainty in estimates of effort, fishing mortality, bycatch and discard levels, and interactions with protected/listed species. Report on the surveillance carried out on the fishery, as reported by the compliance branch responsible for the fishery **Data Quality:** Not found

Governance > Adaptive capacity > Governance arrangements > Climate change recognition

Governance arrangements relevant to the fishery consider the impact of climate change on the fishery, as evidenced by documentation, policies and plans that describe how management is addressing climate change impacts. Does the fishery management plan, harvest strategy or research activity suggest that climate change is recognised, and integrated into management planning?

Fishery-specific plans do not yet propose management responses to climate change.

South Australian government documents recognise the need for industry responses to be planned and implemented, but recommendations are not specific to fisheries[277].

The National Harvest Strategy also recognizes that "*Variability in ocean conditions, due to natural variability, climate change or other factors, can affect the productivity of stocks. Fisheries should seek to account for that variability when developing and implementing harvest strategies*"[278]. The Guidelines for the Harvest Strategy provide explicit approaches for fisheries[279]. The strategy and guidelines do not explicitly apply to state fisheries, but will provide guidance.

Data quality: Bronze

Governance > Adaptive capacity > Coping strategies > Climate responses

The fishery has initiated coping strategies (directed) to reduce the impacts of climate change. Evidence of strategies that have been specifically implemented for the fishery might include codes of practice, restocking programs, early warning systems, and so on. The coping strategies may be for long-term change or for extreme events. A description of the climate change responses that have been implemented or explored in research or application are provided.

There are no management actions currently implemented that address climate change impacts in the fishery.

Data quality: Bronze

Social and Ethical > Fishers wellbeing > Fisher satisfaction > Satisfaction scores

If available, fishery specific surveys of well-being or satisfaction, with interpretation required for the types of questions and sample. When surveys are not available other sources of data may need to include broader surveys (e.g. not fishery specific) or discussions with industry representatives, managers or fishers about the industry and their opinion of general fisher-wellbeing (note this will be subjective).

Satisfaction score: Medium

The Turbo fishery is a small, exploratory fishery in development. It currently lacks a fishery body which makes it hard for PIRSA to consult with license holders, however, a Developmental Fishing permit has also been offered to the Narungga people so indigenous engagement is present to some extent. Stakeholder engagement is undertaken during the assessment of the Exploratory or Developmental Fishing Permits. Engagement with the conservation sector, tertiary institutions, traditional owners, and other government departments is recorded in minutes. Further stakeholder engagement may be required when permits are reviewed after 12 months. There is no ongoing stakeholder engagement in relation to the Turbo fishery.

Data Quality: Bronze

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[277] https://www.environment.sa.gov.au/files/sharedassets/public/climate-change/prospering-in-a-changing-climate-adaptation-framework-sa.pdf

[278] Department of Agriculture and Water Resources 2018, *Commonwealth Fisheries Harvest Strategy Policy*, Canberra, June. CC BY 4.0.

[279] Department of Agriculture and Water Resources 2018, *Guidelines for the Implementation of the Commonwealth Fisheries Harvest Strategy Policy*, Canberra, June. CC BY 4.0.

Social and Ethical > Fishers wellbeing > Age Structure > Proportion of fishers in standard age cohorts

Proportion of fishers in standard age cohorts that were involved in the fishery at any point in the previous 5 years. If the fishery is not attractive or difficult to enter, the age distribution will be skewed to older ages. **Data Quality:** Not released

Social and Ethical > Wider community > Community satisfaction with fishery > Community feedback

Evidence of processes in place to gather direct engagement with the community (diversely represented) to listen and respond to feedback. This may be through a range of means including formal and informal processes and may not be appropriate to all fisheries in the same way. In some cases Marine Stewardship Council accreditation may demonstrate some evidence of community engagement.

Community feedback: Medium.

Limited communication has occurred with the general public. An ESD was undertaken through the development of the harvest strategies. There is a management advisory committee, which could oversee a feedback process. Based on general FRDC community perception surveys, satisfaction with Australian fisheries is rated at 42%.

Data quality: Bronze.

Social and Ethical > Wider Community > Level of local employment > Percentage of local employment

The communities surrounding and supporting fisheries benefit from those fisheries when the majority of employees (direct and indirect) associated with the fishery activity are local. Can be reported as direct, indirect and downstream levels. **Data Quality:** Not found

Social and Ethical > Ethical - Human welfare > Protections in place > Legislation exists

Although all workers are automatically operating under legislation according to their state or territory to a safe work place, the extent to which there is awareness of the relevant Acts, and use of these if required, is highly variable and may be different for each business or individual operation within each fishery. See http://workplaceohs.com.au/legislation for a list of state acts and regulations.

Protections in Place: Medium

The Turbo fishery operates under South Australia (SafeWork SA) – WHS Act 2012 and WHS Regulations 2012. Dive fisheries operate under additional worker protections.

Data Quality: Silver

Social and Ethical > Ethical > Human welfare > Levels of compliance

Levels of compliance (or violations of) with Workplace Health and Safety. If references to Workplace Health and Safety exist in relation to the specific fishery, determine whether these are voluntary or recorded in anyway. If they are recorded, note the level of compliance. As they are likely to be voluntary, there will not likely be a record of compliance, but this may become more readily available in the future.

Level of Compliance: Medium

Compliance work with permit holders and undertake activities on an as-needs-basis. The public register holds details of permits and permit conditions. No other fishing activity may be undertaken while engaged in harvesting Turbo.

Data Quality: Bronze

Social and Ethical > Ethical-animal welfare > Animal welfare protections > Protections in place

At this early stage of development of animal welfare, any type of mention of animal welfare exists, it is probably the most appropriate. As this develops in to the future, assessments as to the level of engagement may become more relevant. **Data Quality:** Not found.

Social and Ethical > Ethical-animal welfare > Level of Compliance > Levels of compliance or violations of animal welfare

If there are any references to animal welfare protections or guidelines in fishery management plans and if reports exist, the indicator reports on the level of compliance or violations with welfare provisions.

Data Quality: Not found.

Social and Ethical > Climate-related > Access to information > Availability of information

This indicator describes available information that will help participants in the fishery adapt to changes. The assumption behind this indicator is that good information availability and flow will help fishers to adapt.

Availability of information: Low
Communication for the Turbo fishery is on an as-needs-basis, and has been in relation to assessing the applications.

Data Quality: Silver

Social and Ethical > Climate-related > Access to networks > Level of membership of industry association

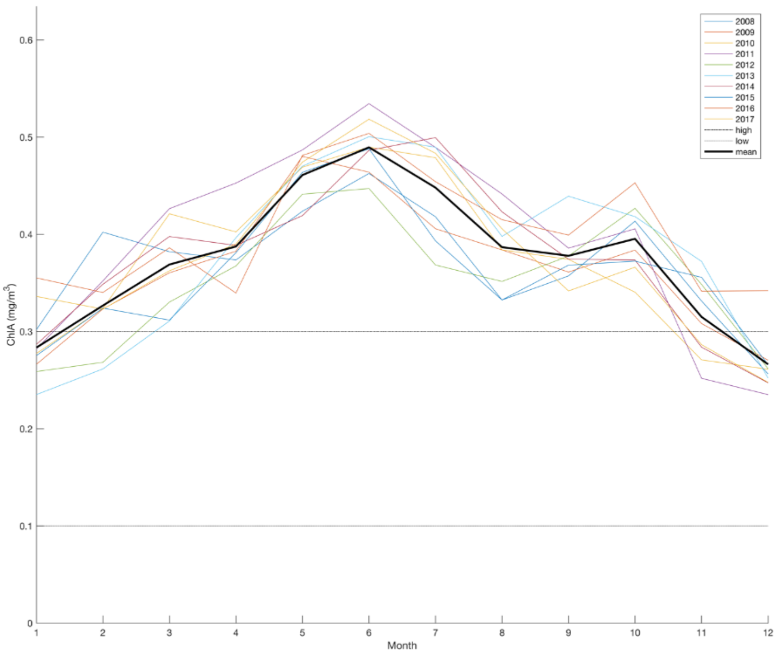
This metric assesses the presence or absence of a dedicated social media or social network group for the fishery. The fishery may still have a strong social network without a social media presence.

Data Quality: Not found.

External > Environmental Context > Productivity > Mean chlorophyll

A measure of environmental productivity is the biomass of phytoplankton, which in oceanic waters can be approximated by chlorophyll a concentration, as estimated from satellite (MODIS,

oceandata.sci.gsfc.nasa.gov). Monthly chlorophyll values for a representative area of the fishery are shown with the mean productivity shown in solid black and references levels of low chlorophyll at 0.1 mg m^{-3}and high chlorophyll levels at 0.3 mg m^{-3}. This indicator shows the mean chlorophyll by month for the years 2008-2017. These data provide information on the relative environmental productivity in the fishery area. Missing data for some months can be due to ice cover. Variability in chlorophyll a concentration between years can indicate high environmental variability, while similar seasonal patterns indicate relative environmental stability.



Data Quality: Gold

External > Environmental Context > Environmental character > Description of the ecosystems

This metric provides a qualitative description of the ecosystem(s) in which the fishery occurs. The goal is to provide a general overview of these environments. The knowledge about which ecosystems are encountered during fishing activity is the indicator (rather than the response of the ecosystems to fishing).

Marine ecosystems are defined for the purposes of this indicator as the composition of plants, animals, and the marine environment (water masses, geomorphology). Types of marine ecosystems include estuaries, the sea floor, the mesopelagic zone, the pelagic zone, the inter-tidal zones, coral reefs, lagoons, and mangroves. A pelagic zone ecosystem for example, is defined by physical, chemical and biological features of the marine water column of the open ocean[280].

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[280] Game, E. T., H. S. Grantham, A. J. Hobday, R. L. Pressey, A. T. Lombard, L. E. Beckley, K. Gjerde, R. H. Bustamante, H. P. Possingham and A. J. Richardson (2009). Pelagic protected areas: the missing dimension in ocean conservation. Trends in Ecology and Evolution **24**(7): 360-369 doi:310.1016/j.tree.2009.1001.1011.

Description of the ecosystems: High

This fishery takes place in coastal rocky reefs.

Data Quality: Gold

External > Climate related > Susceptibility of target species > Impacts on target species

Climate change directly affects the distribution, abundance and phenology of individual species. These changes then affect the fisheries that harvest these species, and can be a strong external influence on the fishery. These impacts can be positive (e.g. increased abundance), or negative (e.g. movements further from fishing ports), and to long-term warming, or short-term extreme events such as marine heatwaves. **Data Quality:** Not Found

External > Climate related > Susceptibility of key habitats > Habitat Impacts

Habitat impact: Low

Data Quality: Bronze

External > Contaminants in the environment > Detection system for seafood contaminants > Risk of contaminants

Potential risk for contamination from the marine environment combined with monitoring arrangements to be able to address risks needed to ensure food safety. Contaminants include those with maximum levels set for by Food Standards Code Australia: metal contaminants, non-metal contaminants, natural toxicants, and average and maximum levels of mercury in fish. Contaminants from poor handling after landing are not assessed but may be indirectly addressed.

Rubric for risk level:

Low risk	Medium risk	High risk
There are no documented levels of contaminants from the marine environment causing risk/diet restrictions to any consumer group in the fishery.	There may be seasonal/area/species/size-based risks of contaminants for some species.	Permanent diet restrictions of species caught to vulnerable consumers such as children or pregnant women.

Risk of Contaminants: Medium

All harvesters are required to follow the Seafood Food Safety Scheme established in the Primary Produce (Food Safety Schemes) (Seafood) Regulations 2017. Growers and harvesters of seafood are required to produce safe and suitable food and conform to the requirements of the Food Standards Code including the Seafood Standard 4.2.1. The targeted species have medium potential risk for contamination from the marine environment. Shellfish (such as turbo) may in different areas and seasons contain natural toxins (toxic algae) and pollution (e.g. dioxins).

Data Quality: Gold

External > Contaminants in the environment > Management arrangements to ensure food safety related to contaminants > Evidence for arrangements

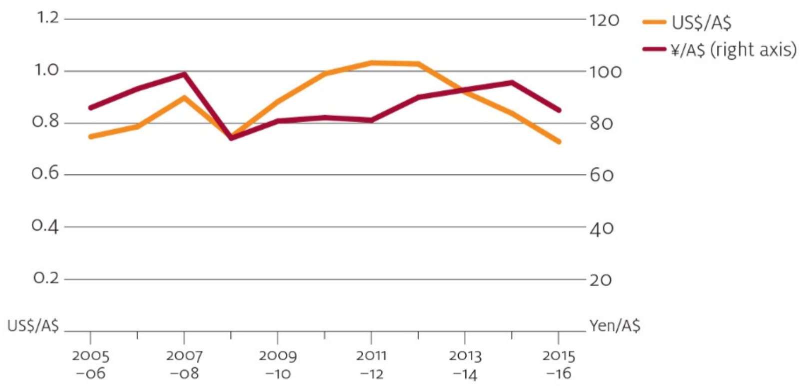
There is evidence of management arrangements to ensure food safety related to contaminants and food safety from the marine environment. No supply chain risks from poor handling are considered. Food standard 4.2.1 requires all seafood business in Australia to identify potential seafood safety hazards and put controls in place that are consistent with the risk.

Data Quality	
GOLD	
SILVER	Follows national standards but fisheries-specific arrangements not found. http://www.pir.sa.gov.au/biosecurity/food_safety/seafood
BRONZE	

External > Market Drivers > Macroeconomic factors > Exchange Rates

A depreciating Australian dollar (or, increasing exchange rate) generally results in producers receiving a higher export price in Australian dollar terms, while an appreciating Australian dollar (or, decreasing exchange rate) results in a lower export price. Domestically, a depreciation of the Australian dollar encourages substitution from imported seafood to domestically produced seafood, as imported products become relatively more expensive. A lower exchange rate also makes Australian exports more competitive in world markets, as exported seafood become relatively cheaper in foreign currency terms.

National export trends are negatively related to exchange rate movements— the Australian dollar declined against the US dollar and Japanese yen from 1990–91 to 2000–01, with exports increasing in volume and value. Exchange rates for the Australian dollar increased against those currencies from 2001–02 to 2015–16. The real export value and volume of Australia's seafood exports decreased between 2005–06 and 2012–13 and then increased between 2012–13 and 2015–16—with a noticeable rise (43 per cent) in volume between 2014–15 and 2015–16.[281]



Data Quality: Gold

281 Mobsby, D and Koduah, A 2017, Australian fisheries and aquaculture statistics 2016, FRDC project 2017-095. ABARES, Canberra, December. CC BY 4.0.

External > Market Drivers > Consumer Trends > Per person annual apparent consumption of seafood (kg)

Annual apparent consumption is estimated by adding the total edible quantity of seafood supplied domestically—that is, total production plus imported seafood— less exports of seafood. Apparent consumption provides an estimate of the total amount of seafood consumed in Australia assuming zero change in stocks.

The production quantity of Australian fishery and aquaculture products is reported by ABARES on a whole weight basis, whereas trade data are reported on a processed basis. To align the units of measurement between production and trade data, it is necessary to convert production volume to a processed edible equivalent.

Production volumes are adjusted to an edible quantity basis using species-specific conversion rates and excluding species that are known to be predominantly supplied for non-human consumption purposes, such as for aquaculture feed or bait. Imports and exports of seafood are sourced from Australian Bureau of Statistics (ABS) trade data and are reported as edible weight. The apparent consumption per person is calculated as the total apparent consumption divided by the total Australian population in each year. The method applied here is consistent with that used by ABARES to estimate apparent consumption of other agricultural commodities produced in Australia.

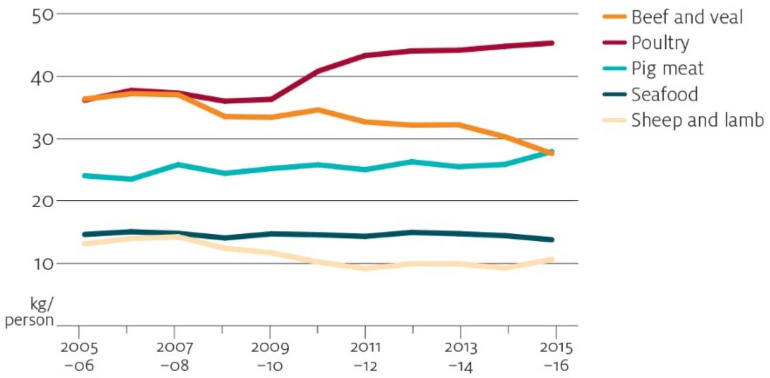
The FAO also compiles statistics on apparent consumption of seafood, applying a consistent method across all countries. FAO estimates indicate that annual consumption of seafood in Australia is around 26 kilograms per person in 2013 (FAO 2016[282]). The discrepancy between FAO and ABARES estimates reflects differences in methodological approaches to estimating consumption. Moreover, ABARES estimates seafood consumption on a processed edible basis, whereas the FAO provides its estimates on a whole weight basis.

In Australia, apparent consumption of seafood per person (edible equivalent) decreased, on average, at an annual rate of 0.6 per cent, from 14.6 kilograms in 2005– 06 to 13.8 kilograms per person in 2015–16. Annual apparent consumption is estimated by the Australian Bureau of Agricultural and Resource Economics and Sciences by adding the total edible quantity of seafood supplied domestically—that is, total production plus imported seafood— less exports of seafood[283]

In comparison, global per capita apparent fish consumption increased from an average of 9.9 kg in the 1960s to 14.4 kg in the 1990s and 20.1 kg in 2014, with preliminary estimates for 2015 indicating further growth, exceeding 20 kg (FAO 2016). Australia's per person seafood consumption in 2013 was estimated by the FAO to be 26kg. The differences in estimates are accounted for by varying methods for calculating consumption. ABARES estimates seafood consumption on a processed edible

[282] The state of world fisheries and aquaculture 2016—opportunities and challenges, Food and Agriculture Organization of the United Nations, Rome.
[283] Mobsby, D and Koduah, A 2017, *Australian fisheries and aquaculture statistics 2016*, FRDC 2017-095. ABARES, Canberra, December. CC BY 4.0

basis, whereas the FAO provides its estimates on a whole weight basis.



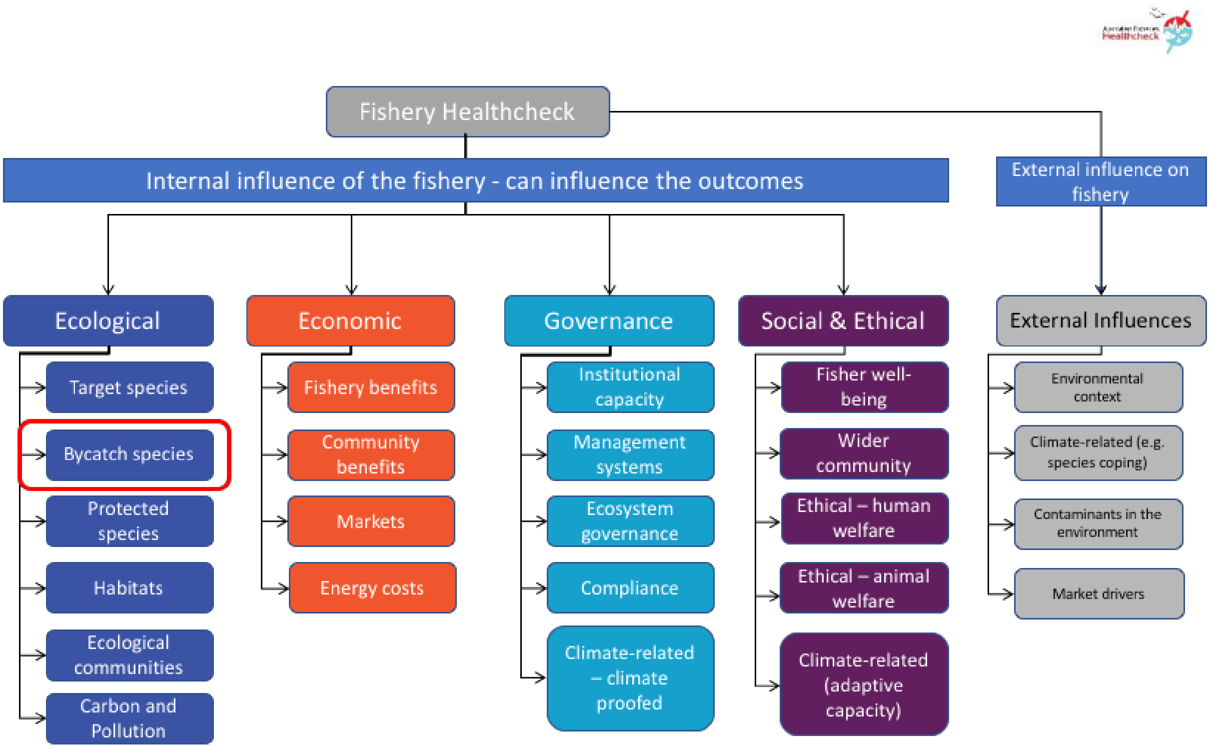
Data quality: Gold

Tasmanian Scalefish Fishery

The Tasmanian Scalefish Fishery is a multi-species and multi-gear fishery that is predominantly made up of small owner operated commercial businesses and a large and diverse recreational fishery. It is managed under the provisions of Tasmania's *Living Marine Resources Management Act 1995*. Catch and effort in the fishery are largely controlled through input controls such as limited entry (capped licence numbers), closed seasons and gear restrictions. Output controls such as minimum and maximum size limits and trip limits are also used, and recently a quota management system was introduced to manage the commercial take of banded morwong from the east coast. (Source: http://dpipwe.tas.gov.au/sea-fishing-aquaculture/commercial-fishing/scalefish-fishery).

Case Study Presentation Format

The case study documents are a collection of metrics, organised by the healthcheck structure:



The presentation of metrics will follow the following heading format:

Ecological > Bycatch species > Bycatch composition > <u>Mean Trophic Level</u>

Understand this to be an indicator (**Bycatch composition**) of the **Ecological** Component, **Bycatch species** subcomponent where the (in the figure and heading example above, is being measured by presenting <u>Mean Trophic Level</u> as the metric.

Ecological > Target species > Stock Status > Status of Australian Fish Stocks (SAFS)

Target species in each fishery are the primary focus for this indicator. Status of these species is ideally assessed with the SAFS approach, however this may not cover all target species for each fishery. In that case, we indicate the number of unassessed species. These species could also be assessed by individual states or by alternative methods.

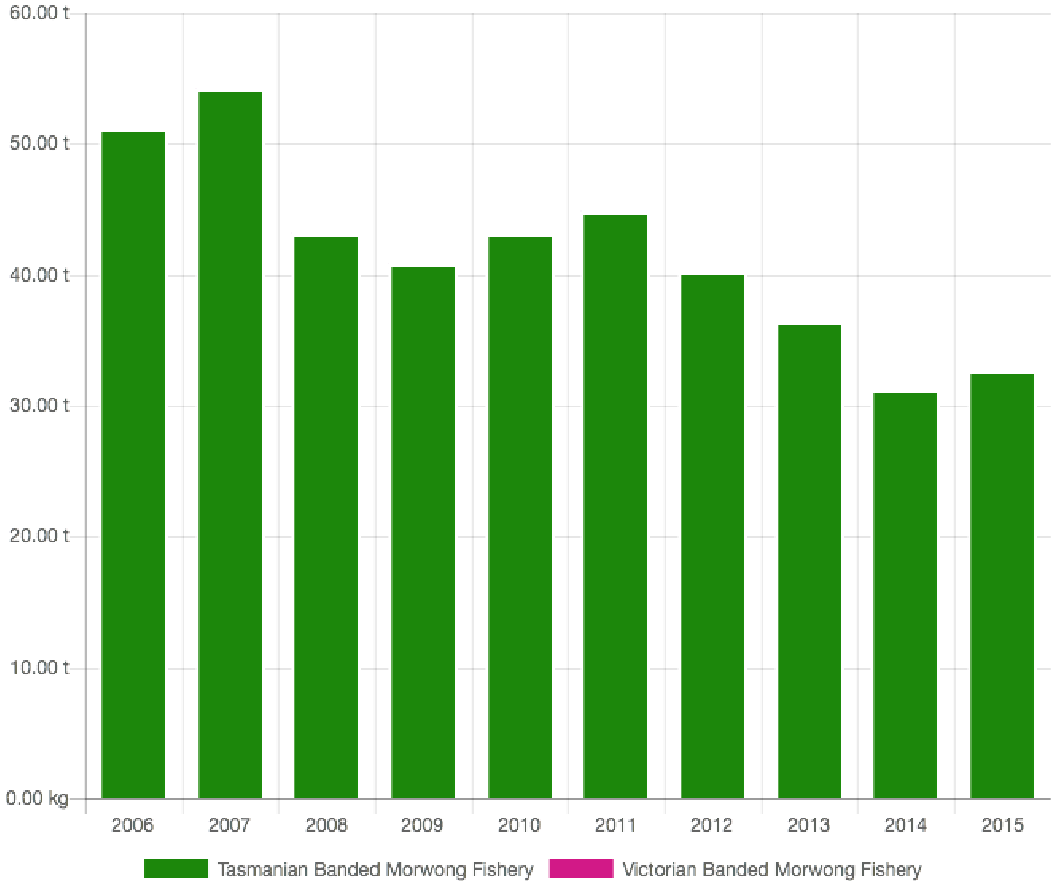
SpeciesName	StockName	StockStatus	Year
AUSTRALIAN SALMONS	Eastern Australia	Sustainable	2016
Blue Mackerel	Eastern	Sustainable	2016
Blue Mackerel	Western	Sustainable	2016
Blue-eye Trevalla	Eastern Australia	Sustainable	2016
Common Jack Mackerel	Eastern	Sustainable	2016
Common Jack Mackerel	Western	Sustainable	2016
Eastern School Whiting	South-Eastern Australia	Sustainable	2016
Gould's Squid	South-Eastern Australia	Sustainable	2016
Gummy Shark	Southern Australia	Sustainable	2016
Luderick	Eastern Australia	Sustainable	2016
School Shark	Southern Australia	Overfished	2016
Silver Trevally	Tasmania	Undefined	2016
Snook	Tasmania	Undefined	2016
Southern Calamari	Tasmania	Sustainable	2016
Southern Garfish	Scalefish Fishery	Transitional-depleting	2016
Southern Sand Flathead	Tasmania	Transitional-depleting	2016
Tiger Flathead	Southern Australia	Sustainable	2016
Yelloweye Mullet	Tasmania	Sustainable	2016

Data Quality: Gold

Ecological > Target Species > Harvest Level > Catch weight

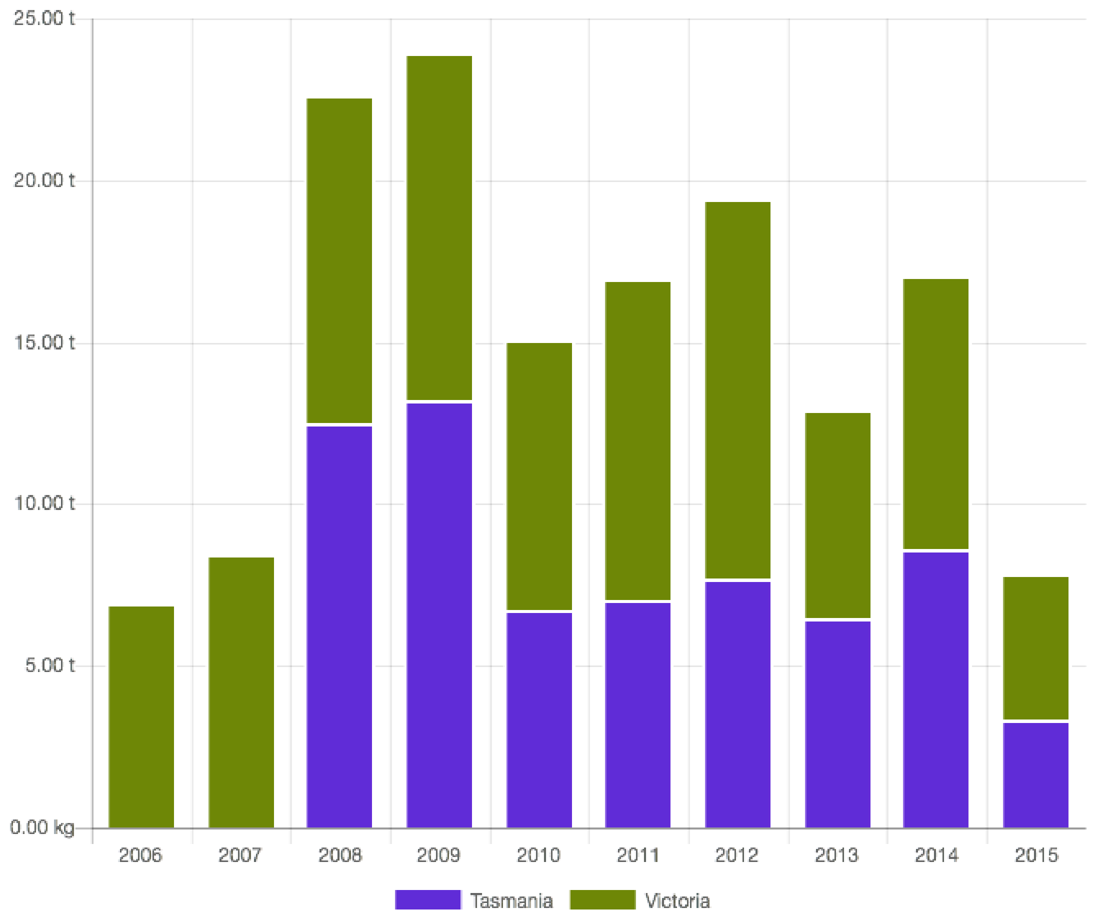
This metric is a proxy for harvest level. The harvested biomass for each species, provides information on the level of the catch. Trends in this metric over time can indicate declining availability of fish, quota restrictions, or changes in market demand. For Australian fisheries, trends are expected to be stable for most species.

The fishery targets a number of species (Banded Morwong[284], Australian Salmon, Bastard Trumpeter, Blue Warehou, Flathead[285], Southern Calamari, Southern Garfish, Striped Stumpeter and Wrasse). Catch histories for these species are:



Commercial catch of Banded Morwong - note confidential catch not shown

[284] http://www.fish.gov.au/report/6-Banded-Morwong-2016
[285] http://www.fish.gov.au/report/66-Southern-Sand-Flathead-2016



Commercial catch of Southern Sand Flathead - note confidential catch not shown

Data quality: Gold

Ecological > Bycatch species > Bycatch composition > Mean Trophic Level

The trophic level is a measure of the position of an organism in a food web, starting at level 1 with primary producers, such as phytoplankton, then moving through the primary consumers at level **2** that eat the primary producers to the secondary consumers at level **3** that eat the primary consumers, and so on. The **bycatch mean trophic level** is an indicator of the mean level of the food chain for bycatch in a fishery. **Data Quality:** Not organised/analysed

Ecological > Bycatch species > Bycatch amount > Total weight of bycatch

Bycatch weights for fishery are typically developed by specific projects, and require a range of assumptions due to issues with reporting and retention of bycatch. **Bycatch** estimates typically cover species that are not target species, while **discard** rates may also include undersized individuals of the target species. Kennelly (2018) provides estimates of discard rates, which include both target and bycatch species, and when discard rates are used, that information is noted for each fishery. Animals can be returned to the ocean alive or dead. The intention of this metric is to provide information on animals that are dead on return to the ocean.

Reference:

Kennelly, S.J., 2018. *Developing a National Bycatch Reporting System.* Final FRDC Report, ISBN 978-0-9924930-5-9, March, 2018. 99 pp.

Kennelly 2018[286] states: "For the multi-method Scalefish fishery, most methods have no discard rates available (Emery et al., 2015a). But for some methods (the two squid jig methods, dip-nets, spears, purse-seine and hand collection), one could assume negligible discards. For the others, however, discarding would almost certainly be occurring. Some discard data exists for the graball gillnet and small mesh net methods, summarised by Lyle et al. (2014) as "discard rates for by-catch species for these methods tended to exceed 80%, whereas discard rates for species typically targeted or retained as by-product typically ranged between 10 – 20%". Table A1.3 in Lyle et al. (2014) gives the retention rate of each species (by numbers) caught by commercial fishers by each of these nets (based on-45 board observations)."

Kennelly (2018) Table 13 - Discard rates (by numbers of individuals) summarised from Lyle et al. (2014) for the gillnet and small mesh net methods of the Tasmanian Scalefish fishery.

Method	**No. caught**	**No. discarded**	**Discard rate (%)**
Banded Morwong net	3143	1638.2	52.1
Standard Graball net	254	125.0	49.2
Both Graball nets combined	**3397**	**1763.2**	**51.9**
Small Mesh Net	**603**	**400.94**	**66.5**

Kennelly (2018) Table 14 – Assumed retained:discard ratios and discard rates (by weights) for Tasmania's various fisheries and methods.

Method	**Retained: Discarded Ratio**	**Discard %**	**Notes**
Automatic squid jig	1:0.00	0.00	5
Beach seine	1:0.00	0.20	1
Purse seine	1:0.00	0.00	5
Graball net	1:0.36	26.45	2
Hand line	1:0.14	12.28	1
Danish seine			
Squid-jig	1:0.00	0.00	5
Dip-net	1:0.00	0.00	5
Small mesh net	1:0.66	39.82	2
Troll			
Fish trap	1:0.02	1.96	1
Drop-line	1:0.07	6.54	1
Spear	1:0.00	0.00	5

1Uses NSW estimate
2Assumes average weight of discarded individuals is one third that of retained individuals
3Assumes scallop fishery operates at around half the mandatory 20% scallop discard level
4Assumes negligible non-Giant Crab discards
5Assumes zero discards

286 Kennelly, S.J., 2018. *Developing a National Bycatch Reporting System.* Final FRDC Report, ISBN 978-0-9924930-5-9, March, 2018. 99 pp.

Kennelly (2018) - Table 15 - Discard estimates (and SE's) for each fishery and method with total estimates for all fisheries and methods derived from combining the data in Tables 12 and 14. Where there were no discard data available (and one could not assume zero discards or use discard estimates from NSW or other methods), those methods were removed (Danish seine and Troll).

Method	Retained catch (tonnes)	SE	Discarded catch (tonnes)	SE
Automatic squid jig	251.00	183.60	0.00	0.00
Beach seine	243.70	62.20	0.49	0.49
Purse seine	239.60	198.60	0.00	0.00
Graball net	105.90	5.80	38.09	38.09
Hand line	81.00	2.80	11.34	11.34
Danish seine	70.50	8.70		
Squid-jig	51.40	3.90	0.00	0.00
Dip-net	19.30	1.50	0.00	0.00
Small mesh net	11.00	1.70	7.28	7.28
Troll	8.80	1.50		
Fish trap	8.50	0.40	0.17	0.17
Drop-line	5.20	1.00	0.36	0.36
Spear	4.20	0.30	0.00	0.00
Hand collection	2.70	0.80	0.00	0.00

Data Quality: Silver

Ecological > Protected species > Capture amount > Captures

The number and diversity of TEP species captured by a fishery in the most recent year, provided as annual numbers.

Kennelly (2018)[287] states:

Information about interactions with TEPs in Tasmania comes from 2 sources: compulsory logbook reporting by fishers and independent observer reporting. As found elsewhere in the world, the data show that interaction rates are much higher in the observer data which throws doubt on the validity of the logbook data. However, despite the existence of the observer dataset, there is little consolidation of TEPs interactions available from those data.
For the Tasmanian scalefish fishery, Lyle et al (2014) do not provide any consolidated data on TEPs interactions for the commercial fishery although a number of interactions were observed in the research study, involving Fur Seals, seabirds, Sygnathids, and the Maugean Skate. Fur Seals

[287] Kennelly, S.J., 2018. *Developing a National Bycatch Reporting System.* Final FRDC Report, ISBN 978-0-9924930-5-9, March, 2018. 99 pp.

were commonly observed in the vicinity of gillnets, the majority of direct interactions with the gear typically involved removal and consumption of entangled fish with no observed instances involving the entanglement of seals. However, the entanglement and drowning of seabirds (cormorants and Little Penguins) in gillnets was observed, though these were rare. Sygnathids (Seahorses and Seadragons) were also encountered in very low numbers with all individuals appearing to use the gillnet meshes as a substrate on which to hang and thus were unharmed. The Maugean Skate was caught regularly in gillnets set in depths of between about 5 – 15m in Macquarie Harbour, one of only two known localities inhabited by the species. Individuals captured during daytime deployments (<6h) were in excellent condition (typically only lightly meshed) and were lively when released. While the vast majority of individuals caught in overnight sets were also in excellent condition, a small proportion (approx. 10%) were either in poor condition, or had died, confirming some by-catch mortality associated with these longer soak durations.

Data quality: Bronze

Ecological > Protected species > Reporting > Level of monitoring

This indicator is to provide information on the level of coverage for a fishery. Annual measures are preferred.

Data quality: Not found

Ecological > Habitats > Habitat impact > Impact score

The habitat impact is an indicator of the effect the fishing gear has on the habitat. Different gear types have different impacts. See the scoring rubric.

Habitat Impact: Minor, based on the gear type used in this fishery.

Data quality: Bronze

Ecological > Habitats > Habitat impact > Habitat status

The status of the habitat types is a measure of the condition relative to a pristine state. Fishing may not be responsible for that habitat status, but it is important to note if fishing is taking place in pristine or disturbed habitats.

Habitat status: Moderate – changing environment as a result of climate change has significantly impacted this system

Data quality: Bronze

Ecological > Ecological communities > Ecosystem status > Ecosystem status

This metric reports the ecosystem status in the region of the fishery.

Ecosystem Status: Good, but declining

Rocky reefs in southern Australia have been impacted by coastal runoff and environmental change. The 2016 SOE report notes the 0-25 m inner shelf as being in good condition[288]. Loss of macroalgal habitat due to warming and urchin barrens have been reported from regions of the east coast where fishing occurs[289]. Ecosystem status in southern and western Tasmania are in good to excellent condition.

Data Quality: Silver

Ecological > Ecological communities > Ecosystem status > Species diversity

The measure of species diversity as a ratio between fished and unfished states.

Data quality: Not organised/analysed

Ecological > Carbon and Pollution > Macro-plastics > Plastic code of conduct

Macro-plastics are plastics that are visible to the naked eye, such as food containers and wrapping, equipment packaging, and fishing equipment. The metric notes a commitment to a zero waste overboard code of conduct to assess attempts to reduce accidental or intentional introduction of macro-plastics to the ocean. There are stated guidelines detailing Australia's guidelines regarding marine pollution from the Australian Maritime Safety Authority[290]:

Pollution of the marine environment by ships, including fishing vessels, is strictly controlled by the International Convention for the Prevention of Pollution from Ships (known as MARPOL).

To minimise pollution, MARPOL prohibits ships from discharging garbage into the sea except in very limited circumstances.

Australian MARPOL regulations apply to Australian fishing vessels wherever they are operating.

Data Quality: Bronze

Ecological > Carbon and Pollution > Carbon footprint > CO_2-equivalents

The emissions of climate forcing gases in kg CO_2-equivalents (CO_2e) per kg live weight fish caught, not including the supply chain after landing.

Data Quality	Gear	Target species	Min (kg CO_2e/kg)	Average (kg CO_2e/kg)	Max (kg CO_2e/kg)	Reference	Description

[288] https://soe.environment.gov.au/assessment-summary/marine-environment/state-and-trends-habitats-and-communities

[289] Johnson, C. R., S. C. Banks, N. S. Barrett, F. Cazassus, P. K. Dunstan, G. J. Edgar, S. D. Frusher, C. Gardner, M. Haddon, F. Helidoniotis, K. L. Hill, N. L. Holbrook, G. W. Hosie, P. R. Last, S. D. Ling, J. Melbourne-Thomas, K. Miller, G. T. Pecl, A. J. Richardson, K. R. Ridgway, S. R. Rintoul, D. A. Ritz, D. J. Ross, J. C. Sanderson, S. A. Shepherd, A. Slotwinski, K. M. Swadling and N. Taw (2011). Climate change cascades: Shifts in oceanography, species' ranges and subtidal marine community dynamics in eastern Tasmania. Journal of Experimental Marine Biology and Ecology **400**: 17–32 doi:10.1016/j.jembe.2011.1002.1032.

[290] https://www.amsa.gov.au/marine-environment/marine-pollution/pollution-fishing-vessels
https://www.amsa.gov.au/marine-environment/marine-pollution/marpol-and-its-implementation-australia

Gold							
Silver							
Bronze	Gillnet	Finfish	0.7		3.9	Parker and Tyedmers 2015	Global, year and fuel type not specified, refrigerants not included.

Economic > Fishery Benefits > Net Economic Returns > Economic Rent

Net Economic Returns (NER) is equal to fishing revenue less fishing costs and measures the economic profit that is derived from fishing activity, it is measured by the Commonwealth as Net Economic Returns and by some States as Economic Rent.
Data Quality: Not found

Economic > Fishery Benefits > Gross Value of Production > Gross Value of Production

GVP calculated as the volume of catch multiplied by the average per unit beach price (AUD$).

Data Quality	Species/Fishery	Year	Amount	Reference	Note/Comment
Silver	TAS Scalefish	2015-2016	$3,209,000	Mobsby, D & Koduah, A (2017) Australian fisheries and aquaculture statistics 2016, Fisheries Research and Development Corporation project 2017-095. ABARES, Canberra, December. CC BY 4.0	Preliminary Total for whole of State
Silver	TAS Scalefish	2014-2015	$3,224,000	Mobsby, D & Koduah, A (2017) Australian fisheries and aquaculture statistics 2016, Fisheries Research and Development Corporation project 2017-095. ABARES, Canberra, December. CC BY 4.0	Total for whole of State
Silver	TAS Scalefish	2013-2014	$3,539,000	Mobsby, D & Koduah, A (2017) Australian fisheries and aquaculture statistics 2016, Fisheries Research and Development	Total for whole of State

				Corporation project 2017-095. ABARES, Canberra, December. CC BY 4.0	

Economic > Fishery Benefits > Profitability > Financial Performance

Economic health of a fishery can be measured by the financial performance of the operators in the fleet. Fleet wide averages or distributions of levels of profitability indicate the extent to which the fishery is generating economic benefits for fishers.

Data Quality: Not found

Economic > Fishery Benefits > Latency > Underutilised Effort

Latency is fishery concessions that are not being fully utilised by fishers, for example, often the annual total allowable catch is left partially or largely uncaught for a fishery. Latency may appear as effort or uncaught TAC or inactive licences.

Data Quality	Indicator used	Year	Amount	Reference	Note
Gold	Inactive licences	2016	140	Moore, B, Lyle, J & Hartmann (2018) Tasmanian Scalefish Fishery Assessment 2016/17. IMAS http://www.imas.utas.edu.au/__data/assets/pdf_file/0004/1088977/Tasmanian-Scalefish-Fishery-Assessment-2016_17.pdf	
Gold	Inactive licences	2015	86	Moore, B, Lyle, J & Hartmann (2018) Tasmanian Scalefish Fishery Assessment 2016/17. IMAS http://www.imas.utas.edu.au/__data/assets/pdf_file/0004/1088977/Tasmanian-Scalefish-Fishery-Assessment-2016_17.pdf	
Gold	Inactive licences	2014	163	Moore, B, Lyle, J & Hartmann (2018) Tasmanian Scalefish Fishery Assessment 2016/17. IMAS http://www.imas.utas.edu.au/__data/assets/pdf_file/0004/1088977/Tasmanian-Scalefish-Fishery-Assessment-2016_17.pdf	
Gold	Inactive licences	2013	178	Moore, B, Lyle, J & Hartmann (2018) Tasmanian Scalefish	

				Fishery Assessment 2016/17. IMAS http://www.imas.utas.edu.au/__data/assets/pdf_file/0004/1088977/Tasmanian-Scalefish-Fishery-Assessment-2016_17.pdf	
Gold	Inactive licences	2012	179	Moore, B, Lyle, J & Hartmann (2018) Tasmanian Scalefish Fishery Assessment 2016/17. IMAS http://www.imas.utas.edu.au/__data/assets/pdf_file/0004/1088977/Tasmanian-Scalefish-Fishery-Assessment-2016_17.pdf	
Gold	Inactive licences	2011	181	Moore, B, Lyle, J & Hartmann (2018) Tasmanian Scalefish Fishery Assessment 2016/17. IMAS http://www.imas.utas.edu.au/__data/assets/pdf_file/0004/1088977/Tasmanian-Scalefish-Fishery-Assessment-2016_17.pdf	
Gold	Inactive licences	2010	182	Moore, B, Lyle, J & Hartmann (2018) Tasmanian Scalefish Fishery Assessment 2016/17. IMAS http://www.imas.utas.edu.au/__data/assets/pdf_file/0004/1088977/Tasmanian-Scalefish-Fishery-Assessment-2016_17.pdf	
Gold	Inactive licences	2009	199	Moore, B, Lyle, J & Hartmann (2018) Tasmanian Scalefish Fishery Assessment 2016/17. IMAS http://www.imas.utas.edu.au/__data/assets/pdf_file/0004/1088977/Tasmanian-Scalefish-Fishery-Assessment-2016_17.pdf	
Gold	Inactive licences	2008	192	Moore, B, Lyle, J & Hartmann (2018) Tasmanian Scalefish Fishery Assessment 2016/17. IMAS http://www.imas.utas.edu.au/__data/assets/pdf_file/0004/1088977/Tasmanian-Scalefish-	

				Fishery-Assessment-2016_17.pdf	

Economic > Community benefits > Value to community > GDP or GSP value

A fisheries contribution to Gross Domestic Production (GDP)/Gross State Product (GSP) is the total economic value that it generates directly, plus the indirect contribution made to other industries, which is also measured in value-add terms.

Data Quality	Indicator used	Year	Amount	Reference	Note
Bronze	GSP	2016-2017	$2,746,000	Tasmanian Government (2017) State Accounts (ABS Cat No 5220.0). Economic Analysis Unit, Department of Treasury and Finance. Release date: 17 November 2017. http://www.treasury.tas.gov.au/Documents/State-Accounts.pdf	Agriculture, forestry and fishing combined
Bronze	GSP	2015-2016	$2,618,000	Tasmanian Government (2017) State Accounts (ABS Cat No 5220.0). Economic Analysis Unit, Department of Treasury and Finance. Release date: 17 November 2017. http://www.treasury.tas.gov.au/Documents/State-Accounts.pdf	Agriculture, forestry and fishing combined

Economic > Community benefits > Wealth Spread > Distribution of fishing firm size

The spread of profits to owners and crew members indicates how widely benefits of fishing are distributed across the fishing community. A wide spread of benefits may be important to some fishery stakeholders. A narrow spread may not indicate a lack of distribution of benefits in the case where all participating businesses are the same size, or if other mechanisms are present to capture and distribute benefits such as high levels of employment of crew. The number of large business versus small business, classified by turnover (direct measure) or catch volume (proxy) may provide an indirect indicator: i.e. are economic returns from commercial fishing gained by one or two large businesses or a spread over many smaller businesses?

For the line sub-sector of the Tasmanian Scalefish Fishery, ABS data on Tasmanian businesses in June 2017 provides the following information on the distribution of Line fishing businesses by annual turn over size.

Zero to less than $50k	$50k to less than $200k	$200k to less than $2m	$2m to less than $5m	$5m to less than $10m	$10m or more
13	**19**	**8**	**0**	**0**	**0**

For the netting and seining sub-sector of the Tasmanian Scalefish Fishery, ABS data on Tasmanian businesses in June 2017 provides the following information on the distribution of trawling, netting and seining fishing businesses by annual turn over size.

Zero to less than $50k	$50k to less than $200k	$200k to less than $2m	$2m to less than $5m	$5m to less than $10m	$10m or more
13	21	16	0	0	0

Economic > Markets > Fish distribution > Fish receivers

One way of measuring benefits from a fishery is by assessing the flow of seafood through the supply chain. In many fishery jurisdictions, the first step in the supply chain is via licensed fish receivers who are allowed to receive fish for sale. They can also trade fish with other receivers. In some jurisdictions, commercial fishers must sell their catch to a receiver (although they can sell small amounts on wharves). While this restricts fishers' options for landing their catch, it means that fish can be tracked, reduces illegal fish trading and ensures that the Quota Management Systems (QMS) work effectively by ensuring catches do not exceed the total allowable catch or quota amounts for individual species. Receivers of fish may be fish processors, wholesalers or retailers.

In some jurisdictions, the fishers and fish receivers are integrated, such that they are effectively the same “business”. In Commonwealth fisheries, the total number of fish receivers per year may differ to the sum of the fish receivers per fishery because some receivers operate in more than one fishery. **Data Quality**: Not found

Economic > Markets > Volatility in market price > Price volatility

Price volatility is the mean beach price for the target species (top one or five depending on price) over the given period (most recent ten years). The level of volatility is the standard deviation in mean price over this period. **Data Quality:** Not found

Economics > Energy costs > Energy Use > Fuel use per kg of fish harvested

Fuel use varies over time and between stocks and are best collected from industry on a yearly basis. Estimates for different fisheries should be compared with caution, and in particular comparing energy use between fisheries with different data quality which is not recommended (different data availability, may be e.g. old or not fisheries-specific). Estimates are provided for all levels of data quality if available and are given in L per kg live-weight.

Data Quality	Gear	Target species	Min (L/kg)	Average (L/kg)	Max (L/kg)	Reference	Description
Gold							
Silver							
Bronze	Gillnet	Finfish	0.3		1.5	Parker and Tyedmers 2015	Global

Economic > Energy costs > Fossil fuel subsidies > Fuel subsidies directed to the fishery

Fossil fuel subsidies (fuel rebates) illustrate to which extent the fuel cost is reduced in the fishery, measured in AUD/kg live weight fish. Note that this form of tax exemption for fisheries is in Australia motivated from the sector not using roads (i.e. costs embedded in fuel price for road construction and maintenance), and are not formally reported as fuel subsidies in Australia.

Data Quality	Gear	Target species	Subsidy (AUD/kg)	Reference	Description
Gold					
Silver					
Bronze	All TAS	All TAS	0.10	Total tax claims per total landings in TAS	2015-16 (2016-17 also available), state level figures on landings are preliminary for 2015-16

Governance > Ecosystem governance > Bycatch mitigation > Description of the bycatch mitigation measures

Bycatch measures can be spatial (e.g. area closure), temporal (time closure, e.g. night setting only) or technical (bycatch reduction devices, hook size). This indicator describes the measures that are in place for a fishery – but not the rates of compliance. For example, spatial closures for different gear types are shown here for AFMA fisheries http://www.afma.gov.au/sustainability-environment/fishing-closures/. **Data Quality:** Not found

Governance > Ecosystem governance > Protected species mitigation > Description of the protected species mitigation measures

TEP mitigation measures can be spatial (e.g. area closure), temporal (time closure, e.g. night setting only) or technical (bycatch reduction devices, hook size). This indicator describes the measures that are in place for a fishery – but not the rates of compliance. **Data Quality:** Not found

Governance > Management system > Harvest strategy > Scope of the harvest strategy

Assessment can be based on scoring presence of the following: a harvest strategy designed to achieve management objectives; harvest control rules and tools; collection of relevant information to support the harvest strategy; and, assessment of stock status or the presence of the following key elements: Defined operational objectives for the fishery; Indicators of fishery performance related to the objectives; Reference points for performance indicators; A statement defining acceptable levels of risk to meeting objectives; A monitoring strategy to collect relevant data to assess fishery performance; A process for conducting assessment of fishery performance relative to objectives; and; Decision rules that control the intensity of fishing activity and/or catch.

The Scalefish Fishery Management Plan [Fisheries (Scalefish) Rules 1998] was first introduced in 1998 (DPIF 1998) and was reviewed in 2001, 2004, 2009 and most recently in 2015. The management plan provides the regulatory framework for the fishery, which covers commercial and recreational components. While the plan contains the overarching legislation under which the fishery operates, the following objectives, strategies and performance indicators are contained in a policy document currently under review. [291]

Major objectives:
To maintain fish stocks at sustainable levels by restricting the level of fishing effort directed at scalefish, including the amount and types of gear that can be used;
To optimise yield and/or value per recruit;
To mitigate any adverse interactions that result from competition between different fishing methods or sectors for access to shared fish stocks and/or fishing grounds;
To maintain or provide reasonable access to fish stocks for recreational fishers;
To minimise the environmental impact of scalefish fishing methods generally, and particularly in areas of special ecological significance;
To reduce by-catch of juveniles and non-target species; and
To implement effective and efficient management.

Primary strategies:
Limit total commercial fishing capacity by restricting the number of licences available to operate in the fishery;
Define allowable fishing methods and amounts of gear that can be used in the scalefish fishery;
Monitor the performance of the fishery over time, including identification and use of biological reference points (or limits) for key scalefish species;
Protect fish nursery areas in recognised inshore and estuarine habitats by prohibiting or restricting fishing in these areas;
Employ measures to reduce the catch and mortality of non-target or undersized fish; and
Manage developing fisheries under permit conditions.

Data Quality: Bronze

Governance > Management system > Management plans > Scope of management plan

Management plans can be assessed by evaluating the presence of minimum requirements, as follows: a description of the fishery, especially its current status and any established user rights: the management objectives; how these objectives are to be achieved; how the plan is to be reviewed and/or appealed, as well as the consultation process for review and appeal.

The Tasmanian Scalefish Fishery is managed under the Living Marine Resources Management Act 1995[292] and the Fisheries (Scalefish) Rules 2015[293], which contain the following minimum requirements:

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[291] Moore, B., Lyle, J. and Hartmann K. (2018). Tasmanian Scalefish Fishery Assessment 2016/17. Institute for Marine and Antarctic Studies, University of Tasmania.
[292] https://www.legislation.tas.gov.au/view/html/inforce/current/act-1995-025
[293] https://www.legislation.tas.gov.au/view/html/inforce/current/sr-2015-068

established user rights
how the management plan is to be reviewed
consultation process for review and appeal

Data Quality: Gold

Governance > Institutional capacity > Accountability of decision making bodies > Level of Accountability

Accountability of Decision-making bodies. Performance of a fisheries management agency is based on the degree to which decision-making processes are consultative, the basis for decisions are fully explained, and information about decision making is publicly available. The assessment applied the three tiers of Principle 3.2.2 (d) 'Decision-making process' of the MSC Fisheries Standard v2.0 (2014) to determine whether the level of accountability was low, medium or high.

High level of accountability. This is demonstrated by publicly-available management plan and fishery assessment reports, and the availability of proceedings of the Fishery Advisory Committee.

Data Quality: Silver

Governance > Institutional capacity > Uncertainty management > Extent of incorporation of uncertainty in management of the targeted stock

This metric reports on the explicit incorporation of uncertainties in decision support processes used to inform and make appropriate choices of management actions. We recognise three levels of uncertainty: Low level of incorporation of uncertainty; Medium level of incorporation of uncertainty; High level of incorporation of uncertainty. These are based on: Major sources of uncertainty are identified; Assessment takes uncertainty into account; Frequency of monitoring of indicators is high; Monitoring of more than one indicator to support management decisions; Assessment evaluates stock status relative to reference points in a probabilistic way; Robustness of assessments are tested, Alternative hypotheses and assessment approaches are rigorously explored.

Medium level of incorporation of uncertainty in management of the targeted stock, noting that this is a multi species multi gear fishery and the extent of incorporation of uncertainty varies across species.	The assessment applied Principle 1.2.4 (c & d) 'Assessment of stock status: Uncertainty in the Assessment' of the MSC Fisheries Standard v2.0 (2014) to assess extent of incorporation of uncertainty in management of the targeted stock.

Data Quality: Silver

Governance > Compliance > Compliance regime > Level of Compliance

Level of compliance with rules and regulations controlling catch can be assessed by audits that measure the agreement between 1) logbook and observer records; 2) catch disposal records submitted by fishers and fish receivers. It might also be assessed by counting the annual number of breaches/observed offences or enforcement actions, preferably scaled to the level of enforcement effort (e.g. $). This indicator can be scored on the basis of the presence of key monitoring, control and surveillance elements and capacities.

All retained catch must be recorded in a Commercial Catch, Effort & Disposal Record, which is submitted within 7 days of the end of the end of each calendar month. Receipts must be provided for all fish commercially sold or transferred.[294]

Data Quality: Bronze

Governance > Compliance > Surveillance > Surveillance Effort

Regulatory controls include logs and catch reporting, on-board observer programs, vessel inspections, vessel monitoring systems, and visual or electronic surveillance using radar or satellite by boat or by air. Higher degrees of surveillance, or coverage using multiple methods, provide greater levels of certainty in estimates of effort, fishing mortality, bycatch and discard levels, and interactions with protected/listed species. Report on the surveillance carried out on the fishery, as reported by the compliance branch responsible for the fishery **Data Quality:** Not found

Governance > Adaptive capacity > Governance arrangements > Climate change recognition

Governance arrangements relevant to the fishery consider the impact of climate change on the fishery, as evidenced by documentation, policies and plans that describe how management is addressing climate change impacts. Does the fishery management plan, harvest strategy or research activity suggest that climate change is recognised, and integrated into management planning?

There is not explicit recognition for climate responses in the fishery-specific documents.

General call for industry responses is made in the Tasmanian Government climate adaptation plan[295].

The National Harvest Strategy also recognizes that "*Variability in ocean conditions, due to natural variability, climate change or other factors, can affect the productivity of stocks. Fisheries should seek to account for that variability when developing and implementing harvest strategies*"[296]. The Guidelines for the Harvest Strategy provide explicit approaches for fisheries[297]. The strategy and guidelines do not explicitly apply to state fisheries, but will provide guidance.
Data quality: Bronze

Governance > Adaptive capacity > Coping strategies > Climate responses

The fishery has initiated coping strategies (directed) to reduce the impacts of climate change. Evidence of strategies that have been specifically implemented for the fishery might include codes of practice, restocking programs, early warning systems, and so on. The coping strategies may be for long-term change or for extreme events. A description of the climate change responses that have been implemented or explored in research or application are provided.

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[294] https://dpipwe.tas.gov.au/sea-fishing-aquaculture/commercial-fishing/scalefish-fishery/commercial-scalefish
[295] http://www.dpac.tas.gov.au/divisions/climatechange/Climate_Change_Priorities/climate_action_21_-_implementation_plan
[296] Department of Agriculture and Water Resources 2018, *Commonwealth Fisheries Harvest Strategy Policy*, Canberra, June. CC BY 4.0.
[297] Department of Agriculture and Water Resources 2018, *Guidelines for the Implementation of the Commonwealth Fisheries Harvest Strategy Policy*, Canberra, June. CC BY 4.0.

There are no management actions currently implemented that address climate change impacts in the fishery.

Data quality: Bronze

Social and Ethical > Fishers wellbeing > Fisher satisfaction > Satisfaction scores

If available, fishery specific surveys of well-being or satisfaction, with interpretation required for the types of questions and sample. When surveys are not available other sources of data may need to include broader surveys (e.g. not fishery specific) or discussions with industry representatives, managers or fishers about the industry and their opinion of general fisher-wellbeing (note this will be subjective).

Satisfaction score: Medium
According to discussions with the manager, fishers are generally satisfied to be part of the fishery, they see it as a lifestyle rather than a job.

Data Quality: Bronze

Social and Ethical > Fishers wellbeing > Age Structure > Proportion of fishers in standard age cohorts

Proportion of fishers in standard age cohorts that were involved in the fishery at any point in the previous 5 years. If the fishery is not attractive or difficult to enter, the age distribution will be skewed to older ages.

The largest proportion of fishers participating in the Tasmanian Scalefish Fishery in 2017 were between 51-55 although the majority of fishers were 50 years or younger[298].

Data Quality: Gold

[298] DPIPWE data records; Australian Bureau of Statistics (31010DO001_201606 Australian Demographic Statistics, Jun 2016).

Social and Ethical > Wider community > Community satisfaction with fishery > Community feedback

Evidence of processes in place to gather direct engagement with the community (diversely represented) to listen and respond to feedback. This may be through a range of means including formal and informal processes and may not be appropriate to all fisheries in the same way. In some cases Marine Stewardship Council accreditation may demonstrate some evidence of community engagement.

Community feedback: Medium.

According to discussions with the manager this fishery is generally accepted by the community. There is a management advisory committee (agenda and minutes available online), which could oversee a feedback process. Based on general FRDC community perception surveys, satisfaction with Australian fisheries is rated at 42%.

Data quality: Bronze.

Social and Ethical > Wider Community > Level of local employment > Percentage of local employment

The communities surrounding and supporting fisheries benefit from those fisheries when the majority of employees (direct and indirect) associated with the fishery activity are local. Can be reported as direct, indirect and downstream levels. **Data Quality:** Not found

Social and Ethical > Ethical - Human welfare > Protections in place > Legislation exists

Although all workers are automatically operating under legislation according to their state or territory to a safe work place, the extent to which there is awareness of the relevant Acts, and use of these if required, is highly variable and may be different for each business or individual operation within each fishery. See http://workplaceohs.com.au/legislation for a list of state acts and regulations.

Protections in Place: Medium

The Scalefish Tas fishery operates under the Tasmania (WorkSafe Tasmania) – WHS Act 2012 and WHS Regulations 2012. In addition, occupational Health and Safety training is conducted for fishers.

Data Quality: Silver

Social and Ethical > Ethical > Human welfare > Levels of compliance

Levels of compliance (or violations of) with Workplace Health and Safety. If references to Workplace Health and Safety exist in relation to the specific fishery, determine whether these are voluntary or recorded in anyway. If they are recorded, note the level of compliance. As they are likely to be voluntary, there will not likely be a record of compliance, but this may become more readily available in the future. **Data Quality:** Not found

Social and Ethical > Ethical-animal welfare > Animal welfare protections > Protections in place

At this early stage of development of animal welfare, any type of mention of animal welfare exists, it is probably the most appropriate. As this develops in to the future, assessments as to the level of engagement may become more relevant.

Fish handling practices are taught but animal welfare is considered a non-issue for this fishery.

Data Quality: Bronze

Social and Ethical > Ethical-animal welfare > Level of Compliance > Levels of compliance or violations of animal welfare

If there are any references to animal welfare protections or guidelines in fishery management plans and if reports exist, the indicator reports on the level of compliance or violations with welfare provisions.

Fish handling practices are taught.

Data Quality: Bronze

Social and Ethical > Climate-related > Access to information > Availability of information

This indicator describes available information that will help participants in the fishery adapt to changes. The assumption behind this indicator is that good information availability and flow will help fishers to adapt.

Data Quality: Not found.

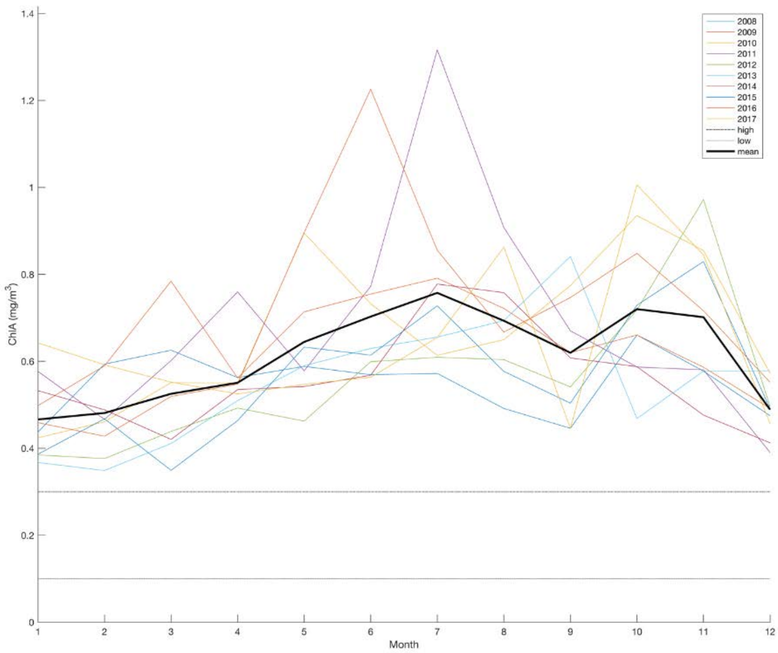
Social and Ethical > Climate-related > Access to networks > Level of membership of industry association

This metric assesses the presence or absence of a dedicated social media or social network group for the fishery. The fishery may still have a strong social network without a social media presence.

Data Quality: Not found.

External > Environmental Context > Productivity > Mean chlorophyll

A measure of environmental productivity is the biomass of phytoplankton, which in oceanic waters can be approximated by chlorophyll a concentration, as estimated from satellite (MODIS, oceandata.sci.gsfc.nasa.gov). Monthly chlorophyll values for a representative area of the fishery are shown with the mean productivity shown in solid black and references levels of low chlorophyll at 0.1 mg $m^{-3}$and high chlorophyll levels at 0.3 mg m^{-3}. This indicator shows the mean chlorophyll by month for the years 2008-2017. These data provide information on the relative environmental productivity in the fishery area. Missing data for some months can be due to ice cover. Variability in chlorophyll a concentration between years can indicate high environmental variability, while similar seasonal patterns indicate relative environmental stability.



Data Quality: Gold

External > Environmental Context > Environmental character > Description of the ecosystems

This metric provides a qualitative description of the ecosystem(s) in which the fishery occurs. The goal is to provide a general overview of these environments. The knowledge about which ecosystems are encountered during fishing activity is the indicator (rather than the response of the ecosystems to fishing).

Marine ecosystems are defined for the purposes of this indicator as the composition of plants, animals, and the marine environment (water masses, geomorphology). Types of marine ecosystems include estuaries, the sea floor, the mesopelagic zone, the pelagic zone, the inter-tidal zones, coral reefs, lagoons, and mangroves. A pelagic zone ecosystem for example, is defined by physical, chemical and biological features of the marine water column of the open ocean[299].

Description of the ecosystems: High

This fishery takes place in coastal and deep waters, predominately over rocky reefs and adjacent soft sediments. Effort data to locate fishing effort were not publically available.

Data Quality: Silver

External > Climate related > Susceptibility of target species > Impacts on target species

[299] Game, E. T., H. S. Grantham, A. J. Hobday, R. L. Pressey, A. T. Lombard, L. E. Beckley, K. Gjerde, R. H. Bustamante, H. P. Possingham and A. J. Richardson (2009). Pelagic protected areas: the missing dimension in ocean conservation. Trends in Ecology and Evolution **24**(7): 360-369 doi:310.1016/j.tree.2009.1001.1011.

Climate change directly affects the distribution, abundance and phenology of individual species. These changes then affect the fisheries that harvest these species, and can be a strong external influence on the fishery. These impacts can be positive (e.g. increased abundance), or negative (e.g. movements further from fishing ports), and to long-term warming, or short-term extreme events such as marine heatwaves.

Sensitivity of the target species to climate change has been assessed[300]. Species in this fishery have sensitivities ranging from low to high.

Common name	Species	Fishery	Score	Sensitivity
Southern sand flathead	Platycephalus bassensis	Scalefish Fishery	5.75	MODERATELY HIGH
Tiger flathead	Platycephalus richardsoni	Scalefish Fishery	5.25	MODERATE
Gummy shark	Mustelus antarcticus	Scalefish Fishery	6	MODERATELY HIGH
Jack mackerel	Trachurus declivis	Scalefish Fishery	5.75	MODERATELY HIGH
Blue mackerel	Scomber australasicus	Scalefish Fishery	5	LOW
Southern calamari	Sepioteuthis australis	Scalefish Fishery	6	MODERATELY HIGH
Southern garfish	Hyporhamphus melanochir	Scalefish Fishery	5.5	MODERATE

Data Quality: Silver

External > Climate related > Susceptibility of key habitats > Habitat Impacts

Habitat impact: Moderate

Data Quality: Bronze

External > Contaminants in the environment > Detection system for seafood contaminants > Risk of contaminants

Potential risk for contamination from the marine environment combined with monitoring arrangements to be able to address risks needed to ensure food safety. Contaminants include those with maximum levels set for by Food Standards Code Australia: metal contaminants, non-metal contaminants, natural toxicants, and average and maximum levels of mercury in fish. Contaminants from poor handling after landing are not assessed but may be indirectly addressed.

Rubric for risk level:

Low risk	Medium risk	High risk

[300] Fulton EA, Hobday AJ, Pethybridge H, Blanchard J, Bulman C, Butler I, Cheung W, Gorton B, Hutton T, Lozano- Montes H, Matear R, Pecl G, Villanueva C, Zhang X (2018). *Decadal scale projection of changes in Australian fisheries stocks under climate change.* CSIRO Report to FRDC. FRDC Project No: 2016/139 – ONLINE.

There are no documented levels of contaminants from the marine environment causing risk/diet restrictions to any consumer group in the fishery.	There may be seasonal/area/species/size-based risks of contaminants for some species.	Permanent diet restrictions of species caught to vulnerable consumers such as children or pregnant women.

Risk of Contaminants: Low

The fishery has a Food Safety Plan, developed in cooperation with the Tasmanian Government (following Primary Production and Processing (PPP) Standard for Seafood developed by Food Standards Australia and New Zealand) and systems to provide industry participants with a means of clearly demonstrating compliance with the PPP Seafood Standard. http://dpipwe.tas.gov.au/biosecurity-tasmania/product-integrity/food-safety/seafood

Data Quality: Gold

External > Contaminants in the environment > Management arrangements to ensure food safety related to contaminants > Evidence for arrangements

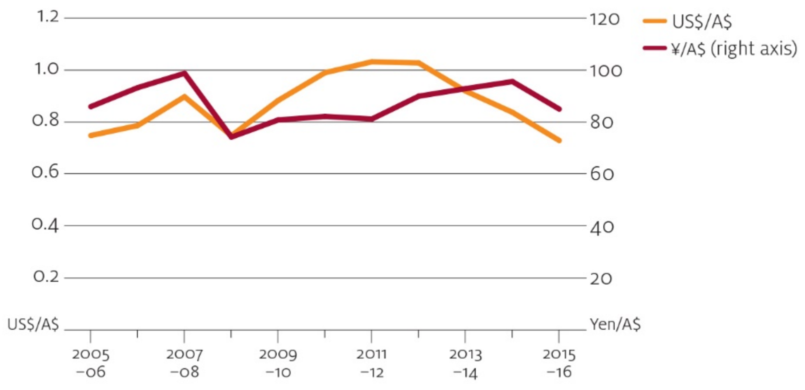
There is evidence of management arrangements to ensure food safety related to contaminants and food safety from the marine environment. No supply chain risks from poor handling are considered. Food standard 4.2.1 requires all seafood business in Australia to identify potential seafood safety hazards and put controls in place that are consistent with the risk.

Data Quality	
GOLD	"Required to comply with the national Primary Production and Processing Standard for Seafood." http://dpipwe.tas.gov.au/sea-fishing-aquaculture/commercial-fishing/scalefish-fishery/commercial-scalefish http://dpipwe.tas.gov.au/sea-fishing-aquaculture/community-resources/cooking-fish/safety-of-fish-and-shellfish-for-eating http://dpipwe.tas.gov.au/sea-fishing-aquaculture/sustainable-fisheries-management/Biotoxin-Fishery-Events
SILVER	
BRONZE	

External > Market Drivers > Macroeconomic factors > Exchange Rates

A depreciating Australian dollar (or, increasing exchange rate) generally results in producers receiving a higher export price in Australian dollar terms, while an appreciating Australian dollar (or, decreasing exchange rate) results in a lower export price. Domestically, a depreciation of the Australian dollar encourages substitution from imported seafood to domestically produced seafood, as imported products become relatively more expensive. A lower exchange rate also makes Australian exports more competitive in world markets, as exported seafood become relatively cheaper in foreign currency terms.

National export trends are negatively related to exchange rate movements— the Australian dollar declined against the US dollar and Japanese yen from 1990–91 to 2000–01, with exports increasing in volume and value. Exchange rates for the Australian dollar increased against those currencies from 2001–02 to 2015–16. The real export value and volume of Australia's seafood exports decreased between 2005–06 and 2012–13 and then increased between 2012–13 and 2015–16—with a noticeable rise (43 per cent) in volume between 2014–15 and 2015–16.[301]



Data Quality: Gold

External > Market Drivers > Consumer Trends > Per person annual apparent consumption of seafood (kg)

Annual apparent consumption is estimated by adding the total edible quantity of seafood supplied domestically—that is, total production plus imported seafood— less exports of seafood. Apparent consumption provides an estimate of the total amount of seafood consumed in Australia assuming zero change in stocks.

The production quantity of Australian fishery and aquaculture products is reported by ABARES on a whole weight basis, whereas trade data are reported on a processed basis. To align the units of measurement between production and trade data, it is necessary to convert production volume to a processed edible equivalent.

Production volumes are adjusted to an edible quantity basis using species-specific conversion rates and excluding species that are known to be predominantly supplied for non-human consumption purposes, such as for aquaculture feed or bait. Imports and exports of seafood are sourced from Australian Bureau of Statistics (ABS) trade data and are reported as edible weight. The apparent consumption per person is calculated as the total apparent consumption divided by the total Australian population in each year. The method applied here is consistent with that used by ABARES to estimate apparent consumption of other agricultural commodities produced in Australia.

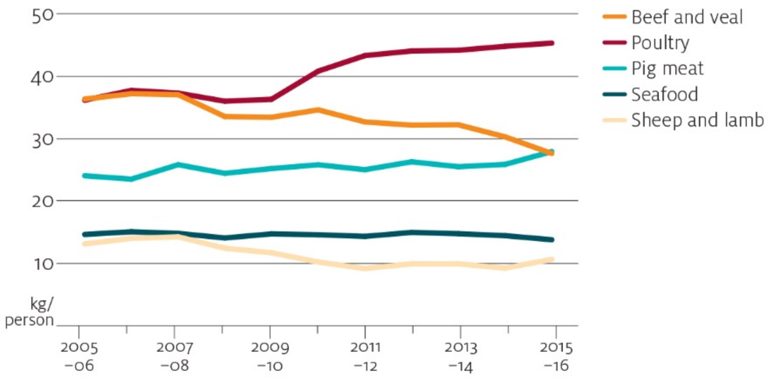
The FAO also compiles statistics on apparent consumption of seafood, applying a consistent method across all countries. FAO estimates indicate that annual consumption of seafood in Australia is around 26 kilograms per person in 2013 (FAO 2016[302]). The discrepancy between FAO and ABARES estimates reflects differences in methodological approaches to estimating consumption. Moreover,

[301] Mobsby, D and Koduah, A 2017, Australian fisheries and aquaculture statistics 2016, FRDC project 2017-095. ABARES, Canberra, December. CC BY 4.0.
[302] The state of world fisheries and aquaculture 2016—opportunities and challenges, Food and Agriculture Organization of the United Nations, Rome.

ABARES estimates seafood consumption on a processed edible basis, whereas the FAO provides its estimates on a whole weight basis.

In Australia, apparent consumption of seafood per person (edible equivalent) decreased, on average, at an annual rate of 0.6 per cent, from 14.6 kilograms in 2005– 06 to 13.8 kilograms per person in 2015–16. Annual apparent consumption is estimated by the Australian Bureau of Agricultural and Resource Economics and Sciences by adding the total edible quantity of seafood supplied domestically—that is, total production plus imported seafood— less exports of seafood[303]

In comparison, global per capita apparent fish consumption increased from an average of 9.9 kg in the 1960s to 14.4 kg in the 1990s and 20.1 kg in 2014, with preliminary estimates for 2015 indicating further growth, exceeding 20 kg (FAO 2016). Australia's per person seafood consumption in 2013 was estimated by the FAO to be 26kg. The differences in estimates are accounted for by varying methods for calculating consumption. ABARES estimates seafood consumption on a processed edible basis, whereas the FAO provides its estimates on a whole weight basis.



Data quality: Gold

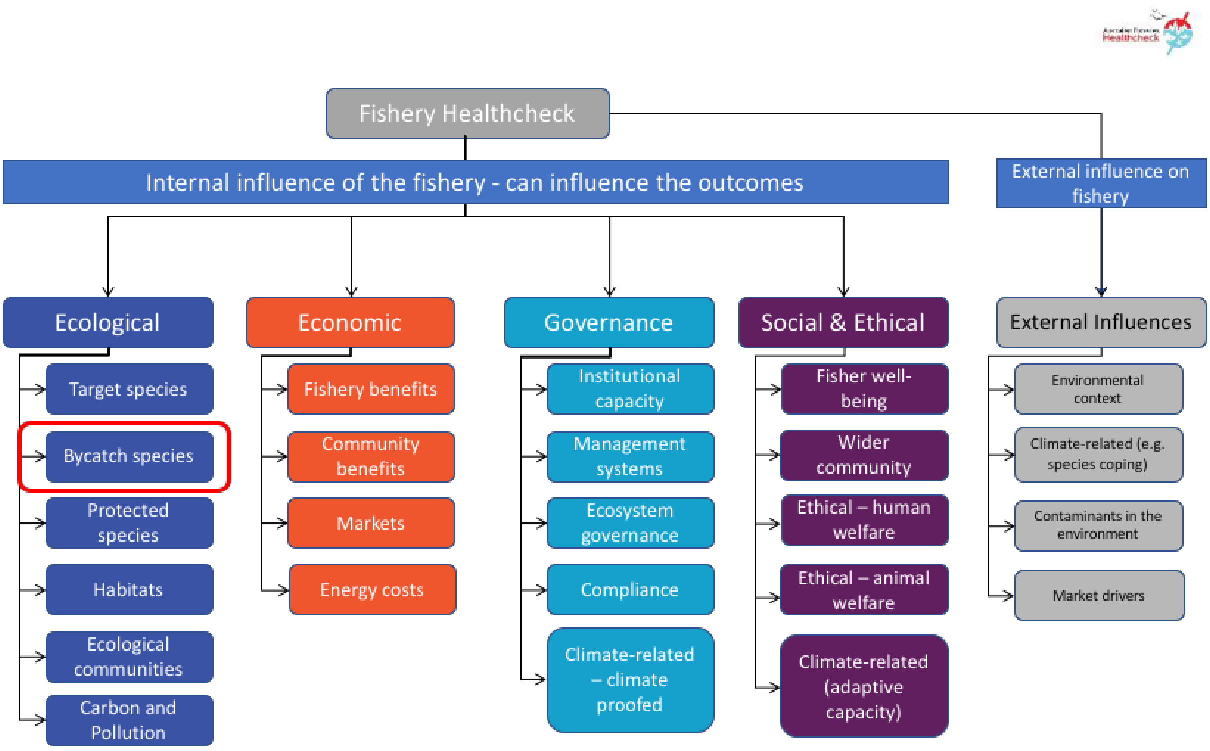
303 Mobsby, D and Koduah, A 2017, *Australian fisheries and aquaculture statistics 2016*, FRDC 2017-095. ABARES, Canberra, December. CC BY 4.0

Tasmanian Abalone Fishery

The Tasmanian Abalone Fishery is one of the three large seafood industries in the state along with the rock lobster fishery and salmon farming. It has a private market capitalisation of around $900 million. Despite the value of the fishery, it has only been a recent adopter of a harvest strategy, which is now used to guide catch settings for the various spatial zones in the fishery. Catch guidance from the harvest strategy is only indicative and there is much discussion around decisions within industry and government committees, before the final decisions are made by the minister. The assessment relies on traditional catch and effort data plus increasingly uses GIS and diver depth data. This is a single species and gear, with most catch exported live. Recreational catch is a minor fraction of the total catch and is monitored through regular surveys. (Source: Fisheries Guidelines Project).

Case Study Presentation Format

The case study documents are a collection of metrics, organised by the healthcheck structure:



The presentation of metrics will follow the following heading format:

Ecological > Bycatch species > Bycatch composition > <u>Mean Trophic Level</u>

Understand this to be an indicator (**Bycatch composition**) of the **Ecological** Component, **Bycatch species** subcomponent where the (in the figure and heading example above, is being measured by presenting <u>Mean Trophic Level</u> as the metric.

Ecological > Target species > Stock Status > Status of Australian Fish Stocks (SAFS)

Target species in each fishery are the primary focus for this indicator. Status of these species is ideally assessed with the SAFS approach, however this may not cover all target species for each fishery. In that case, we indicate the number of unassessed species. These species could also be assessed by individual states or by alternative methods.

SpeciesName	StockName	StockStatus	Year
Greenlip Abalone	Tasmanian Greenlip Abalone Fishery	Transitional-depleting	2016

Data Quality: Gold

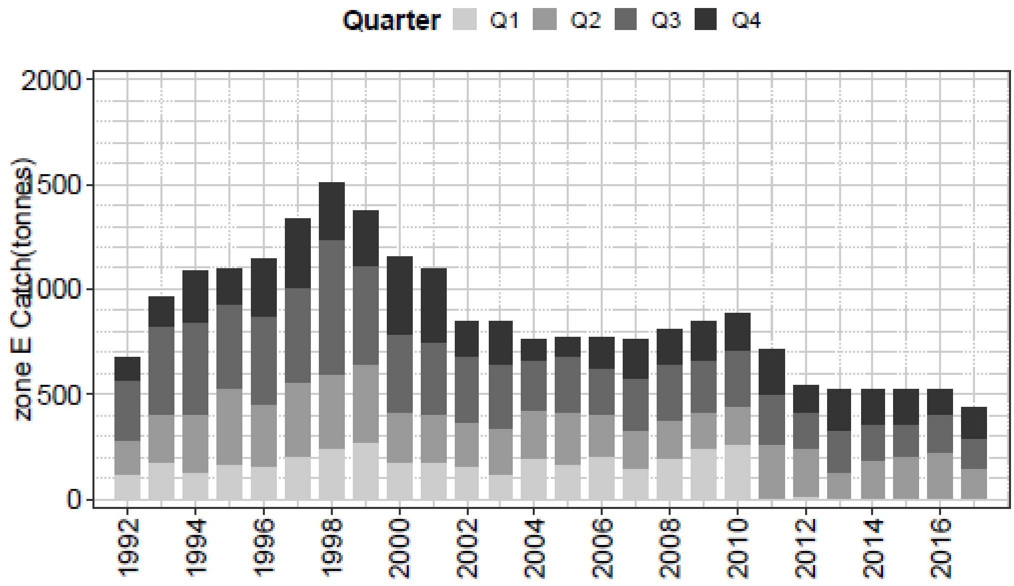
Ecological > Target Species > Harvest Level > Catch weight

This metric is a proxy for harvest level. The harvested biomass for each species, provides information on the level of the catch. Trends in this metric over time can indicate declining availability of fish, quota restrictions, or changes in market demand. For Australian fisheries, trends are expected to be stable for most species.

Comprehensive catch data for Tasmanian abalone was available from the October 2018 IMAS assessment report[304]. This report includes high quality data between 1992-2017, with historical context back to the 1950's. The fishery has predominantly focused on blacklip

abalone (Haliotis rubra), with greenlip abalone (H. laevigata) typically accounting for around 5% of the total wild harvest in Tasmania. Total landings for the 2017 Tasmanian abalone fishery were 1561.2 t, comprising 1420.9 t of blacklip and 140.2 t of greenlip, from a total allowable commercial catch (TACC) of 1,561.0 t. The fishery is managed spatially in five blacklip zones and one greelip zone. Figures and tables from this report show the recent catch in each of these zones, such as the eastern zone shown below.

[304] https://secure.utas.edu.au/__data/assets/pdf_file/0006/1162518/AbaloneAssessment2017Web-sm.pdf



Data quality: Gold

Ecological > Bycatch species > Bycatch composition > Mean Trophic Level

The trophic level is a measure of the position of an organism in a food web, starting at level 1 with primary producers, such as phytoplankton, then moving through the primary consumers at level **2** that eat the primary producers to the secondary consumers at level **3** that eat the primary consumers, and so on. The **bycatch mean trophic level** is an indicator of the mean level of the food chain for bycatch in a fishery.

This fishery has very low bycatch, and so this metric was not calculated

Data Quality: Not applicable

Ecological > Bycatch species > Bycatch amount > Total weight of bycatch

Bycatch weights for fishery are typically developed by specific projects, and require a range of assumptions due to issues with reporting and retention of bycatch. **Bycatch** estimates typically cover species that are not target species, while **discard** rates may also include undersized individuals of the target species. Kennelly (2018) provides estimates of discard rates, which include both target and bycatch species, and when discard rates are used, that information is noted for each fishery. Animals can be returned to the ocean alive or dead. The intention of this metric is to provide information on animals that are dead on return to the ocean.

Reference:

Kennelly, S.J., 2018. *Developing a National Bycatch Reporting System.* Final FRDC Report, ISBN 978-0-9924930-5-9, March, 2018. 99 pp.

The 2018 Tasmanian Abalone Assessment Report[305] notes “There is no bycatch associated with this fishery. All abalone are hand-harvested by divers operating on low pressure surface

[305] https://secure.utas.edu.au/__data/assets/pdf_file/0006/1162518/AbaloneAssessment2017Web-sm.pdf

supply (hookah). The small vessel size used by most abalone fishers, and the shallow water and proximity to the exposed coast also limits negative impacts on other mobile fauna."

However, Kennelly (2018)[306] reports "The Tasmanian Abalone fishery, which uses hand-gathering, can be expected to have very little discarding - although there may be occasional discarding from vessels of undersize/undesirable/over-quota individuals, and this may vary with the experience of divers. Whilst this has not been estimated for the Tasmanian fishery, in NSW, such discarding may be around 8.3% of landings (or a retained: discard ratio of 1:0.09 - Gibson et al., 2002)."

Abalone	Dive	1:0.09	8.26%

Table 15 from Kennelly (2018) - Discard estimates (and SE's) for abalone fishery with total estimates for all fisheries and methods derived from combining the data in Tables 12 and 14. Where there were no discard data available (and one could not assume zero discards or use discard estimates from NSW or other methods), those methods were removed (Danish seine and Troll).

Fishery	Method	Retained catch (tonnes)	SE	Discarded catch (tonnes)	SE
Abalone	Dive	2139.80	124.50	192.58	192.58

Data Quality: Silver

Ecological > Protected species > Capture amount > Captures

The number and diversity of TEP species captured by a fishery in the most recent year, provided as annual numbers.

Information about interactions with TEPs in Tasmania comes from 2 sources: compulsory logbook reporting by fishers and independent observer reporting Kennelly (2018)[307]. As found elsewhere in the world, the data show that interaction rates are much higher in the observer data which throws doubt on the validity of the logbook data. However, despite the existence of the observer dataset, there is little consolidation of TEPs interactions available from those data.

Data quality: Bronze

Ecological > Protected species > Reporting > Level of monitoring

This indicator is to provide information on the level of coverage for a fishery. Annual measures are preferred.

[306] Kennelly, S.J., 2018. *Developing a National Bycatch Reporting System.* Final FRDC Report, ISBN 978-0-9924930-5-9, March, 2018. 99 pp.
[307] Kennelly, S.J., 2018. *Developing a National Bycatch Reporting System.* Final FRDC Report, ISBN 978-0-9924930-5-9, March, 2018. 99 pp.

Data quality: Not found

Ecological > Habitats > Habitat impact > Impact score

The habitat impact is an indicator of the effect the fishing gear has on the habitat. Different gear types have different impacts. See the scoring rubric.

Habitat Impact: Negligible, based on the gear type used in this fishery.

Data quality: Bronze

Ecological > Habitats > Habitat impact > Habitat status

The status of the habitat types is a measure of the condition relative to a pristine state. Fishing may not be responsible for that habitat status, but it is important to note if fishing is taking place in pristine or disturbed habitats.

Habitat status: Moderate – changing environment as a result of climate change and expansion of urchin barrens has significantly impacted this system in eastern Tasmania

Data quality: Bronze

Ecological > Ecological communities > Ecosystem status > Ecosystem status

This metric reports the ecosystem status in the region of the fishery.

Ecosystem Status: Good, but declining

Rocky reefs in southern Australia have been impacted by coastal runoff and environmental change. The 2016 SOE report notes the 0-25 m inner shelf as being in good condition[308]. Loss of macroalgal habitat due to warming and urchin barrens have been reported from regions of the east coast where fishing occurs[309]. Ecosystem status in southern and western Tasmania are in good to excellent condition.

Data Quality: Silver

Ecological > Ecological communities > Ecosystem status > Species diversity

The measure of species diversity as a ratio between fished and unfished states.

Data quality: Not found

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[308] https://soe.environment.gov.au/assessment-summary/marine-environment/state-and-trends-habitats-and-communities

[309] Johnson, C. R., S. C. Banks, N. S. Barrett, F. Cazassus, P. K. Dunstan, G. J. Edgar, S. D. Frusher, C. Gardner, M. Haddon, F. Helidoniotis, K. L. Hill, N. L. Holbrook, G. W. Hosie, P. R. Last, S. D. Ling, J. Melbourne-Thomas, K. Miller, G. T. Pecl, A. J. Richardson, K. R. Ridgway, S. R. Rintoul, D. A. Ritz, D. J. Ross, J. C. Sanderson, S. A. Shepherd, A. Slotwinski, K. M. Swadling and N. Taw (2011). Climate change cascades: Shifts in oceanography, species' ranges and subtidal marine community dynamics in eastern Tasmania. Journal of Experimental Marine Biology and Ecology **400**: 17–32 doi:10.1016/j.jembe.2011.1002.1032.

Ecological > Carbon and Pollution > Macro-plastics > Plastic code of conduct

Macro-plastics are plastics that are visible to the naked eye, such as food containers and wrapping, equipment packaging, and fishing equipment. The metric notes a commitment to a zero waste overboard code of conduct to assess attempts to reduce accidental or intentional introduction of macro-plastics to the ocean. There are stated guidelines detailing Australia's guidelines regarding marine pollution from the Australian Maritime Safety Authority[310]:

Pollution of the marine environment by ships, including fishing vessels, is strictly controlled by the International Convention for the Prevention of Pollution from Ships (known as MARPOL).

To minimise pollution, MARPOL prohibits ships from discharging garbage into the sea except in very limited circumstances.

Australian MARPOL regulations apply to Australian fishing vessels wherever they are operating.

Data Quality: Bronze

Ecological > Carbon and Pollution > Carbon footprint > CO_2-equivalents

The emissions of climate forcing gases in kg CO_2-equivalents (CO_2e) per kg live weight fish caught, not including the supply chain after landing.

Data Quality	Gear	Target species	Min (kg CO_2e/kg)	Average (kg CO_2e/kg)	Max (kg CO_2e/kg)	Reference	Description
Gold							
Silver	Dive	Abalone		2.2		Parker et al 2015	Tasmania, 2012, unspecified fuel type, refrigerants not included
Bronze	Dive	Molluscs	1.5	2.6	3.7	Parker and Tyedmers 2015	Oceania region, year and fuel type not specified, refrigerants not included.

Economic > Fishery Benefits > Net Economic Returns > Economic Rent

Net Economic Returns (NER) is equal to fishing revenue less fishing costs and measures the economic profit that is derived from fishing activity, it is measured by the Commonwealth as Net Economic Returns and by some States as Economic Rent.

Data Quality: Not found

[310] https://www.amsa.gov.au/marine-environment/marine-pollution/pollution-fishing-vessels
https://www.amsa.gov.au/marine-environment/marine-pollution/marpol-and-its-implementation-australia

Economic > Fishery Benefits > Gross Value of Production > Gross Value of Production

GVP calculated as the volume of catch multiplied by the average per unit beach price (AUD$).

Data Quality	Species/Fishery	Year	Amount	Reference	Note/Comment
Gold	TAS Abalone	2015-2016	$79,738,000	Mobsby, D & Koduah, A (2017) Australian fisheries and aquaculture statistics 2016, Fisheries Research and Development Corporation project 2017-095. ABARES, Canberra, December. CC BY 4.0	
Gold	TAS Abalone	2014-2015	$77,841,000	Mobsby, D & Koduah, A (2017) Australian fisheries and aquaculture statistics 2016, Fisheries Research and Development Corporation project 2017-095. ABARES, Canberra, December. CC BY 4.0	
Gold	TAS Abalone	2013-2014	$82,670,000	Mobsby, D & Koduah, A (2017) Australian fisheries and aquaculture statistics 2016, Fisheries Research and Development Corporation project 2017-095. ABARES, Canberra, December. CC BY 4.0	

Economic > Fishery Benefits > Profitability > Financial Performance

Economic health of a fishery can be measured by the financial performance of the operators in the fleet. Fleet wide averages or distributions of levels of profitability indicate the extent to which the fishery is generating economic benefits for fishers.

Data Quality: Not found

Economic > Fishery Benefits > Latency > Underutilised Effort

Latency is fishery concessions that are not being fully utilised by fishers, for example, often the annual total allowable catch is left partially or largely uncaught for a fishery. Latency may appear as effort or uncaught TAC or inactive licences.

Data Quality	Indicator used	Year	Amount	Reference	Note
Gold	Uncaught TAC	2016	1.6% of TACC	Mundy, C & Jones H (2017) Tasmanian abalone fishery assessment 2016. IMAS http://www.imas.utas.edu.au/__data/assets/pdf_file/0006/982464/TasAbaloneAssessmentFY2016.pdf	Eastern Zone
Gold	Uncaught TAC	2016	2.4% of TACC	Mundy, C & Jones H (2017) Tasmanian abalone fishery assessment 2016. IMAS http://www.imas.utas.edu.au/__data/assets/pdf_file/0006/982464/TasAbaloneAssessmentFY2016.pdf	Western Zone
Gold	Uncaught TAC	2016	0% of TACC	Mundy, C & Jones H (2017) Tasmanian abalone fishery assessment 2016. IMAS http://www.imas.utas.edu.au/__data/assets/pdf_file/0006/982464/TasAbaloneAssessmentFY2016.pdf	Central Western Zone
Gold	Uncaught TAC	2016	0.5% of TACC	Mundy, C & Jones H (2017) Tasmanian abalone fishery assessment 2016. IMAS http://www.imas.utas.edu.au/__data/assets/pdf_file/0006/982464/TasAbaloneAssessmentFY2016.pdf	Northern Zone
Gold	Uncaught TAC	2016	2.6% of TACC	Mundy, C & Jones H (2017) Tasmanian abalone fishery assessment 2016. IMAS http://www.imas.utas.edu.au/__data/assets/pdf_file/0006/982464/TasAbaloneAssessmentFY2016.pdf	Bass Strait
Gold	Uncaught TAC	2016	0.7% of TACC	Mundy, C & Jones H (2017) Tasmanian abalone fishery assessment 2016. IMAS http://www.imas.utas.edu.au/__data/assets/pdf_file/0006/982464/TasAbaloneAssessmentFY2016.pdf	Greenlip
Gold	Uncaught TAC	2015	1% of TACC	Mundy, C & Jones H (2017) Tasmanian abalone fishery assessment 2016. IMAS http://www.imas.utas.edu.au/__data/assets/pdf_file/0006/982464/TasAbaloneAssessmentFY2016.pdf	Eastern Zone

Gold	Uncaught TAC	2015	1.1% of TACC	Mundy, C & Jones H (2017) Tasmanian abalone fishery assessment 2016. IMAS http://www.imas.utas.edu.au/__data/assets/pdf_file/0006/982464/TasAbaloneAssessmentFY2016.pdf	Western Zone
Gold	Uncaught TAC	2015	1% of TACC	Mundy, C & Jones H (2017) Tasmanian abalone fishery assessment 2016. IMAS http://www.imas.utas.edu.au/__data/assets/pdf_file/0006/982464/TasAbaloneAssessmentFY2016.pdf	Central Western Zone
Gold	Uncaught TAC	2015	-0.9% of TACC	Mundy, C & Jones H (2017) Tasmanian abalone fishery assessment 2016. IMAS http://www.imas.utas.edu.au/__data/assets/pdf_file/0006/982464/TasAbaloneAssessmentFY2016.pdf	Northern Zone
Gold	Uncaught TAC	2015	0% of TACC	Mundy, C & Jones H (2017) Tasmanian abalone fishery assessment 2016. IMAS http://www.imas.utas.edu.au/__data/assets/pdf_file/0006/982464/TasAbaloneAssessmentFY2016.pdf	Bass Strait
Gold	Uncaught TAC	2015	-2.9% of TACC	Mundy, C & Jones H (2017) Tasmanian abalone fishery assessment 2016. IMAS http://www.imas.utas.edu.au/__data/assets/pdf_file/0006/982464/TasAbaloneAssessmentFY2016.pdf	Greenlip
Gold	Uncaught TAC	2014	1.2% of TACC	Mundy, C & Jones H (2017) Tasmanian abalone fishery assessment 2016. IMAS http://www.imas.utas.edu.au/__data/assets/pdf_file/0006/982464/TasAbaloneAssessmentFY2016.pdf	Eastern Zone
Gold	Uncaught TAC	2014	1.3% of TACC	Mundy, C & Jones H (2017) Tasmanian abalone fishery assessment 2016. IMAS http://www.imas.utas.edu.au/__data/assets/pdf_file/0006/982464/TasAbaloneAssessmentFY2016.pdf	Western Zone
Gold	Uncaught TAC	2014	2% of TACC	Mundy, C & Jones H (2017) Tasmanian abalone fishery	Central Western Zone

				assessment 2016. IMAS http://www.imas.utas.edu.au/__data/assets/pdf_file/0006/982464/TasAbaloneAssessmentFY2016.pdf	
Gold	Uncaught TAC	2014	1.8% of TACC	Mundy, C & Jones H (2017) Tasmanian abalone fishery assessment 2016. IMAS http://www.imas.utas.edu.au/__data/assets/pdf_file/0006/982464/TasAbaloneAssessmentFY2016.pdf	Northern Zone
Gold	Uncaught TAC	2014	5.7% of TACC	Mundy, C & Jones H (2017) Tasmanian abalone fishery assessment 2016. IMAS http://www.imas.utas.edu.au/__data/assets/pdf_file/0006/982464/TasAbaloneAssessmentFY2016.pdf	Bass Strait
Gold	Uncaught TAC	2014	0% of TACC	Mundy, C & Jones H (2017) Tasmanian abalone fishery assessment 2016. IMAS http://www.imas.utas.edu.au/__data/assets/pdf_file/0006/982464/TasAbaloneAssessmentFY2016.pdf	Greenlip
Gold	Uncaught TAC	2013	0.9% of TACC	Mundy, C & Jones H (2017) Tasmanian abalone fishery assessment 2016. IMAS http://www.imas.utas.edu.au/__data/assets/pdf_file/0006/982464/TasAbaloneAssessmentFY2016.pdf	Eastern Zone
Gold	Uncaught TAC	2013	2% of TACC	Mundy, C & Jones H (2017) Tasmanian abalone fishery assessment 2016. IMAS http://www.imas.utas.edu.au/__data/assets/pdf_file/0006/982464/TasAbaloneAssessmentFY2016.pdf	Western Zone
Gold	Uncaught TAC	2013	0.5% of TACC	Mundy, C & Jones H (2017) Tasmanian abalone fishery assessment 2016. IMAS http://www.imas.utas.edu.au/__data/assets/pdf_file/0006/982464/TasAbaloneAssessmentFY2016.pdf	Central Western Zone
Gold	Uncaught TAC	2013	-1.3% of TACC	Mundy, C & Jones H (2017) Tasmanian abalone fishery assessment 2016. IMAS http://www.imas.utas.edu.au/	Northern Zone

				__data/assets/pdf_file/0006/982464/TasAbaloneAssessmentFY2016.pdf	
Gold	Uncaught TAC	2013	1.4% of TACC	Mundy, C & Jones H (2017) Tasmanian abalone fishery assessment 2016. IMAS http://www.imas.utas.edu.au/__data/assets/pdf_file/0006/982464/TasAbaloneAssessmentFY2016.pdf	Bass Strait
Gold	Uncaught TAC	2013	-17% of TACC	Mundy, C & Jones H (2017) Tasmanian abalone fishery assessment 2016. IMAS http://www.imas.utas.edu.au/__data/assets/pdf_file/0006/982464/TasAbaloneAssessmentFY2016.pdf	Greenlip – closed 25 November
Gold	Uncaught TAC	2012	1.2% of TACC	Mundy, C & Jones H (2017) Tasmanian abalone fishery assessment 2016. IMAS http://www.imas.utas.edu.au/__data/assets/pdf_file/0006/982464/TasAbaloneAssessmentFY2016.pdf	Eastern Zone
Gold	Uncaught TAC	2012	-16.1% of TACC	Mundy, C & Jones H (2017) Tasmanian abalone fishery assessment 2016. IMAS http://www.imas.utas.edu.au/__data/assets/pdf_file/0006/982464/TasAbaloneAssessmentFY2016.pdf	Western Zone
Gold	Uncaught TAC	2012	58% of TACC	Mundy, C & Jones H (2017) Tasmanian abalone fishery assessment 2016. IMAS http://www.imas.utas.edu.au/__data/assets/pdf_file/0006/982464/TasAbaloneAssessmentFY2016.pdf	Central Western Zone
Gold	Uncaught TAC	2012	0% of TACC	Mundy, C & Jones H (2017) Tasmanian abalone fishery assessment 2016. IMAS http://www.imas.utas.edu.au/__data/assets/pdf_file/0006/982464/TasAbaloneAssessmentFY2016.pdf	Northern Zone
Gold	Uncaught TAC	2012	2.9% of TACC	Mundy, C & Jones H (2017) Tasmanian abalone fishery assessment 2016. IMAS http://www.imas.utas.edu.au/__data/assets/pdf_file/0006/9	Bass Strait

				82464/TasAbaloneAssessmentFY2016.pdf	
Gold	Uncaught TAC	2012	0% of TACC	Mundy, C & Jones H (2017) Tasmanian abalone fishery assessment 2016. IMAS http://www.imas.utas.edu.au/__data/assets/pdf_file/0006/982464/TasAbaloneAssessmentFY2016.pdf	Greenlip
Gold	Uncaught TAC	2011	1.7% of TACC	Mundy, C & Jones H (2017) Tasmanian abalone fishery assessment 2016. IMAS http://www.imas.utas.edu.au/__data/assets/pdf_file/0006/982464/TasAbaloneAssessmentFY2016.pdf	Eastern Zone
Gold	Uncaught TAC	2011	-13.3% of TACC	Mundy, C & Jones H (2017) Tasmanian abalone fishery assessment 2016. IMAS http://www.imas.utas.edu.au/__data/assets/pdf_file/0006/982464/TasAbaloneAssessmentFY2016.pdf	Western Zone
Gold	Uncaught TAC	2011	55.3% of TACC	Mundy, C & Jones H (2017) Tasmanian abalone fishery assessment 2016. IMAS http://www.imas.utas.edu.au/__data/assets/pdf_file/0006/982464/TasAbaloneAssessmentFY2016.pdf	Central Western Zone
Gold	Uncaught TAC	2011	-0.4% of TACC	Mundy, C & Jones H (2017) Tasmanian abalone fishery assessment 2016. IMAS http://www.imas.utas.edu.au/__data/assets/pdf_file/0006/982464/TasAbaloneAssessmentFY2016.pdf	Northern Zone
Gold	Uncaught TAC	2011	2.9% of TACC	Mundy, C & Jones H (2017) Tasmanian abalone fishery assessment 2016. IMAS http://www.imas.utas.edu.au/__data/assets/pdf_file/0006/982464/TasAbaloneAssessmentFY2016.pdf	Bass Strait
Gold	Uncaught TAC	2011	-5% of TACC	Mundy, C & Jones H (2017) Tasmanian abalone fishery assessment 2016. IMAS http://www.imas.utas.edu.au/__data/assets/pdf_file/0006/982464/TasAbaloneAssessmentFY2016.pdf	Greenlip – Perkins Bay closed 1 October

Gold	Uncaught TAC	2011	-16.7% of TACC	Mundy, C & Jones H (2017) Tasmanian abalone fishery assessment 2016. IMAS http://www.imas.utas.edu.au/__data/assets/pdf_file/0006/982464/TasAbaloneAssessmentFY2016.pdf	Greenlip – NW Greenslip closed 29 October
Gold	Uncaught TAC	2011	-6% of TACC	Mundy, C & Jones H (2017) Tasmanian abalone fishery assessment 2016. IMAS http://www.imas.utas.edu.au/__data/assets/pdf_file/0006/982464/TasAbaloneAssessmentFY2016.pdf	Greenlip – Furneaux Group closed 28 November
Gold	Uncaught TAC	2010	1.3% of TACC	Mundy, C & Jones H (2017) Tasmanian abalone fishery assessment 2016. IMAS http://www.imas.utas.edu.au/__data/assets/pdf_file/0006/982464/TasAbaloneAssessmentFY2016.pdf	Eastern Zone
Gold	Uncaught TAC	2010	-15.5% of TACC	Mundy, C & Jones H (2017) Tasmanian abalone fishery assessment 2016. IMAS http://www.imas.utas.edu.au/__data/assets/pdf_file/0006/982464/TasAbaloneAssessmentFY2016.pdf	Western Zone
Gold	Uncaught TAC	2010	58% of TACC	Mundy, C & Jones H (2017) Tasmanian abalone fishery assessment 2016. IMAS http://www.imas.utas.edu.au/__data/assets/pdf_file/0006/982464/TasAbaloneAssessmentFY2016.pdf	Central Western Zone
Gold	Uncaught TAC	2010	0.8% of TACC	Mundy, C & Jones H (2017) Tasmanian abalone fishery assessment 2016. IMAS http://www.imas.utas.edu.au/__data/assets/pdf_file/0006/982464/TasAbaloneAssessmentFY2016.pdf	Northern Zone
Gold	Uncaught TAC	2010	2.9% of TACC	Mundy, C & Jones H (2017) Tasmanian abalone fishery assessment 2016. IMAS http://www.imas.utas.edu.au/__data/assets/pdf_file/0006/982464/TasAbaloneAssessmentFY2016.pdf	Bass Strait
Gold	Uncaught TAC	2010	0% of TACC	Mundy, C & Jones H (2017) Tasmanian abalone fishery	Greenlip

				assessment 2016. IMAS http://www.imas.utas.edu.au/__data/assets/pdf_file/0006/982464/TasAbaloneAssessmentFY2016.pdf	
Gold	Uncaught TAC	2009	0.1% of TACC	Mundy, C & Jones H (2017) Tasmanian abalone fishery assessment 2016. IMAS http://www.imas.utas.edu.au/__data/assets/pdf_file/0006/982464/TasAbaloneAssessmentFY2016.pdf	Eastern Zone
Gold	Uncaught TAC	2009	-19.3% of TACC	Mundy, C & Jones H (2017) Tasmanian abalone fishery assessment 2016. IMAS http://www.imas.utas.edu.au/__data/assets/pdf_file/0006/982464/TasAbaloneAssessmentFY2016.pdf	Western Zone
Gold	Uncaught TAC	2009	68.8% of TACC	Mundy, C & Jones H (2017) Tasmanian abalone fishery assessment 2016. IMAS http://www.imas.utas.edu.au/__data/assets/pdf_file/0006/982464/TasAbaloneAssessmentFY2016.pdf	Central Western Zone – Zone established
Gold	Uncaught TAC	2009	2.6% of TACC	Mundy, C & Jones H (2017) Tasmanian abalone fishery assessment 2016. IMAS http://www.imas.utas.edu.au/__data/assets/pdf_file/0006/982464/TasAbaloneAssessmentFY2016.pdf	Northern Zone
Gold	Uncaught TAC	2009	-11.4% of TACC	Mundy, C & Jones H (2017) Tasmanian abalone fishery assessment 2016. IMAS http://www.imas.utas.edu.au/__data/assets/pdf_file/0006/982464/TasAbaloneAssessmentFY2016.pdf	Bass Strait
Gold	Uncaught TAC	2009	-0.4% of TACC	Mundy, C & Jones H (2017) Tasmanian abalone fishery assessment 2016. IMAS http://www.imas.utas.edu.au/__data/assets/pdf_file/0006/982464/TasAbaloneAssessmentFY2016.pdf	Greenlip
Gold	Uncaught TAC	2008	0.4% of TACC	Mundy, C & Jones H (2017) Tasmanian abalone fishery assessment 2016. IMAS http://www.imas.utas.edu.au/	Eastern Zone

				__data/assets/pdf_file/0006/982464/TasAbaloneAssessmentFY2016.pdf	
Gold	Uncaught TAC	2008	8.3% of TACC	Mundy, C & Jones H (2017) Tasmanian abalone fishery assessment 2016. IMAS http://www.imas.utas.edu.au/__data/assets/pdf_file/0006/982464/TasAbaloneAssessmentFY2016.pdf	Western Zone
Gold	Uncaught TAC	2008	4.1% of TACC	Mundy, C & Jones H (2017) Tasmanian abalone fishery assessment 2016. IMAS http://www.imas.utas.edu.au/__data/assets/pdf_file/0006/982464/TasAbaloneAssessmentFY2016.pdf	Northern Zone
Gold	Uncaught TAC	2008	-11.4% of TACC	Mundy, C & Jones H (2017) Tasmanian abalone fishery assessment 2016. IMAS http://www.imas.utas.edu.au/__data/assets/pdf_file/0006/982464/TasAbaloneAssessmentFY2016.pdf	Bass Strait
Gold	Uncaught TAC	2008	1.2% of TACC	Mundy, C & Jones H (2017) Tasmanian abalone fishery assessment 2016. IMAS http://www.imas.utas.edu.au/__data/assets/pdf_file/0006/982464/TasAbaloneAssessmentFY2016.pdf	Greenlip

Economic > Community benefits > Value to community > GDP or GSP value

A fisheries contribution to Gross Domestic Production (GDP)/Gross State Product (GSP) is the total economic value that it generates directly, plus the indirect contribution made to other industries, which is also measured in value-add terms.

Data Quality	Indicator used	Year	Amount	Reference	Note
Bronze	GSP	2016-2017	$6.8 billion	Western Australian Government (2018) Western Australia Economic Profile May 2018. Department of Jobs, Tourism, Science and Innovation. Date released:	Agriculture, forestry and fishing combined

Data Quality	Indicator used	Year	Amount	Reference	Note
Bronze	GSP	2016-2017	$2,746,000	Tasmanian Government (2017) State Accounts (ABS Cat No 5220.0). Economic Analysis Unit, Department of Treasury and Finance. Release date: 17 November 2017. http://www.treasury.tas.gov.au/ Documents/State-Accounts.pdf	Agriculture, forestry and fishing combined
Bronze	GSP	2015-2016	$2,618,000	Tasmanian Government (2017) State Accounts (ABS Cat No 5220.0). Economic Analysis Unit, Department of Treasury and Finance. Release date: 17 November 2017. http://www.treasury.tas.gov.au/Documents/State-Accounts.pdf	Agriculture, forestry and fishing combined

Economic > Community benefits > Wealth Spread > Distribution of fishing firm size

The spread of profits to owners and crew members indicates how widely benefits of fishing are distributed across the fishing community. A wide spread of benefits may be important to some fishery stakeholders. A narrow spread may not indicate a lack of distribution of benefits in the case where all participating businesses are the same size, or if other mechanisms are present to capture and distribute benefits such as high levels of employment of crew. The number of large business versus small business, classified by turnover (direct measure) or catch volume (proxy) may provide an indirect indicator: i.e. are economic returns from commercial fishing gained by one or two large businesses or a spread over many smaller businesses?

Extracted data from the DPIPWE licensing and quota management database shows the following distribution of annual catch volumes by commercial Abalone divers (firms) in the Tasmanian Abalone fishery from 2009 to 2016. Proportionally fewer divers are catching larger tonnages each year.

	2009	2010	2011	2012	2013	2014	2015	2016
0 - 5 Ton	15	20	17	15	18	13	18	15
5 - 10 Ton	16	17	15	15	11	18	13	19
10 - 15 Ton	15	15	15	26	24	20	16	11
15 - 20 Ton	15	9	16	9	15	18	17	15
20 - 25 Ton	13	15	10	11	14	15	14	18
25 - 30 Ton	10	12	16	12	10	7	9	7

30 - 35 Ton	10	9	8	8	8	7	7	4
35 - 40 Ton	6	7	6	8	6	7	5	5
40 - 45 Ton	6	5	6	5	4	3	4	2
45 - 50 Ton	4	6	5	5	1		1	1
50 - 55 Ton	5	4	4	2	0	1		
55 - 60 Ton	3	3	0	0	3			
60 - 65 Ton	0	1	1	1				1
	118	123	119	117	114	109	104	97

Economic > Markets > Fish distribution > Fish receivers

One way of measuring benefits from a fishery is by assessing the flow of seafood through the supply chain. In many fishery jurisdictions, the first step in the supply chain is via licensed fish receivers who are allowed to receive fish for sale. They can also trade fish with other receivers. In some jurisdictions, commercial fishers must sell their catch to a receiver (although they can sell small amounts on wharves). While this restricts fishers' options for landing their catch, it means that fish can be tracked, reduces illegal fish trading and ensures that the Quota Management Systems (QMS) work effectively by ensuring catches do not exceed the total allowable catch or quota amounts for individual species. Receivers of fish may be fish processors, wholesalers or retailers.

In some jurisdictions, the fishers and fish receivers are integrated, such that they are effectively the same “business”. In Commonwealth fisheries, the total number of fish receivers per year may differ to the sum of the fish receivers per fishery because some receivers operate in more than one fishery.
Data Quality: Not found

Economic > Markets > Volatility in market price > Price volatility

Price volatility is the mean beach price for the target species (top one or five depending on price) over the given period (most recent ten years). The level of volatility is the standard deviation in mean price over this period.

Data Quality	Species/Fishery	Year/Time period	Amount	Reference	Note
Silver	TAS Abalone	2006-07 to 2015-16	$3.38/kg	Mobsby, D and Koduah, A 2017, Australian fisheries and aquaculture statistics 2016, Fisheries Research and Development Corporation project 2017-095. ABARES,	

				Canberra, December. CC BY 4.0. Supporting data tables	

Economics > Energy costs > Energy Use > Fuel use per kg of fish harvested

Fuel use varies over time and between stocks and are best collected from industry on a yearly basis. Estimates for different fisheries should be compared with caution, and in particular comparing energy use between fisheries with different data quality which is not recommended (different data availability, may be e.g. old or not fisheries-specific). Estimates are provided for all levels of data quality if available and are given in L per kg live-weight.

Data Quality	Gear	Target species	Min (L/kg)	Average (L/kg)	Max (L/kg)	Reference	Description
Gold							
Silver	Divers	Abalone		0.9		Parker et al 2015	Tasmania, 2012
Bronze	Divers	Mollusc	0.6	1.0	1.5	Parker and Tyedmers 2015	Oceania region

Economic > Energy costs > Fossil fuel subsidies > Fuel subsidies directed to the fishery

Fossil fuel subsidies (fuel rebates) illustrate to which extent the fuel cost is reduced in the fishery, measured in AUD/kg live weight fish. Note that this form of tax exemption for fisheries is in Australia motivated from the sector not using roads (i.e. costs embedded in fuel price for road construction and maintenance), and are not formally reported as fuel subsidies in Australia.

Data Quality	Gear	Target species	Subsidy (AUD/kg)	Reference	Description
Gold					
Silver	Divers	Abalone	0.35	Parker et al 2015	Fuel use from Tasmanian abalone fishery in 2012
Bronze	All TAS	All TAS	0.10	Total tax claims per total landings in TAS	2015-16 (2016-17 also available), state level figures on landings are preliminary for 2015-16

Governance > Ecosystem governance > Bycatch mitigation > Description of the bycatch mitigation measures

Bycatch measures can be spatial (e.g. area closure), temporal (time closure, e.g. night setting only) or technical (bycatch reduction devices, hook size). This indicator describes the measures that are in place for a fishery – but not the rates of compliance. For example, spatial closures for different gear types are shown here for AFMA fisheries http://www.afma.gov.au/sustainability-environment/fishing-closures/.

None

Data Quality: Bronze – based on no bycatch species captured

Governance > Ecosystem governance > Protected species mitigation > Description of the protected species mitigation measures

TEP mitigation measures can be spatial (e.g. area closure), temporal (time closure, e.g. night setting only) or technical (bycatch reduction devices, hook size). This indicator describes the measures that are in place for a fishery – but not the rates of compliance.

None

Data Quality: Bronze – based on no interactions with TEPS

Governance > Management system > Harvest strategy > Scope of the harvest strategy

Assessment can be based on scoring presence of the following: a harvest strategy designed to achieve management objectives; harvest control rules and tools; collection of relevant information to support the harvest strategy; and, assessment of stock status or the presence of the following key elements: Defined operational objectives for the fishery; Indicators of fishery performance related to the objectives; Reference points for performance indicators; A statement defining acceptable levels of risk to meeting objectives; A monitoring strategy to collect relevant data to assess fishery performance; A process for conducting assessment of fishery performance relative to objectives; and; Decision rules that control the intensity of fishing activity and/or catch.

The Tasmanian Abalone Management Plan and Policy document is under currently under review. An operational document for the fishery is published prior to the commencement of each fishing year, detailing size limits, quota for each zone, spatial management arrangements and any other operational rules that govern the commercial harvest of abalone in Tasmania.[311]

Data Quality: Bronze

Governance > Management system > Management plans > Scope of management plan

Management plans can be assessed by evaluating the presence of minimum requirements, as follows: a description of the fishery, especially its current status and any established user rights: the management objectives; how these objectives are to be achieved; how the plan is to be reviewed and/or appealed, as well as the consultation process for review and appeal.

The Tasmanian Abalone Fishery is managed under the provisions of the Living Marine Resources Management Act 1995[312] and the Fisheries (Abalone) Rules 2017[313], which contain the following minimum requirements:

established user rights:
how the Rules are reviewed
consultation process for review of the Rules

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[311] Mundy, C. and Jones, H. (2017). Tasmanian Abalone Fishery Assessment 2016. . Institute for Marine and Antarctic Studies, University of Tasmania
[312] https://www.legislation.tas.gov.au/view/html/inforce/current/act-1995-025
[313] https://www.legislation.tas.gov.au/view/html/inforce/current/sr-2017-094

Data Quality: Gold

Governance > Institutional capacity > Accountability of decision making bodies > Level of Accountability

Accountability of Decision-making bodies. Performance of a fisheries management agency is based on the degree to which decision-making processes are consultative, the basis for decisions are fully explained, and information about decision making is publicly available. The assessment applied the three tiers of Principle 3.2.2 (d) 'Decision-making process' of the MSC Fisheries Standard v2.0 (2014) to determine whether the level of accountability was low, medium or high.

High level of accountability. This is demonstrated by publicly-available management plan and fishery assessment reports, and the availability of proceedings of the Fishery Advisory Committee.

Data Quality: Silver

Governance > Institutional capacity > Uncertainty management > Extent of incorporation of uncertainty in management of the targeted stock

This metric reports on the explicit incorporation of uncertainties in decision support processes used to inform and make appropriate choices of management actions. We recognise three levels of uncertainty: Low level of incorporation of uncertainty; Medium level of incorporation of uncertainty; High level of incorporation of uncertainty. These are based on: Major sources of uncertainty are identified; Assessment takes uncertainty into account; Frequency of monitoring of indicators is high; Monitoring of more than one indicator to support management decisions; Assessment evaluates stock status relative to reference points in a probabilistic way; Robustness of assessments are tested, Alternative hypotheses and assessment approaches are rigorously explored.

High level of incorporation of uncertainty in management of the targeted stock.	The assessment applied Principle 1.2.4 (c & d) 'Assessment of stock status: Uncertainty in the Assessment' of the MSC Fisheries Standard v2.0 (2014) to assess extent of incorporation of uncertainty in management of the targeted stock.

Data Quality: Silver

Governance > Compliance > Compliance regime > Level of Compliance

Level of compliance with rules and regulations controlling catch can be assessed by audits that measure the agreement between 1) logbook and observer records; 2) catch disposal records submitted by fishers and fish receivers. It might also be assessed by counting the annual number of breaches/observed offences or enforcement actions, preferably scaled to the level of enforcement effort (e.g. $). This indicator can be scored on the basis of the presence of key monitoring, control and surveillance elements and capacities.

In the Tasmanian Abalone Fishery catch, effort and location are reported daily. Since 1992 the diver has been required to submit catch dockets for every fishing day within a short mandatory return period, usually 48 hours. Up to and including 2000 catch and effort was reported by Block with 57 reporting blocks encompassing the coast of mainland Tasmania and offshore islands, and from 2001 the majority of reporting Blocks were split into between two and five sub-blocks. Currently, fishers are required to report estimated weight of catch and effort in each sub-block for each day of fishing, with a hard copy of the docket submitted within 48 hours.[314]

Data Quality: Bronze

Governance > Compliance > Surveillance > Surveillance Effort

Regulatory controls include logs and catch reporting, on-board observer programs, vessel inspections, vessel monitoring systems, and visual or electronic surveillance using radar or satellite by boat or by air. Higher degrees of surveillance, or coverage using multiple methods, provide greater levels of certainty in estimates of effort, fishing mortality, bycatch and discard levels, and interactions with protected/listed species. Report on the surveillance carried out on the fishery, as reported by the compliance branch responsible for the fishery **Data Quality:** Not found

Governance > Adaptive capacity > Governance arrangements > Climate change recognition

Governance arrangements relevant to the fishery consider the impact of climate change on the fishery, as evidenced by documentation, policies and plans that describe how management is addressing climate change impacts. Does the fishery management plan, harvest strategy or research activity suggest that climate change is recognised, and integrated into management planning?

There is not explicit recognition for climate responses in the fishery-specific documents.

General call for industry responses is made in the Tasmanian Government climate adaptation plan[315].

The National Harvest Strategy also recognizes that "*Variability in ocean conditions, due to natural variability, climate change or other factors, can affect the productivity of stocks. Fisheries should seek to account for that variability when developing and implementing harvest strategies*"[316]. The Guidelines for the Harvest Strategy provide explicit approaches for fisheries[317]. The strategy and guidelines do not explicitly apply to state fisheries, but will provide guidance.
Data quality: Bronze

Governance > Adaptive capacity > Coping strategies > Climate responses

The fishery has initiated coping strategies (directed) to reduce the impacts of climate change. Evidence of strategies that have been specifically implemented for the fishery might include codes of practice, restocking programs, early warning systems, and so on. The coping strategies may be for long-term change or for extreme events. A description of the climate change responses that have been implemented or explored in research or application are provided.

There are no management actions currently implemented that address climate change impacts in the fishery. Long term declines in catch in some regions have been partially attributed to climate change

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[314] http://www.imas.utas.edu.au/__data/assets/pdf_file/0006/982464/TasAbaloneAssessmentFY2016.pdf
[315] http://www.dpac.tas.gov.au/divisions/climatechange/Climate_Change_Priorities/climate_action_21_-_implementation_plan
[316] Department of Agriculture and Water Resources 2018, *Commonwealth Fisheries Harvest Strategy Policy*, Canberra, June. CC BY 4.0.
[317] Department of Agriculture and Water Resources 2018, *Guidelines for the Implementation of the Commonwealth Fisheries Harvest Strategy Policy*, Canberra, June. CC BY 4.0.

and responses such as urchin harvesting have been trialled[318]. Catch quotas on the east coast of Tasmania have been modified in response to these and other signals.

Data quality: Silver

Social and Ethical > Fishers wellbeing > Fisher satisfaction > Satisfaction scores

If available, fishery specific surveys of well-being or satisfaction, with interpretation required for the types of questions and sample. When surveys are not available other sources of data may need to include broader surveys (e.g. not fishery specific) or discussions with industry representatives, managers or fishers about the industry and their opinion of general fisher-wellbeing (note this will be subjective).

Satisfaction score: Low
There is a high number of recreational licenses in this fishery and tensions between recreational and commercial fishers are apparent.

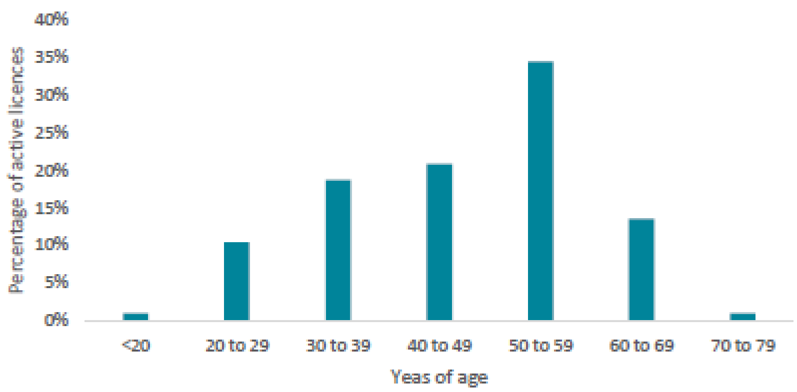
Data Quality: Bronze

Social and Ethical > Fishers wellbeing > Age Structure > Proportion of fishers in standard age cohorts

Proportion of fishers in standard age cohorts that were involved in the fishery at any point in the previous 5 years. If the fishery is not attractive or difficult to enter, the age distribution will be skewed to older ages.

The average age of an abalone dive licence holder or dive licence supervisor in 2016 was 47 years of age. The youngest diver was 19 while the oldest was 77. In terms of age structure, 70% of divers were older than 40 and almost 50% were older than 50[319].

Figure 11: Age structure of abalone dive fishers



Data Quality: Gold

[318] Sanderson, J. C., S. D. Ling, J. G. Dominguez and C. R. Johnson (2016). Limited effectiveness of divers to mitigate 'barrens' formation by culling sea urchins while fishing for abalone. Marine and Freshwater Research **67**: 84-95.
[319] TSIC (2017). Seafood Industry Workforce Profile: May 2017. Report prepared by Stern and Associates. Hobart, Tasmanian Seafood Industry Council.

Social and Ethical > Wider community > Community satisfaction with fishery > Community feedback

Evidence of processes in place to gather direct engagement with the community (diversely represented) to listen and respond to feedback. This may be through a range of means including formal and informal processes and may not be appropriate to all fisheries in the same way. In some cases Marine Stewardship Council accreditation may demonstrate some evidence of community engagement.

Community feedback: Medium.

There is a management advisory committee, which could oversee a feedback process. Based on general FRDC community perception surveys, satisfaction with Australian fisheries is rated at 42%.

Data quality: Bronze.

Social and Ethical > Wider Community > Level of local employment > Percentage of local employment

The communities surrounding and supporting fisheries benefit from those fisheries when the majority of employees (direct and indirect) associated with the fishery activity are local. Can be reported as direct, indirect and downstream levels. **Data Quality:** Not found

Social and Ethical > Ethical - Human welfare > Protections in place > Legislation exists

Although all workers are automatically operating under legislation according to their state or territory to a safe work place, the extent to which there is awareness of the relevant Acts, and use of these if required, is highly variable and may be different for each business or individual operation within each fishery. See http://workplaceohs.com.au/legislation for a list of state acts and regulations.

Protections in Place: Medium

The Abalone Tas fishery operates under the Tasmania (WorkSafe Tasmania) – WHS Act 2012 and WHS Regulations 2012. Under the Work Health and Safety Act, Abalone Tasmania follows the Code of Practice for the Tasmania Abalone Industry, developed by the Tasmanian Abalone Council Ltd. Nevertheless, divers reported they feel they have compromised safety according to a Review of Tasmanian abalone (Knuckey & Sen 2017). The report recommended an urgent review of diver safety standards.

Data Quality: Gold

Social and Ethical > Ethical > Human welfare > Levels of compliance

Levels of compliance (or violations of) with Workplace Health and Safety. If references to Workplace Health and Safety exist in relation to the specific fishery, determine whether these are voluntary or recorded in anyway. If they are recorded, note the level of compliance. As they are likely to be voluntary, there will not likely be a record of compliance, but this may become more readily available in the future.

Level of Compliance: Medium

Divers reported they feel they have compromised safety according to a Review of Tasmanian abalone (Knuckey & Sen 2017). The report recommended an urgent review of diver safety standards.

Data Quality: Bronze

Social and Ethical > Ethical-animal welfare > Animal welfare protections > Protections in place

At this early stage of development of animal welfare, any type of mention of animal welfare exists, it is probably the most appropriate. As this develops in to the future, assessments as to the level of engagement may become more relevant. **Data Quality:** Not found.

Social and Ethical > Ethical-animal welfare > Level of Compliance > Levels of compliance or violations of animal welfare

If there are any references to animal welfare protections or guidelines in fishery management plans and if reports exist, the indicator reports on the level of compliance or violations with welfare provisions.

Data Quality: Not found.

Social and Ethical > Climate-related > Access to information > Availability of information

This indicator describes available information that will help participants in the fishery adapt to changes. The assumption behind this indicator is that good information availability and flow will help fishers to adapt.

Data Quality: Not found.

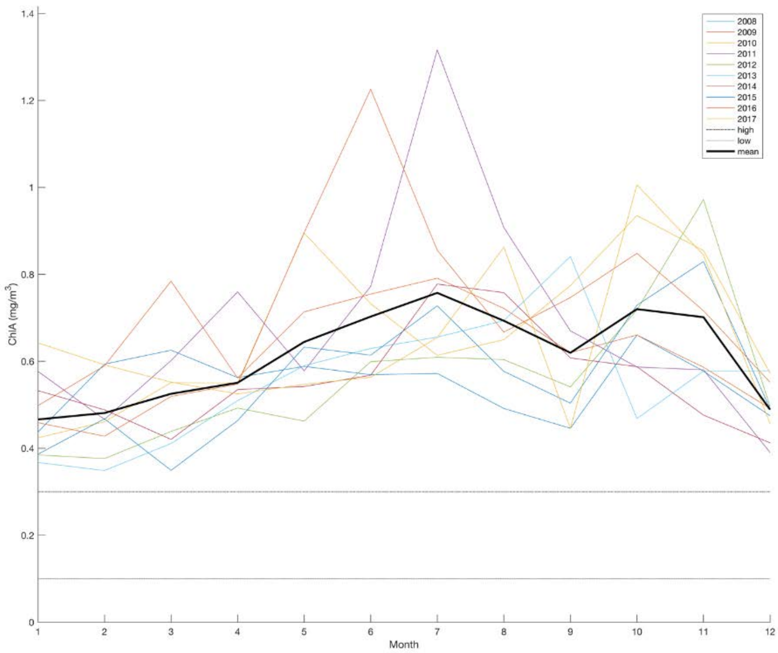
Social and Ethical > Climate-related > Access to networks > Level of membership of industry association

This metric assesses the presence or absence of a dedicated social media or social network group for the fishery. The fishery may still have a strong social network without a social media presence.

Data Quality: Not found.

External > Environmental Context > Productivity > Mean chlorophyll

A measure of environmental productivity is the biomass of phytoplankton, which in oceanic waters can be approximated by chlorophyll a concentration, as estimated from satellite (MODIS, oceandata.sci.gsfc.nasa.gov). Monthly chlorophyll values for a representative area of the fishery are shown with the mean productivity shown in solid black and references levels of low chlorophyll at 0.1 mg $m^{-3}$and high chlorophyll levels at 0.3 mg m^{-3}. This indicator shows the mean chlorophyll by month for the years 2008-2017. These data provide information on the relative environmental productivity in the fishery area. Missing data for some months can be due to ice cover. Variability in chlorophyll a concentration between years can indicate high environmental variability, while similar seasonal patterns indicate relative environmental stability.



Data Quality: Gold

External > Environmental Context > Environmental character > Description of the ecosystems

This metric provides a qualitative description of the ecosystem(s) in which the fishery occurs. The goal is to provide a general overview of these environments. The knowledge about which ecosystems are encountered during fishing activity is the indicator (rather than the response of the ecosystems to fishing).

Marine ecosystems are defined for the purposes of this indicator as the composition of plants, animals, and the marine environment (water masses, geomorphology). Types of marine ecosystems include estuaries, the sea floor, the mesopelagic zone, the pelagic zone, the inter-tidal zones, coral reefs, lagoons, and mangroves. A pelagic zone ecosystem for example, is defined by physical, chemical and biological features of the marine water column of the open ocean[320].

Description of the ecosystems: High

This fishery takes place on rocky reefs from shallow to water depths approaching 30 meters. Macroalgal cover occurs on the rocky reefs.

Data Quality: Gold

[320] Game, E. T., H. S. Grantham, A. J. Hobday, R. L. Pressey, A. T. Lombard, L. E. Beckley, K. Gjerde, R. H. Bustamante, H. P. Possingham and A. J. Richardson (2009). Pelagic protected areas: the missing dimension in ocean conservation. Trends in Ecology and Evolution **24**(7): 360-369 doi:310.1016/j.tree.2009.1001.1011.

External > Climate related > Susceptibility of target species > Impacts on target species

Climate change directly affects the distribution, abundance and phenology of individual species. These changes then affect the fisheries that harvest these species, and can be a strong external influence on the fishery. These impacts can be positive (e.g. increased abundance), or negative (e.g. movements further from fishing ports), and to long-term warming, or short-term extreme events such as marine heatwaves.

Sensitivity of the target species to climate change has been assessed[321]. Species in this fishery have a sensitivity of high.

Common name	Species	Fishery	Score	Sensitivity
Blacklip abalone	Haliotis rubra rubra	Tasmanian Bass Strait Zone Fishery	6.75	HIGH
Blacklip abalone	Haliotis rubra rubra	Tasmanian Central Western Zone Fishery	6.75	HIGH
Blacklip abalone	Haliotis rubra rubra	Tasmanian Eastern Zone Fishery	6.75	HIGH
Blacklip abalone	Haliotis rubra rubra	Tasmanian Northern Zone Fishery	6.75	HIGH
Blacklip abalone	Haliotis rubra rubra	Tasmanian Western Zone Fishery	6.75	HIGH
Greenlip abalone	Haliotis laevigata	Tasmanian Greenlip Abalone Fishery	7	HIGH

Data Quality: Silver

External > Climate related > Susceptibility of key habitats > Habitat Impacts

Habitat impact: High

Loss of habitat associated with urchin barrens on the east coast[322] and reduced kelp abundance[323] have reduced the productivity of abalone fishing regions.

Data Quality: Gold

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[321] Fulton EA, Hobday AJ, Pethybridge H, Blanchard J, Bulman C, Butler I, Cheung W, Gorton B, Hutton T, Lozano- Montes H, Matear R, Pecl G, Villanueva C, Zhang X (2018). *Decadal scale projection of changes in Australian fisheries stocks under climate change.* CSIRO Report to FRDC. FRDC Project No: 2016/139 – ONLINE.

[322] Ling, S. D. (2008). Range expansion of a habitat-modifying species leads to loss of taxonomic diversity: a new and impoverished reef state. Oecologia **156**(4): 883-894 DOI 810.1007/s00442-00008-01043-00449.

[323] Johnson, C. R., S. C. Banks, N. S. Barrett, F. Cazassus, P. K. Dunstan, G. J. Edgar, S. D. Frusher, C. Gardner, M. Haddon, F. Helidoniotis, K. L. Hill, N. L. Holbrook, G. W. Hosie, P. R. Last, S. D. Ling, J. Melbourne-Thomas, K. Miller, G. T. Pecl, A. J. Richardson, K. R. Ridgway, S. R. Rintoul, D. A. Ritz, D. J. Ross, J. C. Sanderson, S. A. Shepherd, A. Slotwinski, K. M. Swadling and N. Taw (2011). Climate change cascades: Shifts in oceanography, species' ranges and subtidal marine community dynamics in eastern Tasmania. Journal of Experimental Marine Biology and Ecology **400**: 17–32 doi:10.1016/j.jembe.2011.1002.1032.

External > Contaminants in the environment > Detection system for seafood contaminants > Risk of contaminants

Potential risk for contamination from the marine environment combined with monitoring arrangements to be able to address risks needed to ensure food safety. Contaminants include those with maximum levels set for by Food Standards Code Australia: metal contaminants, non-metal contaminants, natural toxicants, and average and maximum levels of mercury in fish. Contaminants from poor handling after landing are not assessed but may be indirectly addressed.

Rubric for risk level:

Low risk	Medium risk	High risk
There are no documented levels of contaminants from the marine environment causing risk/diet restrictions to any consumer group in the fishery.	There may be seasonal/area/species/size-based risks of contaminants for some species.	Permanent diet restrictions of species caught to vulnerable consumers such as children or pregnant women.

Risk of Contaminants: Low

The fishery has a Food Safety Plan, developed in cooperation with the Tasmanian Government (following Primary Production and Processing (PPP) Standard for Seafood developed by Food Standards Australia and New Zealand) and systems to provide industry participants with a means of clearly demonstrating compliance with the PPP Seafood Standard.
http://dpipwe.tas.gov.au/biosecurity-tasmania/product-integrity/food-safety/seafood

Data Quality: Gold

External > Contaminants in the environment > Management arrangements to ensure food safety related to contaminants > Evidence for arrangements

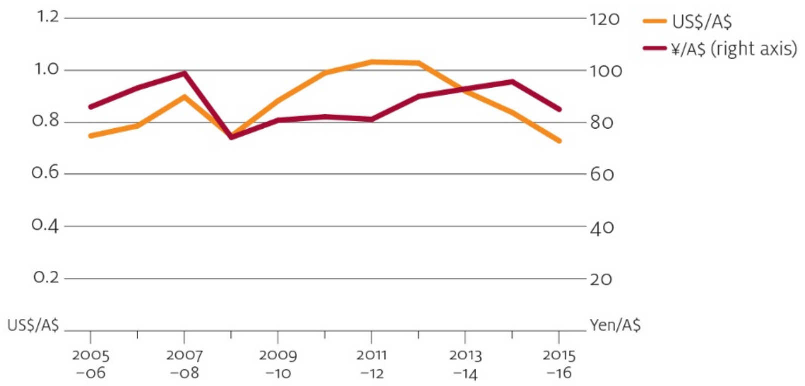
There is evidence of management arrangements to ensure food safety related to contaminants and food safety from the marine environment. No supply chain risks from poor handling are considered. Food standard 4.2.1 requires all seafood business in Australia to identify potential seafood safety hazards and put controls in place that are consistent with the risk.

Data Quality	
GOLD	Implements the Australian Shellfish Quality Assurance Program. Fishing closures (areas and seasons) in place and there is a general code of practise for Australian abalone fisheries. http://dpipwe.tas.gov.au/sea-fishing-aquaculture/commercial-fishing/abalone-fishery/abalone-closures http://dpipwe.tas.gov.au/sea-fishing-aquaculture/sustainable-fisheries-management/Biotoxin-Fishery-Events http://www.australianwildabalone.com.au/wp-content/uploads/2012/11/Australian_CCOP_-QA-manual_November_2012.pdf
SILVER	
BRONZE	

External > Market Drivers > Macroeconomic factors > Exchange Rates

A depreciating Australian dollar (or, increasing exchange rate) generally results in producers receiving a higher export price in Australian dollar terms, while an appreciating Australian dollar (or, decreasing exchange rate) results in a lower export price. Domestically, a depreciation of the Australian dollar encourages substitution from imported seafood to domestically produced seafood, as imported products become relatively more expensive. A lower exchange rate also makes Australian exports more competitive in world markets, as exported seafood become relatively cheaper in foreign currency terms.

National export trends are negatively related to exchange rate movements— the Australian dollar declined against the US dollar and Japanese yen from 1990–91 to 2000–01, with exports increasing in volume and value. Exchange rates for the Australian dollar increased against those currencies from 2001–02 to 2015–16. The real export value and volume of Australia's seafood exports decreased between 2005–06 and 2012–13 and then increased between 2012–13 and 2015–16—with a noticeable rise (43 per cent) in volume between 2014–15 and 2015–16.[324]



Data Quality: Gold

External > Market Drivers > Consumer Trends > Per person annual apparent consumption of seafood (kg)

Annual apparent consumption is estimated by adding the total edible quantity of seafood supplied domestically—that is, total production plus imported seafood— less exports of seafood. Apparent consumption provides an estimate of the total amount of seafood consumed in Australia assuming zero change in stocks.

The production quantity of Australian fishery and aquaculture products is reported by ABARES on a whole weight basis, whereas trade data are reported on a processed basis. To align the units of measurement between production and trade data, it is necessary to convert production volume to a processed edible equivalent.

Production volumes are adjusted to an edible quantity basis using species-specific conversion rates and excluding species that are known to be predominantly supplied for non-human consumption purposes, such as for aquaculture feed or bait. Imports and exports of seafood are sourced from

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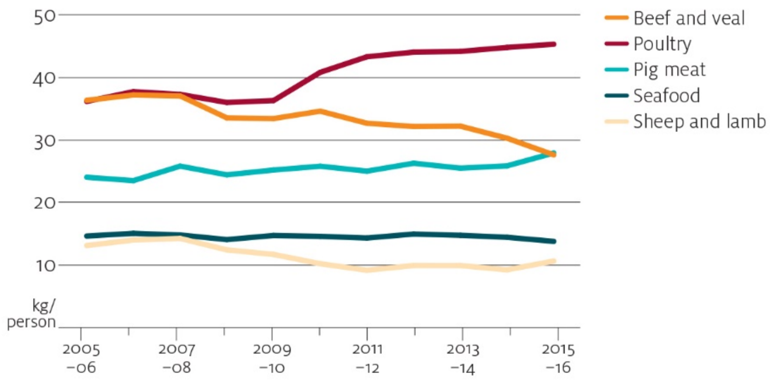
[324] Mobsby, D and Koduah, A 2017, Australian fisheries and aquaculture statistics 2016, FRDC project 2017-095. ABARES, Canberra, December. CC BY 4.0.

Australian Bureau of Statistics (ABS) trade data and are reported as edible weight. The apparent consumption per person is calculated as the total apparent consumption divided by the total Australian population in each year. The method applied here is consistent with that used by ABARES to estimate apparent consumption of other agricultural commodities produced in Australia.

The FAO also compiles statistics on apparent consumption of seafood, applying a consistent method across all countries. FAO estimates indicate that annual consumption of seafood in Australia is around 26 kilograms per person in 2013 (FAO 2016[325]). The discrepancy between FAO and ABARES estimates reflects differences in methodological approaches to estimating consumption. Moreover, ABARES estimates seafood consumption on a processed edible basis, whereas the FAO provides its estimates on a whole weight basis.

In Australia, apparent consumption of seafood per person (edible equivalent) decreased, on average, at an annual rate of 0.6 per cent, from 14.6 kilograms in 2005– 06 to 13.8 kilograms per person in 2015–16. Annual apparent consumption is estimated by the Australian Bureau of Agricultural and Resource Economics and Sciences by adding the total edible quantity of seafood supplied domestically—that is, total production plus imported seafood— less exports of seafood[326]

In comparison, global per capita apparent fish consumption increased from an average of 9.9 kg in the 1960s to 14.4 kg in the 1990s and 20.1 kg in 2014, with preliminary estimates for 2015 indicating further growth, exceeding 20 kg (FAO 2016). Australia's per person seafood consumption in 2013 was estimated by the FAO to be 26kg. The differences in estimates are accounted for by varying methods for calculating consumption. ABARES estimates seafood consumption on a processed edible basis, whereas the FAO provides its estimates on a whole weight basis.



Data quality: Gold

[325] The state of world fisheries and aquaculture 2016—opportunities and challenges, Food and Agriculture Organization of the United Nations, Rome.

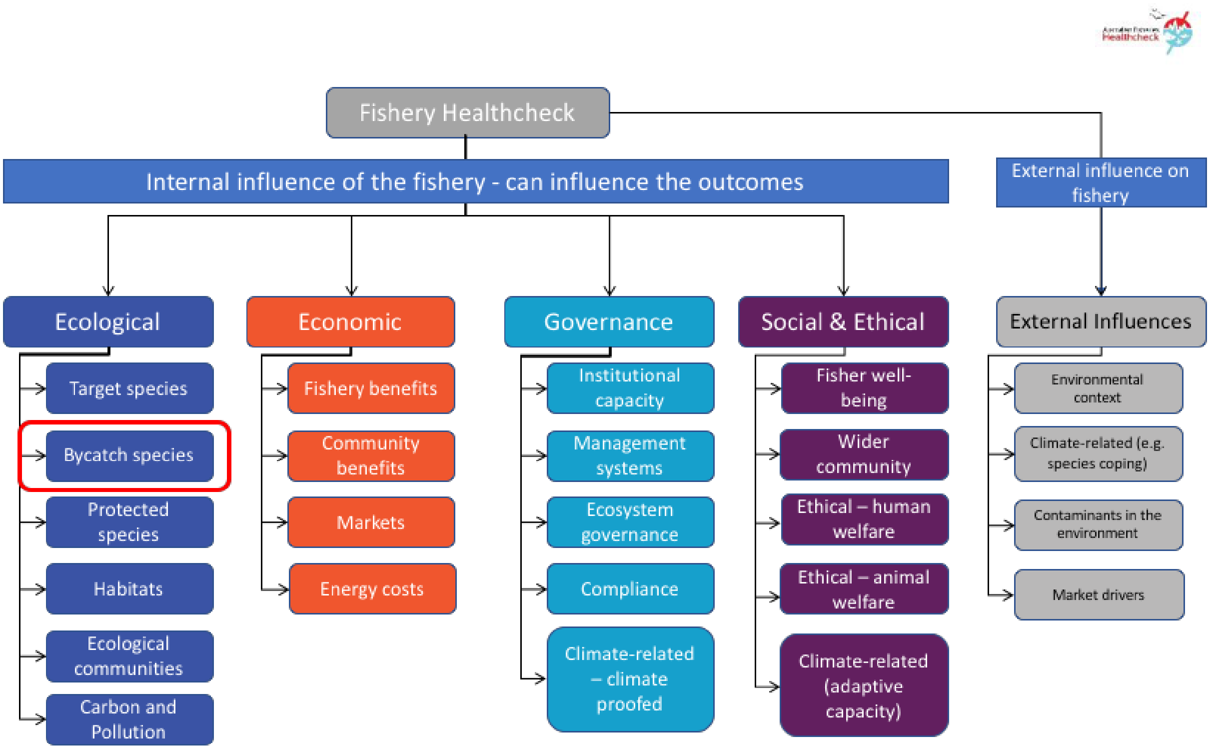
[326] Mobsby, D and Koduah, A 2017, *Australian fisheries and aquaculture statistics 2016*, FRDC 2017-095. ABARES, Canberra, December. CC BY 4.0

Victorian Rock Lobster Fishery

The Rock lobster fishery is Victoria's most valuable, with a commercial value of $25M. There is a mature management framework, with a management plan, Harvest Strategy, data collection program to support assessment, including an observer program, and a resource assessment group with stakeholder representation. This is a single species and gear fishery, with two zones (each managed separately with regard to licences and quota) covering all Victorian and Commonwealth waters (OCS). The majority of the catch is exported live to China. Rock lobster is considered as a single stock in south-east Australia. Recreational catch is included in assessment as a fraction of the commercial quota, but little existing data for recreational activity and catch, with management via bag limits and a closed season. (Source: Fisheries Guidelines Project).

Case Study Presentation Format

The case study documents are a collection of metrics, organised by the healthcheck structure:



The presentation of metrics will follow the following heading format:

Ecological > Bycatch species > Bycatch composition > <u>Mean Trophic Level</u>

Understand this to be an indicator (**Bycatch composition**) of the **Ecological** Component, **Bycatch species** subcomponent where the (in the figure and heading example above, is being measured by presenting Mean Trophic Level as the metric.

Ecological > Target species > Stock Status > Status of Australian Fish Stocks (SAFS)

Target species in each fishery are the primary focus for this indicator. Status of these species is ideally assessed with the SAFS approach, however this may not cover all target species for each fishery. In that case, we indicate the number of unassessed species. These species could also be assessed by individual states or by alternative methods.

SpeciesName	StockName	StockStatus	Year
AUSTRALIAN SALMONS	Eastern Australia	Sustainable	2016
AUSTRALIAN SALMONS	Western Australia	Sustainable	2016
Banded Morwong	Victorian Banded Morwong Fishery	Undefined	2016
Gummy Shark	Southern Australia	Sustainable	2016
Luderick	Eastern Australia	Sustainable	2016
Pale Octopus	Victoria	Undefined	2016
School Shark	Southern Australia	Overfished	2016
Snapper	Western Victoria	Sustainable	2016
Southern Rock Lobster	Southern Australia	Sustainable	2016

Data Quality: Gold

Ecological > Target Species > Harvest Level > Catch weight

This metric is a proxy for harvest level. The harvested biomass for each species, provides information on the level of the catch. Trends in this metric over time can indicate declining availability of fish, quota restrictions, or changes in market demand. For Australian fisheries, trends are expected to be stable for most species.

There are two zones in this fishery, the Eastern and Western Zone. Catch histories[327] are presented along these divisions.

[327] https://vfa.vic.gov.au/__data/assets/pdf_file/0006/348306/RL-Stock-Assessment-Report_2015-16_Final.pdf

6 Western Zone Data

Table 1: Western Zone catch, fishing effort and CPUE (Fishing Year: November-September; SRL: Southern rock lobster; CPUE: Catch per unit effort).

Fishing Year	Catch *(tonne)*	Catch *('000)*	Nominal Effort *('000 potlifts)*	Nominal CPUE *(kg/potlift)*	Standardised CPUE *(kg/potlift)*	Mean Mass *(kg/lobster)*
1978/79	485	485	621	0.78	0.80	1.00
1979/80	451	442	576	0.78	0.81	1.02
1980/81	546	546	679	0.80	0.82	1.00
1981/82	498	498	637	0.78	0.78	1.00
1982/83	460	455	608	0.76	0.79	1.01
1983/84	421	414	571	0.74	0.74	1.02
1984/85	406	394	578	0.70	0.70	1.03
1985/86	345	346	569	0.61	0.62	1.00
1986/87	351	353	595	0.59	0.60	0.99
1987/88	345	349	557	0.62	0.61	0.99
1988/89	303	321	577	0.52	0.53	0.94
1989/90	332	355	613	0.54	0.54	0.94
1990/91	317	337	650	0.49	0.50	0.94
1991/92	409	439	712	0.57	0.59	0.93
1992/93	408	433	779	0.52	0.55	0.94
1993/94	449	456	754	0.59	0.57	0.98
1994/95	435	444	789	0.55	0.51	0.98
1995/96	423	442	761	0.56	0.50	0.96
1996/97	402	414	787	0.51	0.45	0.97
1997/98	467	493	842	0.55	0.49	0.95
1998/99	517	569	864	0.60	0.54	0.91
1999/00	523	596	901	0.58	0.52	0.88
2000/01	526	599	898	0.59	0.50	0.88
2001/02	438	510	703	0.62	0.55	0.86
2002/03	431	495	631	0.68	0.58	0.87
2003/04	460	514	658	0.70	0.56	0.90
2004/05	410	452	667	0.61	0.52	0.91
2005/06	358	405	705	0.51	0.43	0.88
2006/07	336	392	698	0.48	0.42	0.86
2007/08	289	338	668	0.43	0.37	0.86
2008/09	235	267	605	0.39	0.35	0.88
2009/10	240	277	651	0.37	0.34	0.87
2010/11	255	307	590	0.43	0.40	0.83
2011/12	233	279	475	0.49	0.44	0.83
2012/13	259	296	485	0.53	0.46	0.87
2013/14	269	299	486	0.55	0.47	0.90
2014/15	225	242	418	0.54	0.46	0.93
2015/16	226	234	359	0.63	0.51	0.97
2016/17	N/A	N/A	N/A	N/A	0.51*	N/A

** Indicative CPUE using data from the partial 2016/17 season (to February 2017).*

7 Eastern Zone Data

Table 4: Eastern Zone catch, fishing effort and CPUE (Fishing Year: November-September; SRL: Southern rock lobster; CPUE: Catch per unit effort).

Fishing Year	Catch (tonne)	Catch ('000)	Nominal Effort ('000 potlifts)	Nominal CPUE (kg/potlift)	Standardised CPUE (kg/potlift)	Mean Mass (kg/lob.)
1978/79	139	123	192	0.72	0.65	1.13
1979/80	115	108	171	0.67	0.66	1.07
1980/81	133	123	180	0.74	0.66	1.09
1981/82	131	120	193	0.68	0.62	1.09
1982/83	143	132	212	0.68	0.65	1.09
1983/84	136	128	230	0.59	0.55	1.06
1984/85	113	96	201	0.56	0.52	1.18
1985/86	95	81	175	0.54	0.46	1.17
1986/87	78	66	145	0.54	0.45	1.18
1987/88	70	62	130	0.54	0.40	1.13
1988/89	65	61	145	0.45	0.40	1.06
1989/90	84	85	198	0.42	0.37	0.99
1990/91	72	72	172	0.42	0.39	1.00
1991/92	65	64	175	0.37	0.35	1.02
1992/93	70	63	224	0.31	0.30	1.10
1993/94	79	68	260	0.30	0.29	1.17
1994/95	72	58	253	0.29	0.29	1.24
1995/96	57	48	220	0.26	0.28	1.19
1996/97	60	48	222	0.27	0.29	1.25
1997/98	66	54	220	0.30	0.29	1.23
1998/99	66	57	217	0.30	0.31	1.16
1999/00	73	68	228	0.32	0.31	1.07
2000/01	72	66	217	0.33	0.31	1.09
2001/02	54	50	151	0.36	0.34	1.08
2002/03	52	47	133	0.39	0.38	1.10
2003/04	56	52	133	0.42	0.41	1.09
2004/05	54	47	136	0.40	0.40	1.14
2005/06	52	46	122	0.43	0.41	1.14
2006/07	54	48	136	0.40	0.40	1.13
2007/08	46	39	123	0.38	0.39	1.19
2008/09	40	32	108	0.37	0.37	1.25
2009/10	55	49	145	0.38	0.41	1.11
2010/11	66	62	150	0.44	0.47	1.05
2011/12	62	55	114	0.54	0.55	1.13
2012/13	48	43	94	0.51	0.63	1.12
2013/14	59	48	114	0.52	0.61	1.22
2014/15	58	45	110	0.52	0.56	1.28
2015/16	46	37	109	0.43	0.48	1.26
2016/17	N/A	N/A	N/A	N/A	0.43*	N/A

* *Indicative CPUE using data from the partial 2016/17 season (to February 2017).*

Data quality: Gold

Ecological > Bycatch species > Bycatch composition > Mean Trophic Level

The trophic level is a measure of the position of an organism in a food web, starting at level 1 with primary producers, such as phytoplankton, then moving through the primary consumers at level **2** that eat the primary producers to the secondary consumers at level **3** that eat the primary consumers, and so on. The **bycatch mean trophic level** is an indicator of the mean level of the food chain for bycatch in a fishery.

This fishery has very low bycatch, and so this metric was not calculated

Data Quality: Not applicable

Ecological > Bycatch species > Bycatch amount > Total weight of bycatch

Bycatch weights for fishery are typically developed by specific projects, and require a range of assumptions due to issues with reporting and retention of bycatch. **Bycatch** estimates typically cover species that are not target species, while **discard** rates may also include undersized individuals of the target species. Kennelly (2018) provides estimates of discard rates, which include both target and bycatch species, and when discard rates are used, that information is noted for each fishery. Animals can be returned to the ocean alive or dead. The intention of this metric is to provide information on animals that are dead on return to the ocean.

Reference:

Kennelly, S.J., 2018. *Developing a National Bycatch Reporting System.* Final FRDC Report, ISBN 978-0-9924930-5-9, March, 2018. 99 pp.

For Tasmania, Kennelly (2018) assumed that, on average, discarded lobsters and other discarded individuals in this fishery weigh one third that of the average retained lobster. This provides a weight-based retained:discard ratio for the fishery of 1:1.94 (or a discard rate of 66.02%).

Data Quality: Silver

Ecological > Protected species > Capture amount > Captures

The number and diversity of TEP species captured by a fishery in the most recent year, provided as annual numbers.

There are very few interactions with TEP species for this fishery. The Healthcheck team suggests there might be a need to consider interactions with sea lions.

Data quality: Bronze

Ecological > Protected species > Reporting > Level of monitoring

This indicator is to provide information on the level of coverage for a fishery. Annual measures are preferred.

A vital component in the management of the Rock Lobster Fishery is the collection and analysis of data. The Rock Lobster Fishery has a comprehensive data collection program that informs the annual stock assessment and is used in setting the TACC and directing management decisions. The data collection program incorporates a range of fishery-dependent and fishery-independent data.[328]

Fishery dependent data includes:

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[328] https://vfa.vic.gov.au/__data/assets/pdf_file/0006/387717/Victorian-Rock-Lobster-MP-for-web.pdf

commercial catch and effort logbooks,
voluntary pot sampling
wildlife interaction data

Fishery independent data includes:

on-board sampling - The on-board sampling program has been in place since 2004 and has been responsible for, on average, 8,900 observations taken over approximately 140 days annually. Data is collected at sea and includes length, sex, colour, shell hardness, reproductive condition, undersize and bycatch species. There is a commitment to maintaining approximately 80 observer days in the Western Zone and 60 observer days in the Eastern Zone, annually.
fixed site surveys
Puerulus collection

Data quality: Gold

Ecological > Habitats > Habitat impact > Impact score

The habitat impact is an indicator of the effect the fishing gear has on the habitat. Different gear types have different impacts. See the scoring rubric.

Habitat Impact: Moderate, based on the gear type used in this fishery.

Data quality: Bronze

Ecological > Habitats > Habitat impact > Habitat status

The status of the habitat types is a measure of the condition relative to a pristine state. Fishing may not be responsible for that habitat status, but it is important to note if fishing is taking place in pristine or disturbed habitats.

Habitat status: Moderate

Data quality: Bronze

Ecological > Ecological communities > Ecosystem status > Ecosystem status

This metric reports the ecosystem status in the region of the fishery.

Ecosystem Status: Good

Rocky reefs in southern Australia have been impacted by coastal runoff and environmental change. The 2016 SOE report notes the 0-25 m inner shelf as being in good condition[329].

Data Quality: Bronze

Ecological > Ecological communities > Ecosystem status > Species diversity

The measure of species diversity as a ratio between fished and unfished states.

Data quality: Not found

[329] https://soe.environment.gov.au/assessment-summary/marine-environment/state-and-trends-habitats-and-communities

Ecological > Carbon and Pollution > Macro-plastics > Plastic code of conduct

Macro-plastics are plastics that are visible to the naked eye, such as food containers and wrapping, equipment packaging, and fishing equipment. The metric notes a commitment to a zero waste overboard code of conduct to assess attempts to reduce accidental or intentional introduction of macro-plastics to the ocean. There are stated guidelines detailing Australia's guidelines regarding marine pollution from the Australian Maritime Safety Authority[330]:

Pollution of the marine environment by ships, including fishing vessels, is strictly controlled by the International Convention for the Prevention of Pollution from Ships (known as MARPOL).

To minimise pollution, MARPOL prohibits ships from discharging garbage into the sea except in very limited circumstances.

Australian MARPOL regulations apply to Australian fishing vessels wherever they are operating. In addition, there is the Southern Rock Lobster Clean Green initiative[331] which provides for independent third-party auditing of practices. In Victoria, the uptake is low due to the state licensing requirement to be part of PrimeSafe[332]. This is no longer mandatory for Rock Lobster from July 1 2018, and operators may seek to be part of Clean Green or similar in the future.

Data Quality: Gold

Ecological > Carbon and Pollution > Carbon footprint > CO_2-equivalents

The emissions of climate forcing gases in kg CO_2-equivalents (CO_2e) per kg live weight fish caught, not including the supply chain after landing.

Data Quality	Gear	Target species	Min (kg CO_2e/kg)	Average (kg CO_2e/kg)	Max (kg CO_2e/kg)	Reference	Description
Gold							
Silver	Pots	Southern rock lobster		8.1		Parker et al 2017	South Australia (southern zone), 2012-2013, unspecified fuel type, unclear if bait fishing is included, refrigerants not included.
Bronze	Pots and traps	Crustaceans	2.1	10.4	23.8	Parker and Tyedmers 2015	Oceania region, year and fuel type not specified, refrigerants not included, unclear if

[330] https://www.amsa.gov.au/marine-environment/marine-pollution/pollution-fishing-vessels
https://www.amsa.gov.au/marine-environment/marine-pollution/marpol-and-its-implementation-australia
[331] http://southernrocklobster.com/clean-green-program
[332] https://www.primesafe.vic.gov.au/licensing/seafood/wildcatch/

							bait fishing is included.

Economic > Fishery Benefits > Net Economic Returns > Economic Rent

Net Economic Returns (NER) is equal to fishing revenue less fishing costs and measures the economic profit that is derived from fishing activity, it is measured by the Commonwealth as Net Economic Returns and by some States as Economic Rent. **Data Quality:** Not found

Economic > Fishery Benefits > Gross Value of Production > Gross Value of Production

GVP calculated as the volume of catch multiplied by the average per unit beach price (AUD$).

Data Quality	Species/Fishery	Year	Amount	Reference	Note/Comment
Gold	VIC Rock lobster	2015-2016	$24,516,000	Mobsby, D & Koduah, A (2017) Australian fisheries and aquaculture statistics 2016, Fisheries Research and Development Corporation project 2017-095. ABARES, Canberra, December. CC BY 4.0	Preliminary
Gold	VIC Rock lobster	2014-2015	$24,296,000	Mobsby, D & Koduah, A (2017) Australian fisheries and aquaculture statistics 2016, Fisheries Research and Development Corporation project 2017-095. ABARES, Canberra, December. CC BY 4.0	
Gold	VIC Rock lobster	2013-2014	$21,710,000	Mobsby, D & Koduah, A (2017) Australian fisheries and aquaculture statistics 2016, Fisheries Research and Development Corporation project 2017-095. ABARES, Canberra, December. CC BY 4.0	

Economic > Fishery Benefits > Profitability > Financial Performance

Economic health of a fishery can be measured by the financial performance of the operators in the fleet. Fleet wide averages or distributions of levels of profitability indicate the extent to which the fishery is generating economic benefits for fishers.

Data Quality: Not found

Economic > Fishery Benefits > Latency > Underutilised Effort

Latency is fishery concessions that are not being fully utilised by fishers, for example, often the annual total allowable catch is left partially or largely uncaught for a fishery. Latency may appear as effort or uncaught TAC or inactive licences.

Data Quality	Indicator used	Year	Amount	Reference	Note
Gold	Uncaught quota	2016 - 2017	11% of TACC	Victorian Rock Lobster Fishery Management Plan 2017 ISBN 978-1-925733-40-2 https://vfa.vic.gov.au/__data/assets/pdf_file/0006/387717/Victorian-Rock-Lobster-MP-for-web.pdf	Season: 1 Jul-30 Jun Eastern Zone
Gold	Uncaught quota	2016 - 2017	0% of TACC	Victorian Rock Lobster Fishery Management Plan 2017 ISBN 978-1-925733-40-2 https://vfa.vic.gov.au/__data/assets/pdf_file/0006/387717/Victorian-Rock-Lobster-MP-for-web.pdf	Season: 1 Jul-30 Jun Western Zone The 2016/17 catch was reduced from 230t to 209t as a result of a compensation packaged offered to fishers by Origin Energy in recognition of the loss of access to fishing grounds during survey activity. A condition of accepting compensation was to retire an agreed amount of quota for the remainder of the 2016/17 season
Gold	Uncaught quota	2015 - 2016	1% of TACC	Victorian Rock Lobster Fishery Management Plan 2017 ISBN 978-1-925733-40-2 https://vfa.vic.gov.au/__data/assets/pdf_file/0006/387717/Victorian-Rock-Lobster-MP-for-web.pdf	Season: 1 Jul-30 Jun Eastern Zone

Gold	Uncaught quota	2015 - 2016	0% of TACC	Victorian Rock Lobster Fishery Management Plan 2017 ISBN 978-1-925733-40-2 https://vfa.vic.gov.au/__data/assets/pdf_file/0006/387717/Victorian-Rock-Lobster-MP-for-web.pdf	Season: 1 Jul-30 Jun Western Zone
Gold	Uncaught quota	2014 - 2015	0% of TACC	Victorian Rock Lobster Fishery Management Plan 2017 ISBN 978-1-925733-40-2 https://vfa.vic.gov.au/__data/assets/pdf_file/0006/387717/Victorian-Rock-Lobster-MP-for-web.pdf	Season: 1 Jul-30 Jun Eastern Zone
Gold	Uncaught quota	2014 - 2015	0% of TACC	Victorian Rock Lobster Fishery Management Plan 2017 ISBN 978-1-925733-40-2 https://vfa.vic.gov.au/__data/assets/pdf_file/0006/387717/Victorian-Rock-Lobster-MP-for-web.pdf	Season: 1 Jul-30 Jun Western Zone
Gold	Uncaught quota	2013 - 2014	0% of TACC	Victorian Rock Lobster Fishery Management Plan 2017 ISBN 978-1-925733-40-2 https://vfa.vic.gov.au/__data/assets/pdf_file/0006/387717/Victorian-Rock-Lobster-MP-for-web.pdf	Season: 1 Jul-30 Jun Eastern Zone
Gold	Uncaught quota	2013 - 2014	0% of TACC	Victorian Rock Lobster Fishery Management Plan 2017 ISBN 978-1-925733-40-2 https://vfa.vic.gov.au/__data/assets/pdf_file/0006/387717/Victorian-Rock-Lobster-MP-for-web.pdf	Season: 1 Jul-30 Jun Western Zone
Gold	Uncaught quota	2012 - 2013	1% of TACC	Victorian Rock Lobster Fishery Management Plan 2017 ISBN 978-1-925733-40-2 https://vfa.vic.gov.au/__data/assets/pdf_file/0006/387717/Victorian-Rock-Lobster-MP-for-web.pdf	Season: 1 Jul-30 Jun Eastern Zone
Gold	Uncaught quota	2012 - 2013	0% of TACC	Victorian Rock Lobster Fishery Management Plan 2017 ISBN 978-1-925733-40-2 https://vfa.vic.gov.au/__data/assets/pdf_file/0006/387717/Victorian-Rock-Lobster-MP-for-web.pdf	Season: 1 Jul-30 Jun Western Zone

Gold	Uncaught quota	2011 - 2012	1% of TACC	Victorian Rock Lobster Fishery Management Plan 2017 ISBN 978-1-925733-40-2 https://vfa.vic.gov.au/__data/assets/pdf_file/0006/387717/Victorian-Rock-Lobster-MP-for-web.pdf	Season: 1 Jul-30 Jun Eastern Zone
Gold	Uncaught quota	2011 - 2012	1% of TACC	Victorian Rock Lobster Fishery Management Plan 2017 ISBN 978-1-925733-40-2 https://vfa.vic.gov.au/__data/assets/pdf_file/0006/387717/Victorian-Rock-Lobster-MP-for-web.pdf	Season: 1 Jul-30 Jun Western Zone
Gold	Uncaught quota	2010 - 2011	2% of TACC	Victorian Rock Lobster Fishery Management Plan 2017 ISBN 978-1-925733-40-2 https://vfa.vic.gov.au/__data/assets/pdf_file/0006/387717/Victorian-Rock-Lobster-MP-for-web.pdf	Season: 1 Jul-30 Jun Eastern Zone
Gold	Uncaught quota	2010 - 2011	1% of TACC	Victorian Rock Lobster Fishery Management Plan 2017 ISBN 978-1-925733-40-2 https://vfa.vic.gov.au/__data/assets/pdf_file/0006/387717/Victorian-Rock-Lobster-MP-for-web.pdf	Season: 1 Jul-30 Jun Western Zone
Gold	Uncaught quota	2009 - 2010	33% of TACC	Victorian Rock Lobster Fishery Management Plan 2017 ISBN 978-1-925733-40-2 https://vfa.vic.gov.au/__data/assets/pdf_file/0006/387717/Victorian-Rock-Lobster-MP-for-web.pdf	Season: 1 Jul-30 Jun Eastern Zone
Gold	Uncaught quota	2009 - 2010	4% of TACC	Victorian Rock Lobster Fishery Management Plan 2017 ISBN 978-1-925733-40-2 https://vfa.vic.gov.au/__data/assets/pdf_file/0006/387717/Victorian-Rock-Lobster-MP-for-web.pdf	Season: 1 Jul-30 Jun Western Zone
Gold	Uncaught quota	2009	16% of TACC	Victorian Rock Lobster Fishery Management Plan 2017 ISBN 978-1-925733-40-2 https://vfa.vic.gov.au/__data/assets/pdf_file/0006/387717/Victorian-Rock-Lobster-MP-for-web.pdf	Season: 1 Apr-30 Jun Eastern Zone At the request of industry, the quota year was shifted to 1 July – 30 June beginning 2009/10
Gold	Uncaught quota	2009	36% of TACC	Victorian Rock Lobster Fishery Management Plan 2017	Season: 1 Apr-30 Jun

				ISBN 978-1-925733-40-2 https://vfa.vic.gov.au/__data/assets/pdf_file/0006/387717/Victorian-Rock-Lobster-MP-for-web.pdf	Western Zone At the request of industry, the quota year was shifted to 1 July – 30 June beginning 2009/10.
Gold	Uncaught quota	2008 - 2009	37% of TACC	Victorian Rock Lobster Fishery Management Plan 2017 ISBN 978-1-925733-40-2 https://vfa.vic.gov.au/__data/assets/pdf_file/0006/387717/Victorian-Rock-Lobster-MP-for-web.pdf	Season: 1 Apr-31 Mar Eastern Zone
Gold	Uncaught quota	2008 - 2009	24% of TACC	Victorian Rock Lobster Fishery Management Plan 2017 ISBN 978-1-925733-40-2 https://vfa.vic.gov.au/__data/assets/pdf_file/0006/387717/Victorian-Rock-Lobster-MP-for-web.pdf	Season: 1 Apr-31 Mar Western Zone

Economic > Community benefits > Value to community > GDP or GSP value

A fisheries contribution to Gross Domestic Production (GDP)/Gross State Product (GSP) is the total economic value that it generates directly, plus the indirect contribution made to other industries, which is also measured in value-add terms.

Data Quality: Not found

Economic > Community benefits > Wealth Spread > Distribution of fishing firm size

The spread of profits to owners and crew members indicates how widely benefits of fishing are distributed across the fishing community. A wide spread of benefits may be important to some fishery stakeholders. A narrow spread may not indicate a lack of distribution of benefits in the case where all participating businesses are the same size, or if other mechanisms are present to capture and distribute benefits such as high levels of employment of crew. The number of large business versus small business, classified by turnover (direct measure) or catch volume (proxy) may provide an indirect indicator: i.e. are economic returns from commercial fishing gained by one or two large businesses or a spread over many smaller businesses?

ABS data on Victorian businesses in June 2017 provides the following information on the distribution of Rock lobster and Crab potting fishing businesses by annual turn over size.

Zero to less than $50k	$50k to less than $200k	$200k to less than $2m	$2m to less than $5m	$5m to less than $10m	$10m or more
10	26	47	3	0	0

Economic > Markets > Fish distribution > Fish receivers

One way of measuring benefits from a fishery is by assessing the flow of seafood through the supply chain. In many fishery jurisdictions, the first step in the supply chain is via licensed fish receivers who are allowed to receive fish for sale. They can also trade fish with other receivers. In some jurisdictions, commercial fishers must sell their catch to a receiver (although they can sell small amounts on wharves). While this restricts fishers' options for landing their catch, it means that fish can be tracked, reduces illegal fish trading and ensures that the Quota Management Systems (QMS) work effectively by ensuring catches do not exceed the total allowable catch or quota amounts for individual species. Receivers of fish may be fish processors, wholesalers or retailers.

In some jurisdictions, the fishers and fish receivers are integrated, such that they are effectively the same "business". In Commonwealth fisheries, the total number of fish receivers per year may differ to the sum of the fish receivers per fishery because some receivers operate in more than one fishery.
Data Quality: Not found

Economic > Markets > Volatility in market price > Price volatility

Price volatility is the mean beach price for the target species (top one or five depending on price) over the given period (most recent ten years). The level of volatility is the standard deviation in mean price over this period.

Data Quality	**Species/Fishery**	**Year/Time period**	**Amount**	**Reference**	**Note**
Silver	VIC Rock lobster	2006-07 to 2015-16	$15.39/kg	Mobsby, D and Koduah, A 2017, Australian fisheries and aquaculture statistics 2016, Fisheries Research and Development Corporation project 2017-095. ABARES, Canberra, December. CC BY 4.0. Supporting data tables	

Economics > Energy costs > Energy Use > Fuel use per kg of fish harvested

Fuel use varies over time and between stocks and are best collected from industry on a yearly basis. Estimates for different fisheries should be compared with caution, and in particular comparing energy use between fisheries with different data quality which is not recommended (different data availability, may be e.g. old or not fisheries-specific). Estimates are provided for all levels of data quality if available and are given in L per kg live-weight.

Data Quality	Gear	Target species	Min (L/kg)	Average (L/kg)	Max (L/kg)	Reference	Description
Gold							
Silver	Pots	Rock lobster		3.2		Parker et al 2017	Southern rock lobster (SA, southern zone), 2012-2013, lacking bait use

Bronze	Pots and traps	Crustaceans	0.8	3.8	9.5	Parker and Tyedmers 2015	Oceania region

Economic > Energy costs > Fossil fuel subsidies > Fuel subsidies directed to the fishery

Fossil fuel subsidies (fuel rebates) illustrate to which extent the fuel cost is reduced in the fishery, measured in AUD/kg live weight fish. Note that this form of tax exemption for fisheries is in Australia motivated from the sector not using roads (i.e. costs embedded in fuel price for road construction and maintenance), and are not formally reported as fuel subsidies in Australia.

Data Quality	Gear	Target species	Subsidy (AUD/kg)	Reference	Description
Gold					
Silver	Pots	Rock lobster	1.29	Parker et al 2017	Fuel use from Southern rock lobster fishery (SA, southern zone), 2012-2013
Bronze	All VIC	All VIC	0.60	Total tax claims per total landings in VIC	2015-16 (2016-17 also available), state level figures on landings are preliminary for 2015-16

Governance > Ecosystem governance > Bycatch mitigation > Description of the bycatch mitigation measures

Bycatch measures can be spatial (e.g. area closure), temporal (time closure, e.g. night setting only) or technical (bycatch reduction devices, hook size). This indicator describes the measures that are in place for a fishery – but not the rates of compliance. For example, spatial closures for different gear types are shown here for AFMA fisheries http://www.afma.gov.au/sustainability-environment/fishing-closures/.

None

Data Quality: Bronze – based on no bycatch species captured

Governance > Ecosystem governance > Protected species mitigation > Description of the protected species mitigation measures

TEP mitigation measures can be spatial (e.g. area closure), temporal (time closure, e.g. night setting only) or technical (bycatch reduction devices, hook size). This indicator describes the measures that are in place for a fishery – but not the rates of compliance.

None

Data Quality: Bronze – based on no interactions with TEPS

Governance > Management system > Harvest strategy > Scope of the harvest strategy

Assessment can be based on scoring presence of the following: a harvest strategy designed to achieve management objectives; harvest control rules and tools; collection of relevant information to support the harvest strategy; and, assessment of stock status or the presence of the following key elements: Defined operational objectives for the fishery; Indicators of fishery performance related to the objectives; Reference points for performance indicators; A statement defining acceptable levels of risk to meeting objectives; A monitoring strategy to collect relevant data to assess fishery performance; A process for conducting assessment of fishery performance relative to objectives; and; Decision rules that control the intensity of fishing activity and/or catch.

Harvest strategies provide a structured framework for assessing the status of a fishery and a set of rules to determine what the annual catch limits will be. Decisions regarding catch limits are therefore set out in advance, ensuring that fishers, fishery managers and other relevant stakeholders know what action will be taken in response to the conditions in the fishery (Sloane et al 2014). The foundation of this harvest strategy is the exploitation rate, which is the proportion of the available stock that can be caught. Unlike the previous harvest strategy used for the fishery, it does not include a rebuilding target so conservative exploitation rates that ensure that stocks rebuild, catch rates improve, profits are maximised and the objectives of this harvest strategy and management plan are met are used.

Operational Objectives

This harvest strategy aims to achieve two main operational objectives, both of which link to the overarching objectives for the management of the fishery. These operational objectives are:

1. Continue to rebuild the rock lobster population by setting appropriately conservative TACCs on an annual basis.

2. Maintain catch rates above 0.40 kg/pot lift (standardised).[333]

Data Quality: Gold

Governance > Management system > Management plans > Scope of management plan

Management plans can be assessed by evaluating the presence of minimum requirements, as follows: a description of the fishery, especially its current status and any established user rights: the management objectives; how these objectives are to be achieved; how the plan is to be reviewed and/or appealed, as well as the consultation process for review and appeal.

The Victorian Rock Lobster Fishery is managed under the Victorian Rock Lobster Fishery Management Plan[334], which contains the following minimum requirements:

description of the fishery
established user rights
the management objectives & strategies
how these objectives & strategies are to be achieved

Data Quality: Gold

Governance > Institutional capacity > Accountability of decision making bodies > Level of Accountability

[333] Victorian Rock Lobster Fishery Management Plan 2017
[334] https://vfa.vic.gov.au/__data/assets/pdf_file/0006/387717/Victorian-Rock-Lobster-MP-for-web.pdf

Accountability of Decision-making bodies. Performance of a fisheries management agency is based on the degree to which decision-making processes are consultative, the basis for decisions are fully explained, and information about decision making is publicly available. The assessment applied the three tiers of Principle 3.2.2 (d) 'Decision-making process' of the MSC Fisheries Standard v2.0 (2014) to determine whether the level of accountability was low, medium or high.

Medium level of accountability. This is demonstrated by publicly-available stock reports and decision framework which can be accessed online. Information about proceedings and recommendations of the relevant Resource Advisory Group, are not publicly available online.

Data Quality: Silver

Governance > Institutional capacity > Uncertainty management > Extent of incorporation of uncertainty in management of the targeted stock

This metric reports on the explicit incorporation of uncertainties in decision support processes used to inform and make appropriate choices of management actions. We recognise three levels of uncertainty: Low level of incorporation of uncertainty; Medium level of incorporation of uncertainty; High level of incorporation of uncertainty. These are based on: Major sources of uncertainty are identified; Assessment takes uncertainty into account; Frequency of monitoring of indicators is high; Monitoring of more than one indicator to support management decisions; Assessment evaluates stock status relative to reference points in a probabilistic way; Robustness of assessments are tested, Alternative hypotheses and assessment approaches are rigorously explored.

High level of incorporation of uncertainty in management of the targeted stock.	The assessment applied Principle 1.2.4 (c & d) 'Assessment of stock status: Uncertainty in the Assessment' of the MSC Fisheries Standard v2.0 (2014) to assess extent of incorporation of uncertainty in management of the targeted stock.

Data Quality: Silver

Governance > Compliance > Compliance regime > Level of Compliance

Level of compliance with rules and regulations controlling catch can be assessed by audits that measure the agreement between 1) logbook and observer records; 2) catch disposal records submitted by fishers and fish receivers. It might also be assessed by counting the annual number of breaches/observed offences or enforcement actions, preferably scaled to the level of enforcement effort (e.g. $). This indicator can be scored on the basis of the presence of key monitoring, control and surveillance elements and capacities.

A vital component in the management of the Rock Lobster Fishery is the collection and analysis of data. The Rock Lobster Fishery has a comprehensive data collection program that informs the annual stock assessment and is used in setting the TACC and directing management decisions. The data collection program incorporates a range of fishery-dependent and fishery-independent data.
Fishery dependant data
Commercial catch and effort logbooks - the requirement to complete daily commercial logbooks has been in place since 1978. Logbooks are submitted monthly and of each species must be recorded separately in the daily catch logbook

Voluntary pot sampling - A small number of fishers currently measure catch from three specially marked pots each day. This data supplements the data collected by on-board observers. An electronic logger and wet tags combination is being trialled with the aim to streamline the data collection process and improve industry participation. If successful, there is a significant potential to greatly improve the spatial and temporal coverage of data collected across the fishery.
Wildlife interaction data - It is a requirement under the EPBC Act to report all interactions with threatened, endangered and protected species. This requirement has been incorporated into the commercial logbook.
Fishery independent data
Includes on-board sampling, fixed site surveys and Puerulus collection. The on-board sampling program has been in place since 2004 and has been responsible for, on average, 8,900 observations taken over approximately 140 days annually. Data is collected at sea and includes length, sex, colour, shell hardness, reproductive condition, undersize and bycatch species. There is a commitment to maintaining approximately 80 observer days in the Western Zone and 60 observer days in the Eastern Zone, annually[335].

Data Quality: Silver

Governance > Compliance > Surveillance > Surveillance Effort

Regulatory controls include logs and catch reporting, on-board observer programs, vessel inspections, vessel monitoring systems, and visual or electronic surveillance using radar or satellite by boat or by air. Higher degrees of surveillance, or coverage using multiple methods, provide greater levels of certainty in estimates of effort, fishing mortality, bycatch and discard levels, and interactions with protected/listed species. Report on the surveillance carried out on the fishery, as reported by the compliance branch responsible for the fishery

Surveillance effort score: undefined
Victorian Fisheries Officers conducted over 49100 inspections (of all Victorian fisheries) during the period between 1 July 2017 and 30 June 2018.[336]

Fishing sector	Inspections conducted	Offenders detected	Verbal warnings issued	Official warnings issued	Infringement notices issued	Briefs written
Commercial	688	68	38	19	9	3

There is a commitment to maintaining approximately 80 observer days in the Western Zone and 60 observer days in the Eastern Zone, annually.[337]

Data Quality: Silver

Governance > Adaptive capacity > Governance arrangements > Climate change recognition

Governance arrangements relevant to the fishery consider the impact of climate change on the fishery, as evidenced by documentation, policies and plans that describe how management is

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335 https://vfa.vic.gov.au/__data/assets/pdf_file/0006/387717/Victorian-Rock-Lobster-MP-for-web.pdf
336 https://vfa.vic.gov.au/enforcement/enforcement-outcomes
337 https://vfa.vic.gov.au/__data/assets/pdf_file/0006/387717/Victorian-Rock-Lobster-MP-for-web.pdf

addressing climate change impacts. Does the fishery management plan, harvest strategy or research activity suggest that climate change is recognised, and integrated into management planning?

There is not explicit recognition for climate responses in the fishery-specific documents.

The Victorian Fisheries Authority provides information and recognizes that climate change has already influenced species in Victorian waters and suggests that adaptation will be needed [338]

The Victorian government adaptation plan does not specifically address adaptation in fisheries[339].

The National Harvest Strategy also recognizes that "*Variability in ocean conditions, due to natural variability, climate change or other factors, can affect the productivity of stocks. Fisheries should seek to account for that variability when developing and implementing harvest strategies*"[340]. The Guidelines for the Harvest Strategy provide explicit approaches for fisheries[341]. The strategy and guidelines do not explicitly apply to state fisheries, but will provide guidance.
Data quality: Silver

Governance > Adaptive capacity > Coping strategies > Climate responses

The fishery has initiated coping strategies (directed) to reduce the impacts of climate change. Evidence of strategies that have been specifically implemented for the fishery might include codes of practice, restocking programs, early warning systems, and so on. The coping strategies may be for long-term change or for extreme events. A description of the climate change responses that have been implemented or explored in research or application are provided.

There are no management actions currently implemented that address climate change impacts in the fishery. A recent publication[342] suggested that the rock lobster will be relatively resilient to climate change impacts.

Data quality: Bronze

Social and Ethical > Fishers wellbeing > Fisher satisfaction > Satisfaction scores

If available, fishery specific surveys of well-being or satisfaction, with interpretation required for the types of questions and sample. When surveys are not available other sources of data may need to include broader surveys (e.g. not fishery specific) or discussions with industry representatives, managers or fishers about the industry and their opinion of general fisher-wellbeing (note this will be subjective).

Data Quality: Not found

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[338] https://vfa.vic.gov.au/education/teachers-resource/climate-change-fishing-change
[339] https://www.climatechange.vic.gov.au/__data/assets/pdf_file/0024/60729/Victorias-Climate-Change-Adaptation-Plan-2017-2020.pdf
[340] Department of Agriculture and Water Resources 2018, *Commonwealth Fisheries Harvest Strategy Policy*, Canberra, June. CC BY 4.0.
[341] Department of Agriculture and Water Resources 2018, *Guidelines for the Implementation of the Commonwealth Fisheries Harvest Strategy Policy*, Canberra, June. CC BY 4.0.
[342] Hinojosa, I. A., C. Gardner, B. S. Green, A. Jeffs, R. Leon and A. Linnane (2017). Differing environmental drivers of settlement across the range of southern rock lobster (Jasus edwardsii) suggest resilience of the fishery to climate change. Fisheries Oceanography **26**(1): 49-64.

Social and Ethical > Fishers wellbeing > Age Structure > Proportion of fishers in standard age cohorts

Proportion of fishers in standard age cohorts that were involved in the fishery at any point in the previous 5 years. If the fishery is not attractive or difficult to enter, the age distribution will be skewed to older ages.
Data Quality: Not released

Social and Ethical > Wider community > Community satisfaction with fishery > Community feedback

Evidence of processes in place to gather direct engagement with the community (diversely represented) to listen and respond to feedback. This may be through a range of means including formal and informal processes and may not be appropriate to all fisheries in the same way. In some cases Marine Stewardship Council accreditation may demonstrate some evidence of community engagement.

Community feedback: Medium.

There is a management advisory committee, which could oversee a feedback process. Based on general FRDC community perception surveys, satisfaction with Australian fisheries is rated at 42%.

Data quality: Bronze.

Social and Ethical > Wider Community > Level of local employment > Percentage of local employment

The communities surrounding and supporting fisheries benefit from those fisheries when the majority of employees (direct and indirect) associated with the fishery activity are local. Can be reported as direct, indirect and downstream levels.

Indicator	Year	Amount	Reference	Note
Estimated employment	2016	66 people	Mobsby, D & Koduah, A (2017) Australian fisheries and aquaculture statistics 2016, Fisheries Research and Development Corporation project 2017-095. ABARES, Canberra, December. CC BY 4.0.	Rock lobster and crab potting for VIC

Data Quality: Silver

Social and Ethical > Ethical - Human welfare > Protections in place > Legislation exists

Although all workers are automatically operating under legislation according to their state or territory to a safe work place, the extent to which there is awareness of the relevant Acts, and use of these if required, is highly variable and may be different for each business or individual operation within each fishery. See http://workplaceohs.com.au/legislation for a list of state acts and regulations.

Protections in Place: Low

The Rock Lobster Vic fishery operates under Victoria (WorkSafe Victoria) – Occupational Health and Safety Act 2004 and Occupational Health and Safety Regulations 2017 (*Note:* Victoria will not be implementing WHS laws).

Data Quality: Silver

Social and Ethical > Ethical > Human welfare > Levels of compliance

Levels of compliance (or violations of) with Workplace Health and Safety. If references to Workplace Health and Safety exist in relation to the specific fishery, determine whether these are voluntary or recorded in anyway. If they are recorded, note the level of compliance. As they are likely to be voluntary, there will not likely be a record of compliance, but this may become more readily available in the future. **Data Quality:** Not found

Social and Ethical > Ethical-animal welfare > Animal welfare protections > Protections in place

At this early stage of development of animal welfare, any type of mention of animal welfare exists, it is probably the most appropriate. As this develops in to the future, assessments as to the level of engagement may become more relevant. **Data Quality:** Not found.

Social and Ethical > Ethical-animal welfare > Level of Compliance > Levels of compliance or violations of animal welfare

If there are any references to animal welfare protections or guidelines in fishery management plans and if reports exist, the indicator reports on the level of compliance or violations with welfare provisions.

Data Quality: Not found.

Social and Ethical > Climate-related > Access to information > Availability of information

This indicator describes available information that will help participants in the fishery adapt to changes. The assumption behind this indicator is that good information availability and flow will help fishers to adapt.

Data Quality: Not found.

Social and Ethical > Climate-related > Access to networks > Level of membership of industry association

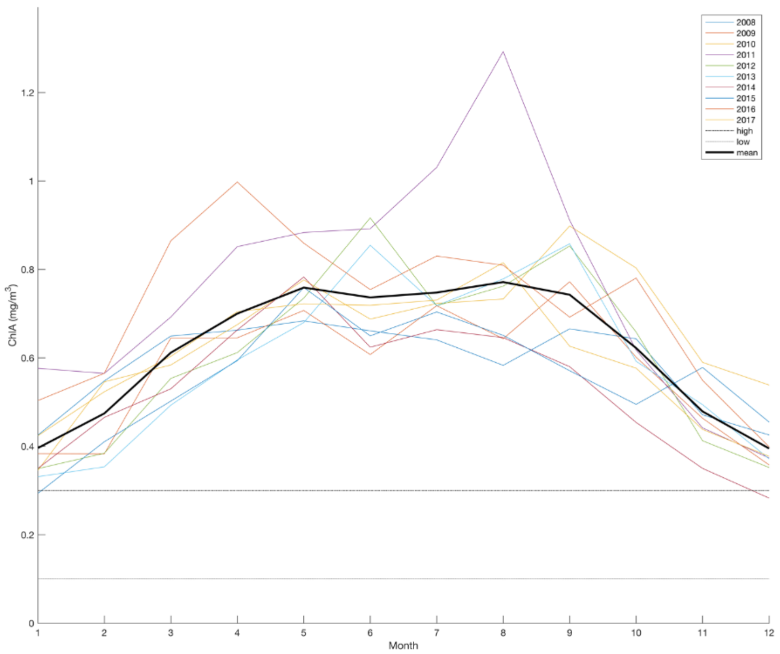
This metric assesses the presence or absence of a dedicated social media or social network group for the fishery. The fishery may still have a strong social network without a social media presence.

Data Quality: Not found.

External > Environmental Context > Productivity > Mean chlorophyll

A measure of environmental productivity is the biomass of phytoplankton, which in oceanic waters can be approximated by chlorophyll a concentration, as estimated from satellite (MODIS, oceandata.sci.gsfc.nasa.gov). Monthly chlorophyll values for a representative area of the fishery are shown with the mean productivity shown in solid black and references levels of low chlorophyll at 0.1

mg $m^{-3}$and high chlorophyll levels at 0.3 mg m^{-3}. This indicator shows the mean chlorophyll by month for the years 2008-2017. These data provide information on the relative environmental productivity in the fishery area. Missing data for some months can be due to ice cover. Variability in chlorophyll a concentration between years can indicate high environmental variability, while similar seasonal patterns indicate relative environmental stability.



Data Quality: Gold

External > Environmental Context > Environmental character > Description of the ecosystems

This metric provides a qualitative description of the ecosystem(s) in which the fishery occurs. The goal is to provide a general overview of these environments. The knowledge about which ecosystems are encountered during fishing activity is the indicator (rather than the response of the ecosystems to fishing).

Marine ecosystems are defined for the purposes of this indicator as the composition of plants, animals, and the marine environment (water masses, geomorphology). Types of marine ecosystems include estuaries, the sea floor, the mesopelagic zone, the pelagic zone, the inter-tidal zones, coral reefs, lagoons, and mangroves. A pelagic zone ecosystem for example, is defined by physical, chemical and biological features of the marine water column of the open ocean[343].

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[343] Game, E. T., H. S. Grantham, A. J. Hobday, R. L. Pressey, A. T. Lombard, L. E. Beckley, K. Gjerde, R. H. Bustamante, H. P. Possingham and A. J. Richardson (2009). Pelagic protected areas: the missing dimension in ocean conservation. Trends in Ecology and Evolution **24**(7): 360-369 doi:310.1016/j.tree.2009.1001.1011.

Description of the ecosystems: High

This fishery takes place on rocky reefs from shallow to water depths approaching 50 meters

Data Quality: Gold

External > Climate related > Susceptibility of target species > Impacts on target species

Climate change directly affects the distribution, abundance and phenology of individual species. These changes then affect the fisheries that harvest these species, and can be a strong external influence on the fishery. These impacts can be positive (e.g. increased abundance), or negative (e.g. movements further from fishing ports), and to long-term warming, or short-term extreme events such as marine heatwaves.

Sensitivity of some of the target species to climate change has been assessed[344]. Species in this fishery have sensitivities ranging from moderately high to high.

Common name	Species	Fishery	Score	Sensitivity
Gummy shark	Mustelus antarcticus	Victorian Rock Lobster Fishery	6	MODERATELY HIGH
Southern rock lobster	Jasus edwardsii	Victorian Rock Lobster Fishery	6.75	HIGH

Data Quality: Silver

External > Climate related > Susceptibility of key habitats > Habitat Impacts

Habitat impact: Moderate

Changing ocean conditions may reduce the productivity of rocky reefs and the macroalgal flora.

Data Quality: Bronze

External > Contaminants in the environment > Detection system for seafood contaminants > Risk of contaminants

Potential risk for contamination from the marine environment combined with monitoring arrangements to be able to address risks needed to ensure food safety. Contaminants include those with maximum levels set for by Food Standards Code Australia: metal contaminants, non-metal contaminants, natural toxicants, and average and maximum levels of mercury in fish. Contaminants from poor handling after landing are not assessed but may be indirectly addressed.

Rubric for risk level:

Low risk	Medium risk	High risk
There are no documented levels of contaminants from	There may be seasonal/area/species/size-	Permanent diet restrictions of species

[344] Fulton EA, Hobday AJ, Pethybridge H, Blanchard J, Bulman C, Butler I, Cheung W, Gorton B, Hutton T, Lozano- Montes H, Matear R, Pecl G, Villanueva C, Zhang X (2018). *Decadal scale projection of changes in Australian fisheries stocks under climate change.* CSIRO Report to FRDC. FRDC Project No: 2016/139 – ONLINE.

the marine environment causing risk/diet restrictions to any consumer group in the fishery.	based risks of contaminants for some species.	caught to vulnerable consumers such as children or pregnant women.

Risk of Contaminants: Medium

No specific monitoring arrangements found for marine contaminants on the fishery webpage: https://vfa.vic.gov.au/commercial-fishing/rock-lobster, targeted species have medium potential risk for contamination from the marine environment. Shellfish (such as rock lobster) may in different areas and season contain natural toxins, bacteria and pollution (e.g. toxic algae, dioxins).

Data Quality: Silver

External > Contaminants in the environment > Management arrangements to ensure food safety related to contaminants > Evidence for arrangements

There is evidence of management arrangements to ensure food safety related to contaminants and food safety from the marine environment. No supply chain risks from poor handling are considered. Food standard 4.2.1 requires all seafood business in Australia to identify potential seafood safety hazards and put controls in place that are consistent with the risk.

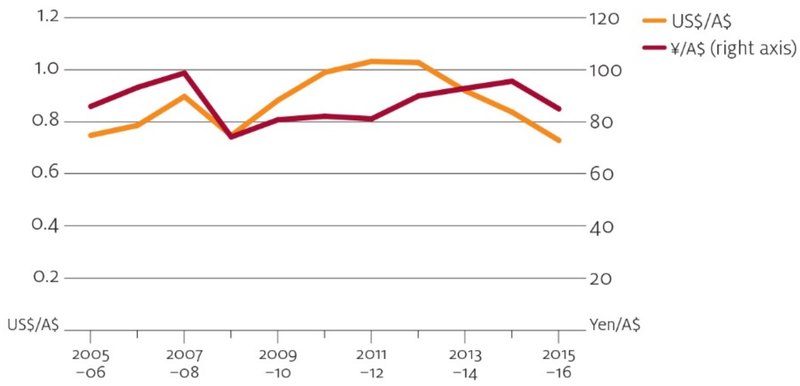
Data Quality	
GOLD	
SILVER	There is an industry code of practise. http://vicrocklobster.weebly.com/uploads/1/6/3/3/16339694/rl_code_final_2013_2.pdf
BRONZE	

External > Market Drivers > Macroeconomic factors > Exchange Rates

A depreciating Australian dollar (or, increasing exchange rate) generally results in producers receiving a higher export price in Australian dollar terms, while an appreciating Australian dollar (or, decreasing exchange rate) results in a lower export price. Domestically, a depreciation of the Australian dollar encourages substitution from imported seafood to domestically produced seafood, as imported products become relatively more expensive. A lower exchange rate also makes Australian exports more competitive in world markets, as exported seafood become relatively cheaper in foreign currency terms.

National export trends are negatively related to exchange rate movements— the Australian dollar declined against the US dollar and Japanese yen from 1990–91 to 2000–01, with exports increasing in volume and value. Exchange rates for the Australian dollar increased against those currencies from 2001–02 to 2015–16. The real export value and volume of Australia’s seafood exports decreased between 2005–06 and 2012–13 and then increased between 2012–13 and 2015–16—with a noticeable rise (43 per cent) in volume between 2014–15 and 2015–16.[345]

[345] Mobsby, D and Koduah, A 2017, Australian fisheries and aquaculture statistics 2016, FRDC project 2017-095. ABARES, Canberra, December. CC BY 4.0.



Data Quality: Gold

External > Market Drivers > Consumer Trends > Per person annual apparent consumption of seafood (kg)

Annual apparent consumption is estimated by adding the total edible quantity of seafood supplied domestically—that is, total production plus imported seafood— less exports of seafood. Apparent consumption provides an estimate of the total amount of seafood consumed in Australia assuming zero change in stocks.

The production quantity of Australian fishery and aquaculture products is reported by ABARES on a whole weight basis, whereas trade data are reported on a processed basis. To align the units of measurement between production and trade data, it is necessary to convert production volume to a processed edible equivalent.

Production volumes are adjusted to an edible quantity basis using species-specific conversion rates and excluding species that are known to be predominantly supplied for non-human consumption purposes, such as for aquaculture feed or bait. Imports and exports of seafood are sourced from Australian Bureau of Statistics (ABS) trade data and are reported as edible weight. The apparent consumption per person is calculated as the total apparent consumption divided by the total Australian population in each year. The method applied here is consistent with that used by ABARES to estimate apparent consumption of other agricultural commodities produced in Australia.

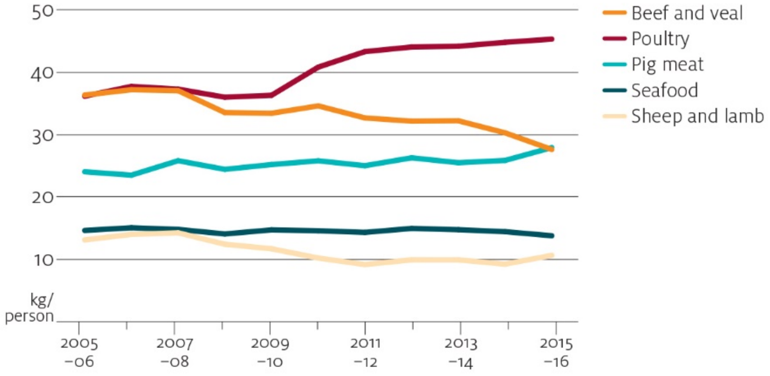
The FAO also compiles statistics on apparent consumption of seafood, applying a consistent method across all countries. FAO estimates indicate that annual consumption of seafood in Australia is around 26 kilograms per person in 2013 (FAO 2016[346]). The discrepancy between FAO and ABARES estimates reflects differences in methodological approaches to estimating consumption. Moreover, ABARES estimates seafood consumption on a processed edible basis, whereas the FAO provides its estimates on a whole weight basis.

In Australia, apparent consumption of seafood per person (edible equivalent) decreased, on average, at an annual rate of 0.6 per cent, from 14.6 kilograms in 2005– 06 to 13.8 kilograms per person in 2015–16. Annual apparent consumption is estimated by the Australian Bureau of Agricultural and

[346] The state of world fisheries and aquaculture 2016—opportunities and challenges, Food and Agriculture Organization of the United Nations, Rome.

Resource Economics and Sciences by adding the total edible quantity of seafood supplied domestically—that is, total production plus imported seafood— less exports of seafood[347]

In comparison, global per capita apparent fish consumption increased from an average of 9.9 kg in the 1960s to 14.4 kg in the 1990s and 20.1 kg in 2014, with preliminary estimates for 2015 indicating further growth, exceeding 20 kg (FAO 2016). Australia's per person seafood consumption in 2013 was estimated by the FAO to be 26kg. The differences in estimates are accounted for by varying methods for calculating consumption. ABARES estimates seafood consumption on a processed edible basis, whereas the FAO provides its estimates on a whole weight basis.

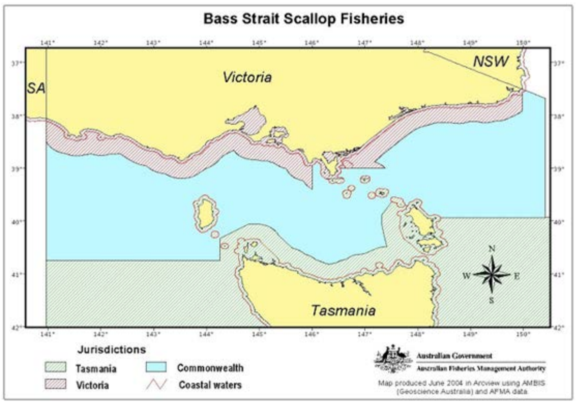


Data quality: Gold

[347] Mobsby, D and Koduah, A 2017, *Australian fisheries and aquaculture statistics 2016*, FRDC 2017-095. ABARES, Canberra, December. CC BY 4.0

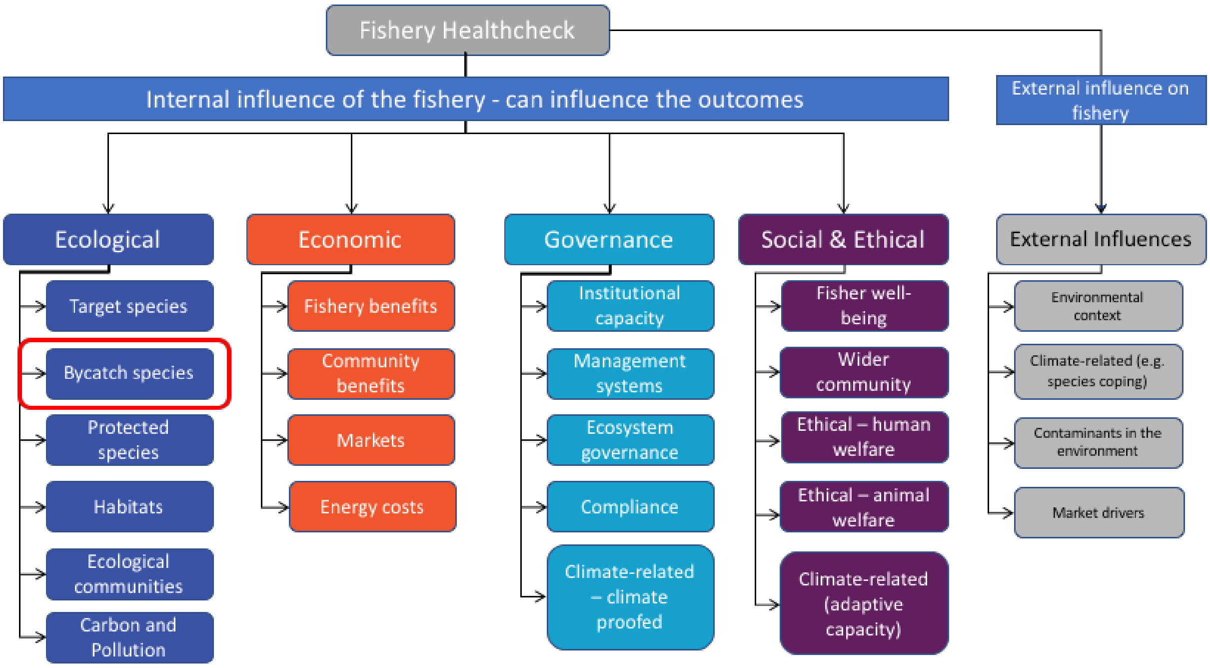
Victorian Scallop Fishery

The Victorian Scallop Fishery is based on the species *Pecten fumatus*. Occasionally, incidental catches of doughboy scallops (*Chlamys asperrimus*) are taken as by-product, but are generally not in commercial quantities. The Victorian Scallop Fishery is one of three scallop zones in the Bass Strait, and extends out from the coastline to 20 nautical miles. Historically, the majority of the fishing activity in the Victorian zone has occurred in the eastern waters of the State, with most vessels launching from the ports of Lakes Entrance and Welshpool. Commercial fishing for scallops is by dredging; vessels tow a single dredge that is dragged along the seabed. Dredges are deployed from the rear of the vessel and are up to 4.5 metres wide. A tooth-bar on the bottom of the mouth of the dredge lifts scallops from the seafloor and into the dredge baskets. The number of licences has been capped at 91, and approximately 10-15 boats operate in the fishery. The majority of active operators in this fishery also possess entitlements to fish in Commonwealth waters. The fishery is primarily an output controlled fishery that has been under Individual Transferrable Quota arrangements since 1998. Quota is set annually and each licence holder is given an equal share at the beginning of each season. Scallop quota is transferable amongst licence holders. (Source: https://vfa.vic.gov.au/commercial-fishing/scallop#summary).



Case Study Presentation Format

The case study documents are a collection of metrics, organised by the healthcheck structure:



The presentation of metrics will follow the following heading format:

Ecological > Bycatch species > Bycatch composition > Mean Trophic Level

Understand this to be an indicator (**Bycatch composition**) of the **Ecological** Component, **Bycatch species** subcomponent where the (in the figure and heading example above, is being measured by presenting Mean Trophic Level as the metric.

Ecological > Target species > Stock Status > Status of Australian Fish Stocks (SAFS)

Target species in each fishery are the primary focus for this indicator. Status of these species is ideally assessed with the SAFS approach, however this may not cover all target species for each fishery. In that case, we indicate the number of unassessed species. These species could also be assessed by individual states or by alternative methods.

SpeciesName	StockName	StockStatus	Year
Commercial Scallop	Port Phillip Bay Dive Scallop Fishery	Sustainable	2016

Data Quality: Gold

Ecological > Target Species > Harvest Level > Catch weight

This metric is a proxy for harvest level. The harvested biomass for each species, provides information on the level of the catch. Trends in this metric over time can indicate declining availability of fish, quota restrictions, or changes in market demand. For Australian fisheries, trends are expected to be stable for most species. **Data quality:** Not applicable

Ecological > Bycatch species > Bycatch composition > Mean Trophic Level

The trophic level is a measure of the position of an organism in a food web, starting at level 1 with primary producers, such as phytoplankton, then moving through the primary consumers at level **2** that eat the primary producers to the secondary consumers at level **3** that eat the primary consumers, and so on. The **bycatch mean trophic level** is an indicator of the mean level of the food chain for bycatch in a fishery. **Data Quality:** Not organised/analysed

Ecological > Bycatch species > Bycatch amount > Total weight of bycatch

Bycatch weights for fishery are typically developed by specific projects, and require a range of assumptions due to issues with reporting and retention of bycatch. **Bycatch** estimates typically cover species that are not target species, while **discard** rates may also include undersized individuals of the target species. Kennelly (2018) provides estimates of discard rates, which include both target and bycatch species, and when discard rates are used, that information is noted for each fishery. Animals can be returned to the ocean alive or dead. The intention of this metric is to provide information on animals that are dead on return to the ocean.

Reference:

Kennelly, S.J., 2018. *Developing a National Bycatch Reporting System.* Final FRDC Report, ISBN 978-0-9924930-5-9, March, 2018. 99 pp.

Data Quality: Not applicable

Ecological > Protected species > Capture amount > Captures

The number and diversity of TEP species captured by a fishery in the most recent year, provided as annual numbers.

The fishery is currently closed.

Data quality: Bronze

Ecological > Protected species > Reporting > Level of monitoring

This indicator is to provide information on the level of coverage for a fishery. Annual measures are preferred.

Fishery closed

Data quality: Not found

Ecological > Habitats > Habitat impact > Impact score

The habitat impact is an indicator of the effect the fishing gear has on the habitat. Different gear types have different impacts. See the scoring rubric.

Habitat Impact: Major, based on the gear type used in this fishery.

Data quality: Bronze

Ecological > Habitats > Habitat impact > Habitat status

The status of the habitat types is a measure of the condition relative to a pristine state. Fishing may not be responsible for that habitat status, but it is important to note if fishing is taking place in pristine or disturbed habitats.

Habitat status: Moderate – changing environment as a result of climate change has significantly impacted this system

Data quality: Bronze

Ecological > Ecological communities > Ecosystem status > Ecosystem status

This metric reports the ecosystem status in the region of the fishery.

Ecosystem Status: Moderate

Modification to the marine environment, ongoing oil and gas exploration and seismic testing, invasion of marine species, and climate related warming have reduced the status of the environments in this region. Unexplained occasional dieoff of scallop beds have occurred.

Data Quality: Bronze

Ecological > Ecological communities > Ecosystem status > Species diversity

The measure of species diversity as a ratio between fished and unfished states.

Data quality: Not organised/analysed

Ecological > Carbon and Pollution > Macro-plastics > Plastic code of conduct

Macro-plastics are plastics that are visible to the naked eye, such as food containers and wrapping, equipment packaging, and fishing equipment. The metric notes a commitment to a zero waste overboard code of conduct to assess attempts to reduce accidental or intentional introduction of macro-plastics to the ocean. There are stated guidelines detailing Australia's guidelines regarding marine pollution from the Australian Maritime Safety Authority[348]:

Pollution of the marine environment by ships, including fishing vessels, is strictly controlled by the International Convention for the Prevention of Pollution from Ships (known as MARPOL).

To minimise pollution, MARPOL prohibits ships from discharging garbage into the sea except in very limited circumstances.

Australian MARPOL regulations apply to Australian fishing vessels wherever they are operating.

Data Quality: Bronze

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[348] https://www.amsa.gov.au/marine-environment/marine-pollution/pollution-fishing-vessels
https://www.amsa.gov.au/marine-environment/marine-pollution/marpol-and-its-implementation-australia

Ecological > Carbon and Pollution > Carbon footprint > CO2-equivalents

The emissions of climate forcing gases in kg CO_2-equivalents (CO_2e) per kg live weight fish caught, not including the supply chain after landing.

Data Quality	Gear	Target species	Min (kg CO_2e/kg)	Average (kg CO_2e/kg)	Max (kg CO_2e/kg)	Reference	Description
Gold							
Silver							
Bronze	Dredge	Molluscs	0.04		5.0	Parker and Tyedmers 2015	Oceania region, year not specified, assume diesel, refrigerants not included.

Economic > Fishery Benefits > Net Economic Returns > Economic Rent

Net Economic Returns (NER) is equal to fishing revenue less fishing costs and measures the economic profit that is derived from fishing activity, it is measured by the Commonwealth as Net Economic Returns and by some States as Economic Rent.

Data Quality: Not found

Economic > Fishery Benefits > Gross Value of Production > Gross Value of Production

GVP calculated as the volume of catch multiplied by the average per unit beach price (AUD$).

Data Quality	**Species/Fishery**	**Year**	**Amount**	**Reference**	**Note/Comment**
Bronze	VIC Scallop	2013-14	$54.6 million	http://agriculture.vic.gov.au/agriculture/fisheries	Estimated total value for wild catch fisheries in Victoria
Gold	VIC Scallop	2015-2016	0	Mobsby, D & Koduah, A (2017) Australian fisheries and aquaculture statistics 2016, Fisheries Research and Development Corporation project 2017-095. ABARES, Canberra, December. CC BY 4.0	
Gold	VIC Scallop	2014-2015	0	Mobsby, D & Koduah, A (2017) Australian fisheries and aquaculture statistics	

				2016, Fisheries Research and Development Corporation project 2017-095. ABARES, Canberra, December. CC BY 4.0	
Gold	VIC Scallop	2013-2014	0	Mobsby, D & Koduah, A (2017) Australian fisheries and aquaculture statistics 2016, Fisheries Research and Development Corporation project 2017-095. ABARES, Canberra, December. CC BY 4.0	

Economic > Fishery Benefits > Profitability > Financial Performance

Economic health of a fishery can be measured by the financial performance of the operators in the fleet. Fleet wide averages or distributions of levels of profitability indicate the extent to which the fishery is generating economic benefits for fishers.

Data Quality: Not found

Economic > Fishery Benefits > Latency > Underutilised Effort

Latency is fishery concessions that are not being fully utilised by fishers, for example, often the annual total allowable catch is left partially or largely uncaught for a fishery. Latency may appear as effort or uncaught TAC or inactive licences.

Data Quality: Not found

Economic > Community benefits > Value to community > GDP or GSP value

A fisheries contribution to Gross Domestic Production (GDP)/Gross State Product (GSP) is the total economic value that it generates directly, plus the indirect contribution made to other industries, which is also measured in value-add terms.

Data Quality: Not found

Economic > Community benefits > Wealth Spread > Distribution of fishing firm size

The spread of profits to owners and crew members indicates how widely benefits of fishing are distributed across the fishing community. A wide spread of benefits may be important to some fishery stakeholders. A narrow spread may not indicate a lack of distribution of benefits in the case where all participating businesses are the same size, or if other mechanisms are present to capture and distribute benefits such as high levels of employment of crew. The number of large business versus small business, classified by turnover (direct measure) or catch volume (proxy) may provide an indirect indicator: i.e. are economic returns from commercial fishing gained by one or two large businesses or a spread over many smaller businesses? **Data Quality:** Not released

Economic > Markets > Fish distribution > Fish receivers

One way of measuring benefits from a fishery is by assessing the flow of seafood through the supply chain. In many fishery jurisdictions, the first step in the supply chain is via licensed fish receivers who are allowed to receive fish for sale. They can also trade fish with other receivers. In some jurisdictions, commercial fishers must sell their catch to a receiver (although they can sell small amounts on wharves). While this restricts fishers' options for landing their catch, it means that fish can be tracked, reduces illegal fish trading and ensures that the Quota Management Systems (QMS) work effectively by ensuring catches do not exceed the total allowable catch or quota amounts for individual species. Receivers of fish may be fish processors, wholesalers or retailers.

In some jurisdictions, the fishers and fish receivers are integrated, such that they are effectively the same "business". In Commonwealth fisheries, the total number of fish receivers per year may differ to the sum of the fish receivers per fishery because some receivers operate in more than one fishery.

The Victorian scallop fishery has been closed in recent years, and so the fish receiver permit system has been suspended. As operators typically hold quota in the commonwealth fishery (BSCZSF), and deliver to the same fish receivers, the number of fish receivers for the BSCZSF is used as a proxy for this fishery. Assistance provided by Toby Geeves at Queenscliff - 03 5258 0280

	number of active fish receivers								
Fishery	2009	2010	2011	2012	2013	2014	2015	2016	2017
BSCZSF	16	23	16	13	15	20	18	21	20

Data Quality: Silver (based on BSCZSF data from AFMA)

Economic > Markets > Volatility in market price > Price volatility

Price volatility is the mean beach price for the target species (top one or five depending on price) over the given period (most recent ten years). The level of volatility is the standard deviation in mean price over this period. **Data Quality:** Not found

Economics > Energy costs > Energy Use > Fuel use per kg of fish harvested

Fuel use varies over time and between stocks and are best collected from industry on a yearly basis. Estimates for different fisheries should be compared with caution, and in particular comparing energy use between fisheries with different data quality which is not recommended (different data availability, may be e.g. old or not fisheries-specific). Estimates are provided for all levels of data quality if available and are given in L per kg live-weight.

Data Quality	Gear	Target species	Min (L/kg)	Average (L/kg)	Max (L/kg)	Reference	Description
Gold							
Silver							
Bronze	Dredge	Mollusc	0.02		1.8	Parker and Tyedmers 2015	Global

Economic > Energy costs > Fossil fuel subsidies > Fuel subsidies directed to the fishery

Fossil fuel subsidies (fuel rebates) illustrate to which extent the fuel cost is reduced in the fishery, measured in AUD/kg live weight fish. Note that this form of tax exemption for fisheries is in Australia motivated from the sector not using roads (i.e. costs embedded in fuel price for road construction and maintenance), and are not formally reported as fuel subsidies in Australia.

Data Quality	Gear	Target species	Subsidy (AUD/kg)	Reference	Description
Gold					
Silver					
Bronze	All VIC	All VIC	0.60	Total tax claims per total landings in VIC	2015-16 (2016-17 also available), state level figures on landings are preliminary for 2015-16

Governance > Ecosystem governance > Bycatch mitigation > Description of the bycatch mitigation measures

Bycatch measures can be spatial (e.g. area closure), temporal (time closure, e.g. night setting only) or technical (bycatch reduction devices, hook size). This indicator describes the measures that are in place for a fishery – but not the rates of compliance. For example, spatial closures for different gear types are shown here for AFMA fisheries http://www.afma.gov.au/sustainability-environment/fishing-closures/. **Data Quality:** Not found

Governance > Ecosystem governance > Protected species mitigation > Description of the protected species mitigation measures

TEP mitigation measures can be spatial (e.g. area closure), temporal (time closure, e.g. night setting only) or technical (bycatch reduction devices, hook size). This indicator describes the measures that are in place for a fishery – but not the rates of compliance. **Data Quality:** Not found

Governance > Management system > Harvest strategy > Scope of the harvest strategy

Assessment can be based on scoring presence of the following: a harvest strategy designed to achieve management objectives; harvest control rules and tools; collection of relevant information to support the harvest strategy; and, assessment of stock status or the presence of the following key elements: Defined operational objectives for the fishery; Indicators of fishery performance related to the objectives; Reference points for performance indicators; A statement defining acceptable levels of risk to meeting objectives; A monitoring strategy to collect relevant data to assess fishery performance; A process for conducting assessment of fishery performance relative to objectives; and; Decision rules that control the intensity of fishing activity and/or catch.

Although the fishery is currently closed, there was a proposed harvest strategy that encompassed scallops harvested from Commonwealth harvest areas and Tasmanian and Victorian state waters.

Data Quality: Not Applicable

Governance > Management system > Management plans > Scope of management plan

Management plans can be assessed by evaluating the presence of minimum requirements, as follows: a description of the fishery, especially its current status and any established user rights: the management objectives; how these objectives are to be achieved; how the plan is to be reviewed and/or appealed, as well as the consultation process for review and appeal.

This fishery is closed

Data Quality: Not found

Governance > Institutional capacity > Accountability of decision making bodies > Level of Accountability

Accountability of Decision-making bodies. Performance of a fisheries management agency is based on the degree to which decision-making processes are consultative, the basis for decisions are fully explained, and information about decision making is publicly available. The assessment applied the three tiers of Principle 3.2.2 (d) 'Decision-making process' of the MSC Fisheries Standard v2.0 (2014) to determine whether the level of accountability was low, medium or high.

Medium level of accountability. This is demonstrated by publicly-available description of management arrangements and stock status which can be accessed online. No management plan operates. Information about annual consultation to inform decisions regarding annual harvest levels are not publicly available online.

Data Quality: Silver

Governance > Institutional capacity > Uncertainty management > Extent of incorporation of uncertainty in management of the targeted stock

This metric reports on the explicit incorporation of uncertainties in decision support processes used to inform and make appropriate choices of management actions. We recognise three levels of uncertainty: Low level of incorporation of uncertainty; Medium level of incorporation of uncertainty; High level of incorporation of uncertainty. These are based on: Major sources of uncertainty are identified; Assessment takes uncertainty into account; Frequency of monitoring of indicators is high; Monitoring of more than one indicator to support management decisions; Assessment evaluates stock status relative to reference points in a probabilistic way; Robustness of assessments are tested, Alternative hypotheses and assessment approaches are rigorously explored.

Low level of incorporation of uncertainty in management of the targeted stock	The assessment applied Principle 1.2.4 (c & d) 'Assessment of stock status: Uncertainty in the Assessment' of the MSC Fisheries Standard v2.0 (2014) to assess extent of incorporation of uncertainty in management of the targeted stock.

Data Quality: Silver

Governance > Compliance > Compliance regime > Level of Compliance

Level of compliance with rules and regulations controlling catch can be assessed by audits that measure the agreement between 1) logbook and observer records; 2) catch disposal records submitted by fishers and fish receivers. It might also be assessed by counting the annual number of breaches/observed offences or enforcement actions, preferably scaled to the level of enforcement effort (e.g. $). This indicator can be scored on the basis of the presence of key monitoring, control and surveillance elements and capacities.

Fishery closed

Governance > Compliance > Surveillance > Surveillance Effort

Regulatory controls include logs and catch reporting, on-board observer programs, vessel inspections, vessel monitoring systems, and visual or electronic surveillance using radar or satellite by boat or by air. Higher degrees of surveillance, or coverage using multiple methods, provide greater levels of certainty in estimates of effort, fishing mortality, bycatch and discard levels, and interactions with protected/listed species. Report on the surveillance carried out on the fishery, as reported by the compliance branch responsible for the fishery Fishery closed

Governance > Adaptive capacity > Governance arrangements > Climate change recognition

Governance arrangements relevant to the fishery consider the impact of climate change on the fishery, as evidenced by documentation, policies and plans that describe how management is addressing climate change impacts. Does the fishery management plan, harvest strategy or research activity suggest that climate change is recognised, and integrated into management planning?

There is not explicit recognition for climate responses in the fishery-specific documents.

The Victorian Fisheries Authority provides information and recognizes that climate change has already influenced species in Victorian waters and suggests that adaptation will be needed [349]

The Victorian government adaptation plan does not specifically address adaptation in fisheries[350].

The National Harvest Strategy also recognizes that "*Variability in ocean conditions, due to natural variability, climate change or other factors, can affect the productivity of stocks. Fisheries should seek to account for that variability when developing and implementing harvest strategies*"[351]. The Guidelines for the Harvest Strategy provide explicit approaches for fisheries[352]. The strategy and guidelines do not explicitly apply to state fisheries, but will provide guidance.
Data quality: Silver

Governance > Adaptive capacity > Coping strategies > Climate responses

The fishery has initiated coping strategies (directed) to reduce the impacts of climate change. Evidence of strategies that have been specifically implemented for the fishery might include codes of practice, restocking programs, early warning systems, and so on. The coping strategies may be for

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349 https://vfa.vic.gov.au/education/teachers-resource/climate-change-fishing-change
350 https://www.climatechange.vic.gov.au/__data/assets/pdf_file/0024/60729/Victorias-Climate-Change-Adaptation-Plan-2017-2020.pdf
351 Department of Agriculture and Water Resources 2018, *Commonwealth Fisheries Harvest Strategy Policy*, Canberra, June. CC BY 4.0.
352 Department of Agriculture and Water Resources 2018, *Guidelines for the Implementation of the Commonwealth Fisheries Harvest Strategy Policy*, Canberra, June. CC BY 4.0.

long-term change or for extreme events. A description of the climate change responses that have been implemented or explored in research or application are provided.

There are no management actions currently implemented that address climate change impacts in the fishery.

Data quality: Bronze

Social and Ethical > Fishers wellbeing > Fisher satisfaction > Satisfaction scores

If available, fishery specific surveys of well-being or satisfaction, with interpretation required for the types of questions and sample. When surveys are not available other sources of data may need to include broader surveys (e.g. not fishery specific) or discussions with industry representatives, managers or fishers about the industry and their opinion of general fisher-wellbeing (note this will be subjective).

Data Quality: Not found

Social and Ethical > Fishers wellbeing > Age Structure > Proportion of fishers in standard age cohorts

Proportion of fishers in standard age cohorts that were involved in the fishery at any point in the previous 5 years. If the fishery is not attractive or difficult to enter, the age distribution will be skewed to older ages.

Data Quality: Not released

Social and Ethical > Wider community > Community satisfaction with fishery > Community feedback

Evidence of processes in place to gather direct engagement with the community (diversely represented) to listen and respond to feedback. This may be through a range of means including formal and informal processes and may not be appropriate to all fisheries in the same way. In some cases Marine Stewardship Council accreditation may demonstrate some evidence of community engagement.

Community feedback: Medium.

There is a management advisory committee, which could oversee a feedback process. Based on general FRDC community perception surveys, satisfaction with Australian fisheries is rated at 42%.

Data quality: Bronze.

Social and Ethical > Wider Community > Level of local employment > Percentage of local employment

The communities surrounding and supporting fisheries benefit from those fisheries when the majority of employees (direct and indirect) associated with the fishery activity are local. Can be reported as direct, indirect and downstream levels. **Data Quality:** Not found

Social and Ethical > Ethical - Human welfare > Protections in place > Legislation exists

Although all workers are automatically operating under legislation according to their state or territory to a safe work place, the extent to which there is awareness of the relevant Acts, and use of these if required, is highly variable and may be different for each business or individual operation within each fishery. See http://workplaceohs.com.au/legislation for a list of state acts and regulations.

Protections in Place: Low

The Scallop Vic fishery operates under Victoria (WorkSafe Victoria) – Occupational Health and Safety Act 2004 and Occupational Health and Safety Regulations 2017 (*Note:* Victoria will not be implementing WHS laws).

Data Quality: Silver

Social and Ethical > Ethical > Human welfare > Levels of compliance

Levels of compliance (or violations of) with Workplace Health and Safety. If references to Workplace Health and Safety exist in relation to the specific fishery, determine whether these are voluntary or recorded in anyway. If they are recorded, note the level of compliance. As they are likely to be voluntary, there will not likely be a record of compliance, but this may become more readily available in the future. **Data Quality:** Not found

Social and Ethical > Ethical-animal welfare > Animal welfare protections > Protections in place

At this early stage of development of animal welfare, any type of mention of animal welfare exists, it is probably the most appropriate. As this develops in to the future, assessments as to the level of engagement may become more relevant.
Data Quality: Not found.

Social and Ethical > Ethical-animal welfare > Level of Compliance > Levels of compliance or violations of animal welfare

If there are any references to animal welfare protections or guidelines in fishery management plans and if reports exist, the indicator reports on the level of compliance or violations with welfare provisions.

Data Quality: Not found.

Social and Ethical > Climate-related > Access to information > Availability of information

This indicator describes available information that will help participants in the fishery adapt to changes. The assumption behind this indicator is that good information availability and flow will help fishers to adapt.

Availability of information: Low
AFMA maintains a website for this fishery.

Data Quality: Gold

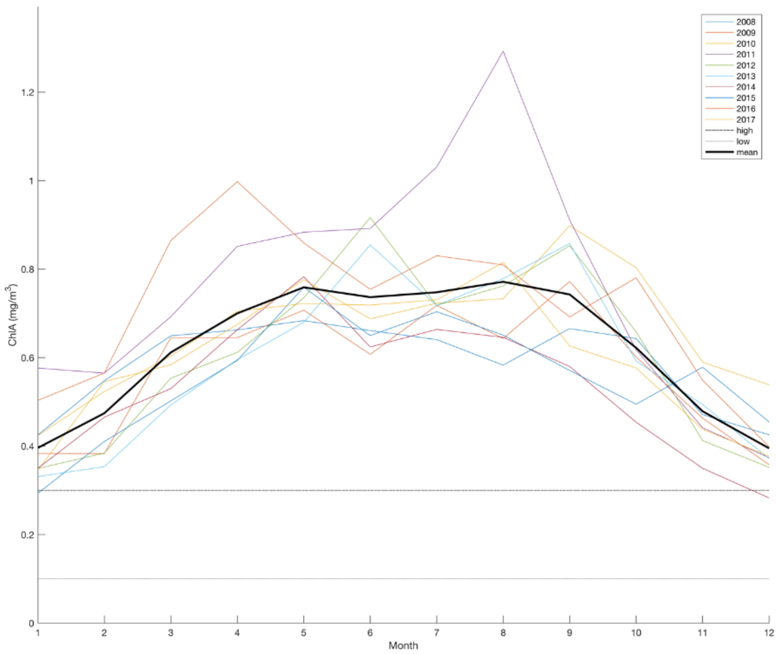
Social and Ethical > Climate-related > Access to networks > Level of membership of industry association

This metric assesses the presence or absence of a dedicated social media or social network group for the fishery. The fishery may still have a strong social network without a social media presence.

Data Quality: Not found.

External > Environmental Context > Productivity > Mean chlorophyll

A measure of environmental productivity is the biomass of phytoplankton, which in oceanic waters can be approximated by chlorophyll a concentration, as estimated from satellite (MODIS, oceandata.sci.gsfc.nasa.gov). Monthly chlorophyll values for a representative area of the fishery are shown with the mean productivity shown in solid black and references levels of low chlorophyll at 0.1 mg $m^{-3}$and high chlorophyll levels at 0.3 mg m^{-3}. This indicator shows the mean chlorophyll by month for the years 2008-2017. These data provide information on the relative environmental productivity in the fishery area. Missing data for some months can be due to ice cover. Variability in chlorophyll a concentration between years can indicate high environmental variability, while similar seasonal patterns indicate relative environmental stability.



Data Quality: Gold

External > Environmental Context > Environmental character > Description of the ecosystems

This metric provides a qualitative description of the ecosystem(s) in which the fishery occurs. The goal is to provide a general overview of these environments. The knowledge about which ecosystems are encountered during fishing activity is the indicator (rather than the response of the ecosystems to fishing).

Marine ecosystems are defined for the purposes of this indicator as the composition of plants, animals, and the marine environment (water masses, geomorphology). Types of marine ecosystems include estuaries, the sea floor, the mesopelagic zone, the pelagic zone, the inter-tidal zones, coral reefs, lagoons, and mangroves. A pelagic zone ecosystem for example, is defined by physical, chemical and biological features of the marine water column of the open ocean[353].

Description of the ecosystems: High

The fishery takes place on soft sediment bottoms in Bass Strait.

Data Quality: Gold

External > Climate related > Susceptibility of target species > Impacts on target species

Climate change directly affects the distribution, abundance and phenology of individual species. These changes then affect the fisheries that harvest these species, and can be a strong external influence on the fishery. These impacts can be positive (e.g. increased abundance), or negative (e.g. movements further from fishing ports), and to long-term warming, or short-term extreme events such as marine heatwaves.

Sensitivity of some of the target species to climate change has been assessed[354]. Species in this fishery have a sensitivity of high.

Common name	Species	Fishery	Score	Sensitivity
Commercial scallop	Pecten fumatus	Ocean Scallop Fishery	6.5	HIGH

Data Quality: Silver

External > Climate related > Susceptibility of key habitats > Habitat Impacts

Habitat impact: Moderate

Changing ocean conditions may reduce the productivity of Bass Strait waters

Data Quality: Bronze

External > Contaminants in the environment > Detection system for seafood contaminants > Risk of contaminants

Potential risk for contamination from the marine environment combined with monitoring arrangements to be able to address risks needed to ensure food safety. Contaminants include those with maximum levels set for by Food Standards Code Australia: metal contaminants, non-metal contaminants, natural toxicants, and average and maximum levels of mercury in fish. Contaminants from poor handling after landing are not assessed but may be indirectly addressed.

Rubric for risk level:

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[353] Game, E. T., H. S. Grantham, A. J. Hobday, R. L. Pressey, A. T. Lombard, L. E. Beckley, K. Gjerde, R. H. Bustamante, H. P. Possingham and A. J. Richardson (2009). Pelagic protected areas: the missing dimension in ocean conservation. Trends in Ecology and Evolution **24**(7): 360-369 doi:310.1016/j.tree.2009.1001.1011.

[354] Fulton EA, Hobday AJ, Pethybridge H, Blanchard J, Bulman C, Butler I, Cheung W, Gorton B, Hutton T, Lozano- Montes H, Matear R, Pecl G, Villanueva C, Zhang X (2018). *Decadal scale projection of changes in Australian fisheries stocks under climate change.* CSIRO Report to FRDC. FRDC Project No: 2016/139 – ONLINE.

Low risk	Medium risk	High risk
There are no documented levels of contaminants from the marine environment causing risk/diet restrictions to any consumer group in the fishery.	There may be seasonal/area/species/size-based risks of contaminants for some species.	Permanent diet restrictions of species caught to vulnerable consumers such as children or pregnant women.

Risk of Contaminants: Medium

No specific monitoring arrangements found for marine contaminants on the fishery webpage: https://vfa.vic.gov.au/commercial-fishing/scallop, targeted species have medium potential risk for contamination from the marine environment. Shellfish (such as scallop) may in different areas and season contain natural toxins, bacteria and pollution (e.g. toxic algae, dioxins).

Data Quality: Silver

External > Contaminants in the environment > Management arrangements to ensure food safety related to contaminants > Evidence for arrangements

There is evidence of management arrangements to ensure food safety related to contaminants and food safety from the marine environment. No supply chain risks from poor handling are considered. Food standard 4.2.1 requires all seafood business in Australia to identify potential seafood safety hazards and put controls in place that are consistent with the risk.

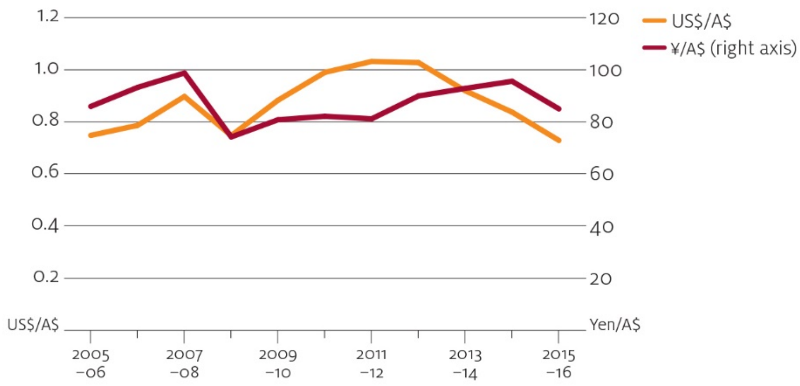
Data quality: Not found

External > Market Drivers > Macroeconomic factors > Exchange Rates

A depreciating Australian dollar (or, increasing exchange rate) generally results in producers receiving a higher export price in Australian dollar terms, while an appreciating Australian dollar (or, decreasing exchange rate) results in a lower export price. Domestically, a depreciation of the Australian dollar encourages substitution from imported seafood to domestically produced seafood, as imported products become relatively more expensive. A lower exchange rate also makes Australian exports more competitive in world markets, as exported seafood become relatively cheaper in foreign currency terms.

National export trends are negatively related to exchange rate movements— the Australian dollar declined against the US dollar and Japanese yen from 1990–91 to 2000–01, with exports increasing in volume and value. Exchange rates for the Australian dollar increased against those currencies from 2001–02 to 2015–16. The real export value and volume of Australia's seafood exports decreased between 2005–06 and 2012–13 and then increased between 2012–13 and 2015–16—with a noticeable rise (43 per cent) in volume between 2014–15 and 2015–16.[355]

[355] Mobsby, D and Koduah, A 2017, Australian fisheries and aquaculture statistics 2016, FRDC project 2017-095. ABARES, Canberra, December. CC BY 4.0.



Data Quality: Gold

External > Market Drivers > Consumer Trends > Per person annual apparent consumption of seafood (kg)

Annual apparent consumption is estimated by adding the total edible quantity of seafood supplied domestically—that is, total production plus imported seafood— less exports of seafood. Apparent consumption provides an estimate of the total amount of seafood consumed in Australia assuming zero change in stocks.

The production quantity of Australian fishery and aquaculture products is reported by ABARES on a whole weight basis, whereas trade data are reported on a processed basis. To align the units of measurement between production and trade data, it is necessary to convert production volume to a processed edible equivalent.

Production volumes are adjusted to an edible quantity basis using species-specific conversion rates and excluding species that are known to be predominantly supplied for non-human consumption purposes, such as for aquaculture feed or bait. Imports and exports of seafood are sourced from Australian Bureau of Statistics (ABS) trade data and are reported as edible weight. The apparent consumption per person is calculated as the total apparent consumption divided by the total Australian population in each year. The method applied here is consistent with that used by ABARES to estimate apparent consumption of other agricultural commodities produced in Australia.

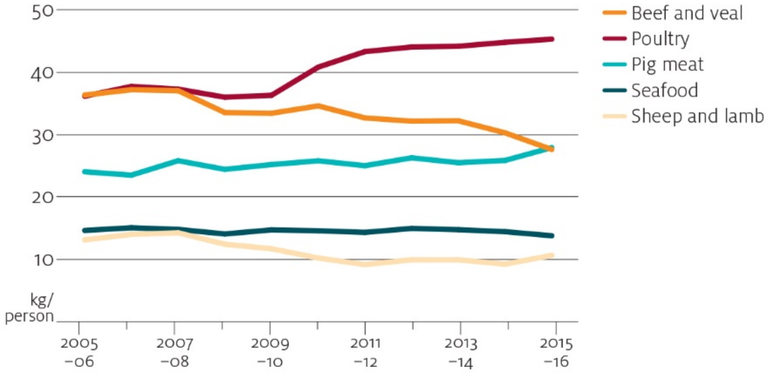
The FAO also compiles statistics on apparent consumption of seafood, applying a consistent method across all countries. FAO estimates indicate that annual consumption of seafood in Australia is around 26 kilograms per person in 2013 (FAO 2016[356]). The discrepancy between FAO and ABARES estimates reflects differences in methodological approaches to estimating consumption. Moreover, ABARES estimates seafood consumption on a processed edible basis, whereas the FAO provides its estimates on a whole weight basis.

In Australia, apparent consumption of seafood per person (edible equivalent) decreased, on average, at an annual rate of 0.6 per cent, from 14.6 kilograms in 2005– 06 to 13.8 kilograms per person in 2015–16. Annual apparent consumption is estimated by the Australian Bureau of Agricultural and

[356] The state of world fisheries and aquaculture 2016—opportunities and challenges, Food and Agriculture Organization of the United Nations, Rome.

Resource Economics and Sciences by adding the total edible quantity of seafood supplied domestically—that is, total production plus imported seafood— less exports of seafood[357]

In comparison, global per capita apparent fish consumption increased from an average of 9.9 kg in the 1960s to 14.4 kg in the 1990s and 20.1 kg in 2014, with preliminary estimates for 2015 indicating further growth, exceeding 20 kg (FAO 2016). Australia's per person seafood consumption in 2013 was estimated by the FAO to be 26kg. The differences in estimates are accounted for by varying methods for calculating consumption. ABARES estimates seafood consumption on a processed edible basis, whereas the FAO provides its estimates on a whole weight basis.



Data quality: Gold

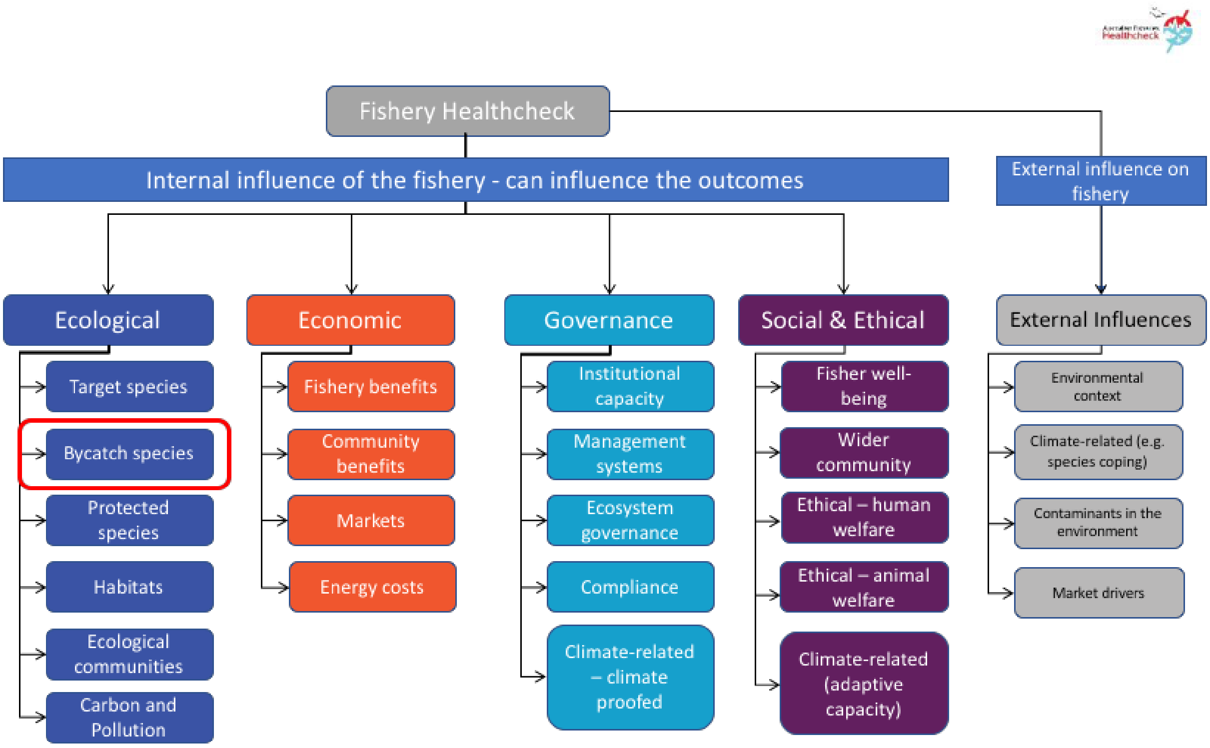
[357] Mobsby, D and Koduah, A 2017, *Australian fisheries and aquaculture statistics 2016*, FRDC 2017-095. ABARES, Canberra, December. CC BY 4.0

Western Australia Abalone Fishery

The Western Australia Abalone Fishery comprises three species of abalone, Greenlip, Brownlip and Roe's. The annual commercial harvest is around 150 t of Greenlip and Brownlip abalone (primarily from the south coast), and 50 t of Roe's abalone (from the west and south coast) which primarily supplies the Asia market. The commercial fishery is managed primarily by TACC allocated to management areas as Individual Transferable Quota, is valued around $8 million (landed price) and achieved Marine Stewardship Council (MSC) certification in 2017.The recreational fishery is primarily managed by licences, management zones, open seasons, bag limits, size limits and a TARC in the Perth Metropolitan area where most of the fishing occurs (15-25 t). (Source: Fisheries Guidelines Project).

Case Study Presentation Format

The case study documents are a collection of metrics, organised by the healthcheck structure:



The presentation of metrics will follow the following heading format:

Ecological > Bycatch species > Bycatch composition > <u>Mean Trophic Level</u>

Understand this to be an indicator (**Bycatch composition**) of the **Ecological** Component, **Bycatch species** subcomponent where the (in the figure and heading example above, is being measured by presenting <u>Mean Trophic Level</u> as the metric.

Ecological > Target species > Stock Status > Status of Australian Fish Stocks (SAFS)

Target species in each fishery are the primary focus for this indicator. Status of these species is ideally assessed with the SAFS approach, however this may not cover all target species for each fishery. In that case, we indicate the number of unassessed species. These species could also be assessed by individual states or by alternative methods.

Greenlip Abalone	Western Australian Area 2 Fishery	Transitional-depleting	2016
Greenlip Abalone	Western Australian Area 3 Fishery	Transitional-depleting	2016

Data Quality: Gold

Ecological > Target Species > Harvest Level > Catch weight

This metric is a proxy for harvest level. The harvested biomass for each species, provides information on the level of the catch. Trends in this metric over time can indicate declining availability of fish, quota restrictions, or changes in market demand. For Australian fisheries, trends are expected to be stable for most species.

Information on the Fisheries page[358] of the Department of Primary Industries and Regional Development was last updated 10/2/2016. This reports the following catch:

WA commercial abalone catch 2014

Species	Commercial catch
Roe's abalone	49 tonnes
Greenlip/brownlip abalone	193 tonnes

Data quality: Silver

Ecological > Bycatch species > Bycatch composition > Mean Trophic Level

The trophic level is a measure of the position of an organism in a food web, starting at level 1 with primary producers, such as phytoplankton, then moving through the primary consumers at level **2** that eat the primary producers to the secondary consumers at level **3** that eat the primary

[358] http://www.fish.wa.gov.au/Species/Abalone/Pages/Abalone-Commercial-Fishing.aspx

consumers, and so on. The **bycatch mean trophic level** is an indicator of the mean level of the food chain for bycatch in a fishery.

This fishery has very low bycatch, and so this metric was not calculated

Data Quality: Not applicable

Ecological > Bycatch species > Bycatch amount > Total weight of bycatch

Bycatch weights for fishery are typically developed by specific projects, and require a range of assumptions due to issues with reporting and retention of bycatch. **Bycatch** estimates typically cover species that are not target species, while **discard** rates may also include undersized individuals of the target species. Kennelly (2018) provides estimates of discard rates, which include both target and bycatch species, and when discard rates are used, that information is noted for each fishery. Animals can be returned to the ocean alive or dead. The intention of this metric is to provide information on animals that are dead on return to the ocean.

Reference:

Kennelly, S.J., 2018. *Developing a National Bycatch Reporting System.* Final FRDC Report, ISBN 978-0-9924930-5-9, March, 2018. 99 pp.

This fishery has very low bycatch, and so this metric was not calculated.

Data Quality: Not applicable

Ecological > Protected species > Capture amount > Captures

The number and diversity of TEP species captured by a fishery in the most recent year, provided as annual numbers.

No interactions with TEP species for this dive fishery.

Data quality: Bronze

Ecological > Protected species > Reporting > Level of monitoring

This indicator is to provide information on the level of coverage for a fishery. Annual measures are preferred.

There is a statutory obligation for abalone fishers to provide the Department with a daily catch and effort record, with data recorded for 10 x 10 mile statistical reporting blocks. Although daily reporting of catch and effort has been in place since 1986 for Greenlip/Brownlip abalone and 1989 for Roe's abalone, there is a longer historical time series of monthly catch and effort records for this fishery dating back to the early 1970s. Note that, prior to 1984, catches of Greenlip and Brownlip abalone were not separated.
The selective nature of the fishing method, e.g. hand collection by divers, minimises the risk of interactions with ETP species. The only recorded interactions with ETP species have been attacks by sharks on divers. The AMF has been assessed under the provisions the EPBC Act 1999 (Part 13 and 13A)[359], part of which considers the effects of the fishery on ETP species. In the most recent

[359] https://www.legislation.gov.au/Details/C2005C00338

assessment in 2015, the fishery was considered not likely to adversely affect the survival or recovery of any listed threatened species. [360]

Data quality: Bronze

Ecological > Habitats > Habitat impact > Impact score

The habitat impact is an indicator of the effect the fishing gear has on the habitat. Different gear types have different impacts. See the scoring rubric.

Habitat Impact: Negligible, based on the gear type used in this fishery.

Data quality: Bronze

Ecological > Habitats > Habitat impact > Habitat status

The status of the habitat types is a measure of the condition relative to a pristine state. Fishing may not be responsible for that habitat status, but it is important to note if fishing is taking place in pristine or disturbed habitats.

Habitat status: Moderate – changing environment as a result of climate change has significantly impacted this system along the west coast. Southwest habitats in Good to excellent condition.

Data quality: Bronze

Ecological > Ecological communities > Ecosystem status > Ecosystem status

This metric reports the ecosystem status in the region of the fishery.

Ecosystem Status: Good

Reefs around the southwest coast of Western Australia are subject to a range of recreational and commercial fisheries, coastal development and estuarine modification has impacted water quality in some regions.

Data Quality: Bronze

Ecological > Ecological communities > Ecosystem status > Species diversity

The measure of species diversity as a ratio between fished and unfished states.

Data Quality: Not found

Ecological > Carbon and Pollution > Macro-plastics > Plastic code of conduct

Macro-plastics are plastics that are visible to the naked eye, such as food containers and wrapping, equipment packaging, and fishing equipment. The metric notes a commitment to a zero waste overboard code of conduct to assess attempts to reduce accidental or intentional introduction of macro-plastics to the ocean. There are stated guidelines detailing Australia's guidelines regarding marine pollution from the Australian Maritime Safety Authority[361]:

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[360] http://www.fish.wa.gov.au/Documents/wamsc_reports/wamsc_report_no_8.pdf
[361] https://www.amsa.gov.au/marine-environment/marine-pollution/pollution-fishing-vessels

Pollution of the marine environment by ships, including fishing vessels, is strictly controlled by the International Convention for the Prevention of Pollution from Ships (known as MARPOL).

To minimise pollution, MARPOL prohibits ships from discharging garbage into the sea except in very limited circumstances.

Australian MARPOL regulations apply to Australian fishing vessels wherever they are operating.

Data Quality: Bronze

Ecological > Carbon and Pollution > Carbon footprint > CO_2-equivalents

The emissions of climate forcing gases in kg CO_2-equivalents (CO_2e) per kg live weight fish caught, not including the supply chain after landing.

Data Quality	Gear	Target species	Min (kg CO_2e/kg)	Average (kg CO_2e/kg)	Max (kg CO_2e/kg)	Reference	Description
Gold							
Silver							
Bronze	Dive	Molluscs	1.5	2.6	3.7	Parker and Tyedmers 2015	Oceania region, year and fuel type not specified, refrigerants not included.

Economic > Fishery Benefits > Net Economic Returns > Economic Rent

Net Economic Returns (NER) is equal to fishing revenue less fishing costs and measures the economic profit that is derived from fishing activity, it is measured by the Commonwealth as Net Economic Returns and by some States as Economic Rent.
Data Quality: Not found

Economic > Fishery Benefits > Gross Value of Production > Gross Value of Production

GVP calculated as the volume of catch multiplied by the average per unit beach price (AUD$).

Data Quality	**Species/Fishery**	**Year**	**Amount**	**Reference**	**Note/Comment**
Gold	Abalone	2015-2016	$6,250,000	Mobsby, D & Koduah, A (2017) Australian fisheries and aquaculture statistics 2016, Fisheries Research and Development Corporation project 2017-095. ABARES,	Preliminary

https://www.amsa.gov.au/marine-environment/marine-pollution/marpol-and-its-implementation-australia

				Canberra, December. CC BY 4.0	
Gold	Abalone	2014-2015	$8,888,000	Mobsby, D & Koduah, A (2017) Australian fisheries and aquaculture statistics 2016, Fisheries Research and Development Corporation project 2017-095. ABARES, Canberra, December. CC BY 4.0	
Gold	Abalone	2013-2014	$8,058,000	Mobsby, D & Koduah, A (2017) Australian fisheries and aquaculture statistics 2016, Fisheries Research and Development Corporation project 2017-095. ABARES, Canberra, December. CC BY 4.0	
Gold	Roe's abalone (Haliotis roei)	2015	$1.2 million	Strain, L; Brown, J and Walters, S (2017) West Coast Roe's Abalone Resource Status Report 2016. In: Status Reports of the Fisheries and Aquatic Resources of Western Australia 2015/16: The State of the Fisheries eds. WJ Fletcher, MD Mumme and FJ Webster Department of Fisheries, Western Australia. pp. 39-43.	West Coast Bioregion
Gold	Greenlip abalone (Haliotis laevigata) / Brownlip abalone (Haliotis conicopora)	2015	$6.6 million	Strain, L; Brown, J and Walters, S (2017) South Coast Greenlip/Brownlip Abalone Resource Status Report 2016. In: Status Reports of the Fisheries and Aquatic Resources of Western Australia 2015/16: The State of the Fisheries eds. WJ Fletcher, MD Mumme and FJ Webster Department of Fisheries,	South Coast Bioregion

				Western Australia. pp. 186-191.	

Economic > Fishery Benefits > Profitability > Financial Performance

Economic health of a fishery can be measured by the financial performance of the operators in the fleet. Fleet wide averages or distributions of levels of profitability indicate the extent to which the fishery is generating economic benefits for fishers.

Data Quality: Not found

Economic > Fishery Benefits > Latency > Underutilised Effort

Latency is fishery concessions that are not being fully utilised by fishers, for example, often the annual total allowable catch is left partially or largely uncaught for a fishery. Latency may appear as effort or uncaught TAC or inactive licences.

Data Quality	Indicator used	Year	Amount	Reference	Note
Gold	Uncaught quota	2016	44% of TACC	Strain, L., Brown, J. and Walters, S. (2018). West Coast Roe's Abalone Resource Status Report 2017. In: Status Reports of the Fisheries and Aquatic Resources of Western Australia 2016/17: The State of the Fisheries eds. D.J. Gaughan and K. Santoro. Department of Primary Industries and Regional Development, Western Australia. pp. 36- http://www.fisheries.wa.gov.au/Documents/sofar/status_reports_of_the_fisheries_and_aquatic_resources_2016-17.pdf	Roe's Abalone Due to low value of catch and few viable markets), high cost of accessing these areas and prevailing weather conditions (Area 6)
Gold	Uncaught quota	2016	17% of TACC	Strain, L, Fabris, F and Walters, S (2018). South Coast Greenlip/Brownlip Abalone Resource Status Report 2017. In In: Status Reports of the Fisheries and Aquatic Resources of Western Australia 2016/17: The State of the Fisheries eds. D.J. Gaughan and K. Santoro. Department of Primary Industries and Regional Development, Western Australia. pp. 36-	Greenlip/Brownlip abalone Non-achievement of TAC was due to commercial industry decisions

				http://www.fisheries.wa.gov.au/Documents/sofar/status_reports_of_the_fisheries_and_aquatic_resources_2016-17.pdf	

Economic > Community benefits > Value to community > GDP or GSP value

A fisheries contribution to Gross Domestic Production (GDP)/Gross State Product (GSP) is the total economic value that it generates directly, plus the indirect contribution made to other industries, which is also measured in value-add terms.

Data Quality	Indicator used	Year	Amount	Reference	Note
Bronze	GSP	2016-2017	$6.8 billion	Western Australian Government (2018) Western Australia Economic Profile May 2018. Department of Jobs, Tourism, Science and Innovation. Date released:	Agriculture, forestry and fishing combined

Economic > Community benefits > Wealth Spread > Distribution of fishing firm size

The spread of profits to owners and crew members indicates how widely benefits of fishing are distributed across the fishing community. A wide spread of benefits may be important to some fishery stakeholders. A narrow spread may not indicate a lack of distribution of benefits in the case where all participating businesses are the same size, or if other mechanisms are present to capture and distribute benefits such as high levels of employment of crew. The number of large business versus small business, classified by turnover (direct measure) or catch volume (proxy) may provide an indirect indicator: i.e. are economic returns from commercial fishing gained by one or two large businesses or a spread over many smaller businesses?
Data Quality: Not released

Economic > Markets > Fish distribution > Fish receivers

One way of measuring benefits from a fishery is by assessing the flow of seafood through the supply chain. In many fishery jurisdictions, the first step in the supply chain is via licensed fish receivers who are allowed to receive fish for sale. They can also trade fish with other receivers. In some jurisdictions, commercial fishers must sell their catch to a receiver (although they can sell small amounts on wharves). While this restricts fishers' options for landing their catch, it means that fish can be tracked, reduces illegal fish trading and ensures that the Quota Management Systems (QMS) work effectively by ensuring catches do not exceed the total allowable catch or quota amounts for individual species. Receivers of fish may be fish processors, wholesalers or retailers.

In some jurisdictions, the fishers and fish receivers are integrated, such that they are effectively the same “business”. In Commonwealth fisheries, the total number of fish receivers per year may differ to the sum of the fish receivers per fishery because some receivers operate in more than one fishery.
Data Quality: Not found

Economic > Markets > Volatility in market price > Price volatility

Price volatility is the mean beach price for the target species (top one or five depending on price) over the given period (most recent ten years). The level of volatility is the standard deviation in mean price over this period.

Data Quality	**Species/Fishery**	**Year/Time period**	**Amount**	**Reference**	**Note**
Silver	WA Abalone	2006-07 to 205-16	$4.29/kg	Mobsby, D and Koduah, A 2017, Australian fisheries and aquaculture statistics 2016, Fisheries Research and Development Corporation project 2017-095. ABARES, Canberra, December. CC BY 4.0. Supporting data tables	

Economics > Energy costs > Energy Use > Fuel use per kg of fish harvested

Fuel use varies over time and between stocks and are best collected from industry on a yearly basis. Estimates for different fisheries should be compared with caution, and in particular comparing energy use between fisheries with different data quality which is not recommended (different data availability, may be e.g. old or not fisheries-specific). Estimates are provided for all levels of data quality if available and are given in L per kg live-weight.

Data Quality	Gear	Target species	Min (L/kg)	Average (L/kg)	Max (L/kg)	Reference	Description
Gold							
Silver							
Bronze	Divers	Mollusc	0.6	1.0	1.5	Parker and Tyedmers 2015	Oceania region

Economic > Energy costs > Fossil fuel subsidies > Fuel subsidies directed to the fishery

Fossil fuel subsidies (fuel rebates) illustrate to which extent the fuel cost is reduced in the fishery, measured in AUD/kg live weight fish. Note that this form of tax exemption for fisheries is in Australia motivated from the sector not using roads (i.e. costs embedded in fuel price for road construction and maintenance), and are not formally reported as fuel subsidies in Australia.

Data Quality	Gear	Target species	Subsidy (AUD/kg)	Reference	Description
Gold					
Silver					

Bronze	All WA	All WA	0.46	Total tax claims per total landings in WA	2015-16 (2016-17 also available), state level figures on landings are preliminary for 2015-16

Governance > Ecosystem governance > Bycatch mitigation > Description of the bycatch mitigation measures

Bycatch measures can be spatial (e.g. area closure), temporal (time closure, e.g. night setting only) or technical (bycatch reduction devices, hook size). This indicator describes the measures that are in place for a fishery – but not the rates of compliance. For example, spatial closures for different gear types are shown here for AFMA fisheries http://www.afma.gov.au/sustainability-environment/fishing-closures/.

Divers have the ability to target abalone of choice (species, sizes and quality of abalone) and do not inadvertently harvest bycatch in their normal fishing activities.[362]

Data Quality: Bronze – based on no bycatch species captured

Governance > Ecosystem governance > Protected species mitigation > Description of the protected species mitigation measures

TEP mitigation measures can be spatial (e.g. area closure), temporal (time closure, e.g. night setting only) or technical (bycatch reduction devices, hook size). This indicator describes the measures that are in place for a fishery – but not the rates of compliance.

Divers have the ability to target abalone of choice (species, sizes and quality of abalone) and do not inadvertently interact with TEPS in their normal fishing activities. The only potential listed species interaction is with the white shark (Carcharodon carcharias), which has been known to attack divers. Most divers now use diving cages and/or electronic shark deterrent devices for their personal protection, and are recording their encounters with white sharks.

Data Quality: Silver – based on no interactions with TEPS

Governance > Management system > Harvest strategy > Scope of the harvest strategy

Assessment can be based on scoring presence of the following: a harvest strategy designed to achieve management objectives; harvest control rules and tools; collection of relevant information to support the harvest strategy; and, assessment of stock status or the presence of the following key elements: Defined operational objectives for the fishery; Indicators of fishery performance related to the objectives; Reference points for performance indicators; A statement defining acceptable levels of risk to meeting objectives; A monitoring strategy to collect relevant data to assess fishery performance; A process for conducting assessment of fishery performance relative to objectives; and; Decision rules that control the intensity of fishing activity and/or catch.

In addition to ensuring the biological sustainability of all captured aquatic resources, this harvest strategy includes broader ecological objectives for each relevant ecosystem component, as well as social and economic objectives for each fishery as a whole. It is important to note that the social and

362 http://www.fish.wa.gov.au/Documents/sofar/status_reports_of_the_fisheries_and_aquatic_resources_2016-17.pdf

economic objectives are applied within the context of Ecological Sustainable Development. The harvest strategy for the abalone resource of Western Australia is based on a constant exploitation approach, where the annual TAC varies in proportion to variations in stock abundance. The overarching tool to implement this harvest strategy is a weight-of-evidence approach designed to ensure catches are at the appropriate level to maintain constant exploitation. In principle this approach requires the use of multiple lines of evidence to assess stock status. These lines of evidence can include trends in catch, catch distribution, catch rates, vulnerability assessments, size and/or age composition, fishing mortality, and fishery recruitment and abundance indices. In practice, a primary performance indicator is specified that can be assessed against reference levels and defined harvest control rules, and this is assisted by the various other lines of evidence, depending on the species and fishery. In line with this approach, the commercial AMF is managed primarily through output controls in the form of TACCs, set annually for each management area and allocated to licence holders as Individually Transferable Quotas (ITQs). The TACCs are set each year based on the state of resource relative to species- and area-specific reference levels.[363]

Data Quality: Gold

Governance > Management system > Management plans > Scope of management plan

Management plans can be assessed by evaluating the presence of minimum requirements, as follows: a description of the fishery, especially its current status and any established user rights: the management objectives; how these objectives are to be achieved; how the plan is to be reviewed and/or appealed, as well as the consultation process for review and appeal.

The Western Australian Abalone Fishery is managed under the Fish Resources Management Act 1994[364] and the Abalone Fishery Management Plan 1992[365], which contains the following minimum requirements:

description of the fishery
established user rights
the management objectives
how these objectives are to be achieved

Data Quality: Gold

Governance > Institutional capacity > Accountability of decision making bodies > Level of Accountability

Accountability of Decision-making bodies. Performance of a fisheries management agency is based on the degree to which decision-making processes are consultative, the basis for decisions are fully explained, and information about decision making is publicly available. The assessment applied the three tiers of Principle 3.2.2 (d) 'Decision-making process' of the MSC Fisheries Standard v2.0 (2014) to determine whether the level of accountability was low, medium or high.

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[363] Department of Fisheries (2017) Abalone Resource of Western Australia Harvest Strategy 2016-2021.

[364] https://www.legislation.wa.gov.au/legislation/prod/filestore.nsf/FileURL/mrdoc_29426.pdf/$FILE/Fish%20Resources%20Management%20Act%201994%20-%20%5B05-d0-00%5D.pdf?OpenElement

[365] https://www.slp.wa.gov.au/statutes/subsiduary.nsf/0/ABC550C1B146589348257E050001EF63/$file/34+abalone+management+plan+++10.03.15.pdf

High level of accountability. This is demonstrated by the public availability of a harvest strategy, public register of authorisations (licenses and quota holdings), and fishery assessment report. Proceedings and recommendations of the Scientific Advisory Committee are not available online but are available on request. The abalone fishery has achieved and maintained MSC certification since 2017, and this includes assessment of Principle 3 and 3.2.2 (d) at the highest level.

Data Quality: Gold

Governance > Institutional capacity > Uncertainty management > Extent of incorporation of uncertainty in management of the targeted stock

This metric reports on the explicit incorporation of uncertainties in decision support processes used to inform and make appropriate choices of management actions. We recognise three levels of uncertainty: Low level of incorporation of uncertainty; Medium level of incorporation of uncertainty; High level of incorporation of uncertainty. These are based on: Major sources of uncertainty are identified; Assessment takes uncertainty into account; Frequency of monitoring of indicators is high; Monitoring of more than one indicator to support management decisions; Assessment evaluates stock status relative to reference points in a probabilistic way; Robustness of assessments are tested, Alternative hypotheses and assessment approaches are rigorously explored.

High level of incorporation of uncertainty in management of the targeted stock. The fishery has achieved and maintained MSC Certification since 2017, and this includes assessment of Principle 1.2.4 at the highest level.	MSC Certification by SCG Global Services (2017)

Data Quality: Gold

Governance > Compliance > Compliance regime > Level of Compliance

Level of compliance with rules and regulations controlling catch can be assessed by audits that measure the agreement between 1) logbook and observer records; 2) catch disposal records submitted by fishers and fish receivers. It might also be assessed by counting the annual number of breaches/observed offences or enforcement actions, preferably scaled to the level of enforcement effort (e.g. $). This indicator can be scored on the basis of the presence of key monitoring, control and surveillance elements and capacities.

The Department conducts regular inspections of commercial catch at both the point of landing and processing facilities to ensure the commercial industry is adhering to governing legislation.[366]

Data Quality: Bronze

Governance > Compliance > Surveillance > Surveillance Effort

Regulatory controls include logs and catch reporting, on-board observer programs, vessel inspections, vessel monitoring systems, and visual or electronic surveillance using radar or satellite by boat or by air. Higher degrees of surveillance, or coverage using multiple methods, provide greater levels of certainty in estimates of effort, fishing mortality, bycatch and discard levels, and interactions

[366] http://www.fish.wa.gov.au/Documents/sofar/status_reports_of_the_fisheries_and_aquatic_resources_2016-17.pdf

with protected/listed species. Report on the surveillance carried out on the fishery, as reported by the compliance branch responsible for the fishery

Surveillance effort score: undefined
Compliance with management measures is monitored by field officers based in the Metropolitan and regional areas who patrol the entire fishing area. Compliance officers also inspect catches at processing factories and monitor quota via the Catch and Disposal Record Book[367].

Data Quality: Bronze

Governance > Adaptive capacity > Governance arrangements > Climate change recognition

Governance arrangements relevant to the fishery consider the impact of climate change on the fishery, as evidenced by documentation, policies and plans that describe how management is addressing climate change impacts. Does the fishery management plan, harvest strategy or research activity suggest that climate change is recognised, and integrated into management planning?

There is not explicit recognition for climate responses in the fishery-specific documents.

There is general recognition for the need for climate response preparation in Western Australian government reports, but fisheries are not singled out[368]

The National Harvest Strategy also recognizes that "*Variability in ocean conditions, due to natural variability, climate change or other factors, can affect the productivity of stocks. Fisheries should seek to account for that variability when developing and implementing harvest strategies*"[369]. The Guidelines for the Harvest Strategy provide explicit approaches for fisheries[370]. The strategy and guidelines do not explicitly apply to state fisheries, but will provide guidance.
Data quality: Bronze

Governance > Adaptive capacity > Coping strategies > Climate responses

The fishery has initiated coping strategies (directed) to reduce the impacts of climate change. Evidence of strategies that have been specifically implemented for the fishery might include codes of practice, restocking programs, early warning systems, and so on. The coping strategies may be for long-term change or for extreme events. A description of the climate change responses that have been implemented or explored in research or application are provided.

There are no management actions currently implemented that address climate change impacts in the fishery.

Data quality: Bronze

Social and Ethical > Fishers wellbeing > Fisher satisfaction > Satisfaction scores

If available, fishery specific surveys of well-being or satisfaction, with interpretation required for the types of questions and sample. When surveys are not available other sources of data may need to

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367 http://www.fish.wa.gov.au/Documents/wamsc_reports/wamsc_report_no_8.pdf
368 https://www.der.wa.gov.au/your-environment/climate-change/254-adapting-to-climate-change?showall=&start=2
369 Department of Agriculture and Water Resources 2018, *Commonwealth Fisheries Harvest Strategy Policy*, Canberra, June. CC BY 4.0.
370 Department of Agriculture and Water Resources 2018, *Guidelines for the Implementation of the Commonwealth Fisheries Harvest Strategy Policy*, Canberra, June. CC BY 4.0.

include broader surveys (e.g. not fishery specific) or discussions with industry representatives, managers or fishers about the industry and their opinion of general fisher-wellbeing (note this will be subjective).

Data Quality: Not found

Social and Ethical > Fishers wellbeing > Age Structure > Proportion of fishers in standard age cohorts

Proportion of fishers in standard age cohorts that were involved in the fishery at any point in the previous 5 years. If the fishery is not attractive or difficult to enter, the age distribution will be skewed to older ages. **Data Quality:** Not released

Social and Ethical > Wider community > Community satisfaction with fishery > Community feedback

Evidence of processes in place to gather direct engagement with the community (diversely represented) to listen and respond to feedback. This may be through a range of means including formal and informal processes and may not be appropriate to all fisheries in the same way. In some cases Marine Stewardship Council accreditation may demonstrate some evidence of community engagement.

Community feedback: Medium.

There is a management advisory committee, which could oversee a feedback process. Based on general FRDC community perception surveys, satisfaction with Australian fisheries is rated at 42%.

Data quality: Bronze.

Social and Ethical > Wider Community > Level of local employment > Percentage of local employment

The communities surrounding and supporting fisheries benefit from those fisheries when the majority of employees (direct and indirect) associated with the fishery activity are local. Can be reported as direct, indirect and downstream levels.

Indicator	Year	Amount	Reference	Note
Fishing (direct)	2015	approx. 45 people	Strain, L; Brown, J and Walters, S (2017) South Coast Greenlip/Brownlip Abalone Resource Status Report 2016. In: Status Reports of the Fisheries and Aquatic Resources of Western Australia 2015/16: The State of the Fisheries eds. WJ Fletcher, MD Mumme and FJ Webster Department of Fisheries, Western Australia. pp. 186-191.	Greenlip/Brownlip abalone fishery

Fishing (direct)	2015	approx. 50 people	Strain, L; Brown, J and Walters, S (2017) West Coast Roe's Abalone Resource Status Report 2016. In: Status Reports of the Fisheries and Aquatic Resources of Western Australia 2015/16: The State of the Fisheries eds. WJ Fletcher, MD Mumme and FJ Webster Department of Fisheries, Western Australia. pp. 39-43.	Roe's abalone fishery

Data Quality: Gold

Social and Ethical > Ethical - Human welfare > Protections in place > Legislation exists

Although all workers are automatically operating under legislation according to their state or territory to a safe work place, the extent to which there is awareness of the relevant Acts, and use of these if required, is highly variable and may be different for each business or individual operation within each fishery. See http://workplaceohs.com.au/legislation for a list of state acts and regulations.

Protections in Place: Low

The Abalone WA fishery operates under Western Australia (Worksafe) – Occupational Safety and Health Act 1984 and Occupational Safety and Health Regulations 1996.

Data Quality: Silver

Social and Ethical > Ethical > Human welfare > Levels of compliance

Levels of compliance (or violations of) with Workplace Health and Safety. If references to Workplace Health and Safety exist in relation to the specific fishery, determine whether these are voluntary or recorded in anyway. If they are recorded, note the level of compliance. As they are likely to be voluntary, there will not likely be a record of compliance, but this may become more readily available in the future. **Data Quality:** Not found

Social and Ethical > Ethical-animal welfare > Animal welfare protections > Protections in place

At this early stage of development of animal welfare, any type of mention of animal welfare exists, it is probably the most appropriate. As this develops in to the future, assessments as to the level of engagement may become more relevant. **Data Quality:** Not found.

Social and Ethical > Ethical-animal welfare > Level of Compliance > Levels of compliance or violations of animal welfare

If there are any references to animal welfare protections or guidelines in fishery management plans and if reports exist, the indicator reports on the level of compliance or violations with welfare provisions.

Data Quality: Not found.

Social and Ethical > Climate-related > Access to information > Availability of information

This indicator describes available information that will help participants in the fishery adapt to changes. The assumption behind this indicator is that good information availability and flow will help fishers to adapt.

Data Quality: Not found.

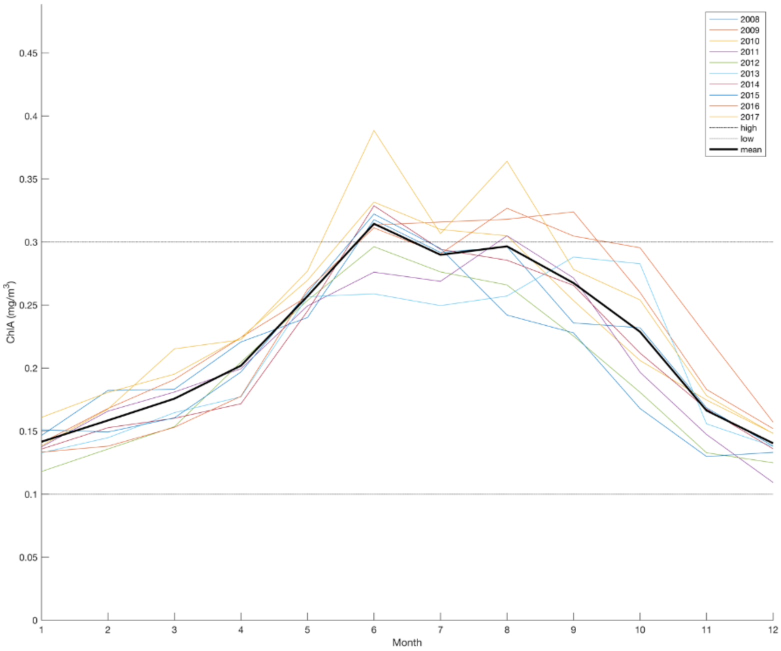
Social and Ethical > Climate-related > Access to networks > Level of membership of industry association

This metric assesses the presence or absence of a dedicated social media or social network group for the fishery. The fishery may still have a strong social network without a social media presence.

Data Quality: Not found.

External > Environmental Context > Productivity > Mean chlorophyll

A measure of environmental productivity is the biomass of phytoplankton, which in oceanic waters can be approximated by chlorophyll a concentration, as estimated from satellite (MODIS, oceandata.sci.gsfc.nasa.gov). Monthly chlorophyll values for a representative area of the fishery are shown with the mean productivity shown in solid black and references levels of low chlorophyll at 0.1 mg $m^{-3}$and high chlorophyll levels at 0.3 mg m^{-3}. This indicator shows the mean chlorophyll by month for the years 2008-2017. These data provide information on the relative environmental productivity in the fishery area. Missing data for some months can be due to ice cover. Variability in chlorophyll a concentration between years can indicate high environmental variability, while similar seasonal patterns indicate relative environmental stability.



Data Quality: Gold

External > Environmental Context > Environmental character > Description of the ecosystems

This metric provides a qualitative description of the ecosystem(s) in which the fishery occurs. The goal is to provide a general overview of these environments. The knowledge about which ecosystems are encountered during fishing activity is the indicator (rather than the response of the ecosystems to fishing).

Marine ecosystems are defined for the purposes of this indicator as the composition of plants, animals, and the marine environment (water masses, geomorphology). Types of marine ecosystems include estuaries, the sea floor, the mesopelagic zone, the pelagic zone, the inter-tidal zones, coral reefs, lagoons, and mangroves. A pelagic zone ecosystem for example, is defined by physical, chemical and biological features of the marine water column of the open ocean[371].

Description of the ecosystems: High

This fishery takes place on rocky reefs from shallow to water depths approaching 30 meters. Macroalgal cover occurs on the rocky reefs.

Data Quality: Gold

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[371] Game, E. T., H. S. Grantham, A. J. Hobday, R. L. Pressey, A. T. Lombard, L. E. Beckley, K. Gjerde, R. H. Bustamante, H. P. Possingham and A. J. Richardson (2009). Pelagic protected areas: the missing dimension in ocean conservation. Trends in Ecology and Evolution **24**(7): 360-369 doi:310.1016/j.tree.2009.1001.1011.

External > Climate related > Susceptibility of target species > Impacts on target species

Climate change directly affects the distribution, abundance and phenology of individual species. These changes then affect the fisheries that harvest these species, and can be a strong external influence on the fishery. These impacts can be positive (e.g. increased abundance), or negative (e.g. movements further from fishing ports), and to long-term warming, or short-term extreme events such as marine heatwaves.

Sensitivity of the target species to climate change has been assessed[372]. Species in this fishery have a sensitivity of high.

Common name	Species	Fishery	Score	Sensitivity
Greenlip abalone	Haliotis laevigata	Western Australian Area 2 Fishery	6.5	HIGH
Greenlip abalone	Haliotis laevigata	Western Australian Area 3 Fishery	6.5	HIGH

Data Quality: Silver

External > Climate related > Susceptibility of key habitats > Habitat Impacts

Habitat impact: Moderate

Changing ocean conditions (warming) may reduce the productivity of coastal waters on Western Australia

Data Quality: Bronze

External > Contaminants in the environment > Detection system for seafood contaminants > Risk of contaminants

Potential risk for contamination from the marine environment combined with monitoring arrangements to be able to address risks needed to ensure food safety. Contaminants include those with maximum levels set for by Food Standards Code Australia: metal contaminants, non-metal contaminants, natural toxicants, and average and maximum levels of mercury in fish. Contaminants from poor handling after landing are not assessed but may be indirectly addressed.

Rubric for risk level:

Low risk	Medium risk	High risk
There are no documented levels of contaminants from	There may be seasonal/area/species/size-	Permanent diet restrictions of species

[372] Fulton EA, Hobday AJ, Pethybridge H, Blanchard J, Bulman C, Butler I, Cheung W, Gorton B, Hutton T, Lozano- Montes H, Matear R, Pecl G, Villanueva C, Zhang X (2018). *Decadal scale projection of changes in Australian fisheries stocks under climate change.* CSIRO Report to FRDC. FRDC Project No: 2016/139 – ONLINE.

the marine environment causing risk/diet restrictions to any consumer group in the fishery.	based risks of contaminants for some species.	caught to vulnerable consumers such as children or pregnant women.

Risk of Contaminants: Medium

No specific monitoring arrangements found for marine contaminants occurring in the fishery on the fishery webpage: http://www.fish.wa.gov.au/Species/Abalone/Pages/default.aspx, targeted species have medium potential risk for contamination from the marine environment. Shellfish (such as abalone) may in different areas and season contain natural toxins, bacteria and pollution (e.g. toxic algae, dioxins).

Data Quality: Silver

External > Contaminants in the environment > Management arrangements to ensure food safety related to contaminants > Evidence for arrangements

There is evidence of management arrangements to ensure food safety related to contaminants and food safety from the marine environment. No supply chain risks from poor handling are considered. Food standard 4.2.1 requires all seafood business in Australia to identify potential seafood safety hazards and put controls in place that are consistent with the risk.

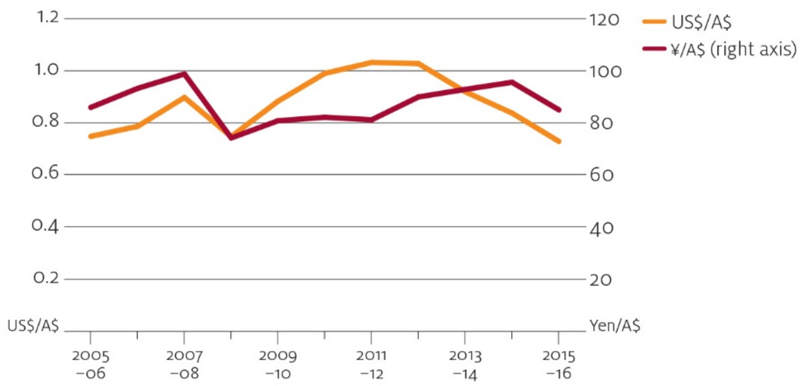
Data Quality	
GOLD	
SILVER	There is a code of practise for abalone fisheries in Australia. http://www.australianwildabalone.com.au/wp-content/uploads/2012/11/Australian_CCOP_-QA-manual_November_2012.pdf
BRONZE	

External > Market Drivers > Macroeconomic factors > Exchange Rates

A depreciating Australian dollar (or, increasing exchange rate) generally results in producers receiving a higher export price in Australian dollar terms, while an appreciating Australian dollar (or, decreasing exchange rate) results in a lower export price. Domestically, a depreciation of the Australian dollar encourages substitution from imported seafood to domestically produced seafood, as imported products become relatively more expensive. A lower exchange rate also makes Australian exports more competitive in world markets, as exported seafood become relatively cheaper in foreign currency terms.

National export trends are negatively related to exchange rate movements— the Australian dollar declined against the US dollar and Japanese yen from 1990–91 to 2000–01, with exports increasing in volume and value. Exchange rates for the Australian dollar increased against those currencies from 2001–02 to 2015–16. The real export value and volume of Australia’s seafood exports decreased

between 2005–06 and 2012–13 and then increased between 2012–13 and 2015–16—with a noticeable rise (43 per cent) in volume between 2014–15 and 2015–16.[373]



Data Quality: Gold

External > Market Drivers > Consumer Trends > Per person annual apparent consumption of seafood (kg)

Annual apparent consumption is estimated by adding the total edible quantity of seafood supplied domestically—that is, total production plus imported seafood— less exports of seafood. Apparent consumption provides an estimate of the total amount of seafood consumed in Australia assuming zero change in stocks.

The production quantity of Australian fishery and aquaculture products is reported by ABARES on a whole weight basis, whereas trade data are reported on a processed basis. To align the units of measurement between production and trade data, it is necessary to convert production volume to a processed edible equivalent.

Production volumes are adjusted to an edible quantity basis using species-specific conversion rates and excluding species that are known to be predominantly supplied for non-human consumption purposes, such as for aquaculture feed or bait. Imports and exports of seafood are sourced from Australian Bureau of Statistics (ABS) trade data and are reported as edible weight. The apparent consumption per person is calculated as the total apparent consumption divided by the total Australian population in each year. The method applied here is consistent with that used by ABARES to estimate apparent consumption of other agricultural commodities produced in Australia.

The FAO also compiles statistics on apparent consumption of seafood, applying a consistent method across all countries. FAO estimates indicate that annual consumption of seafood in Australia is around 26 kilograms per person in 2013 (FAO 2016[374]). The discrepancy between FAO and ABARES estimates reflects differences in methodological approaches to estimating consumption. Moreover, ABARES estimates seafood consumption on a processed edible basis, whereas the FAO provides its estimates on a whole weight basis.

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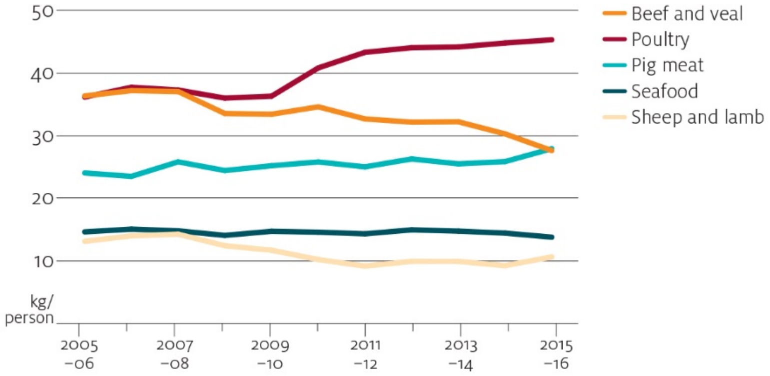
[373] Mobsby, D and Koduah, A 2017, Australian fisheries and aquaculture statistics 2016, FRDC project 2017-095. ABARES, Canberra, December. CC BY 4.0.
[374] The state of world fisheries and aquaculture 2016—opportunities and challenges, Food and Agriculture Organization of the United Nations, Rome.

In Australia, apparent consumption of seafood per person (edible equivalent) decreased, on average, at an annual rate of 0.6 per cent, from 14.6 kilograms in 2005– 06 to 13.8 kilograms per person in 2015–16. Annual apparent consumption is estimated by the Australian Bureau of Agricultural and Resource Economics and Sciences by adding the total edible quantity of seafood supplied domestically—that is, total production plus imported seafood— less exports of seafood[375]

In comparison, global per capita apparent fish consumption increased from an average of 9.9 kg in the 1960s to 14.4 kg in the 1990s and 20.1 kg in 2014, with preliminary estimates for 2015 indicating further growth, exceeding 20 kg (FAO 2016). Australia's per person seafood consumption in 2013 was estimated by the FAO to be 26kg. The differences in estimates are accounted for by varying methods for calculating consumption. ABARES estimates seafood consumption on a processed edible basis, whereas the FAO provides its estimates on a whole weight basis.

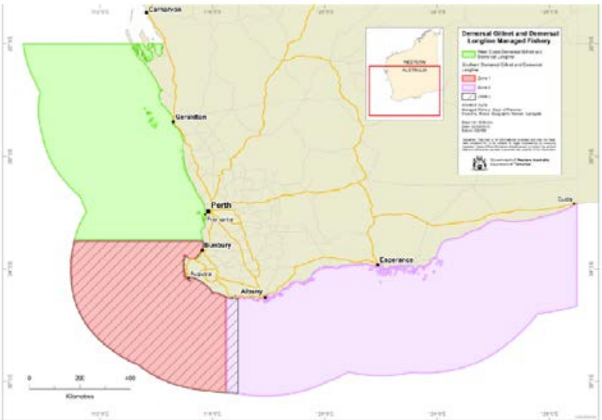


Data quality: Gold

[375] Mobsby, D and Koduah, A 2017, *Australian fisheries and aquaculture statistics 2016*, FRDC 2017-095. ABARES, Canberra, December. CC BY 4.0

Western Australia Southern and West Coast demersal gillnet and longline Fishery

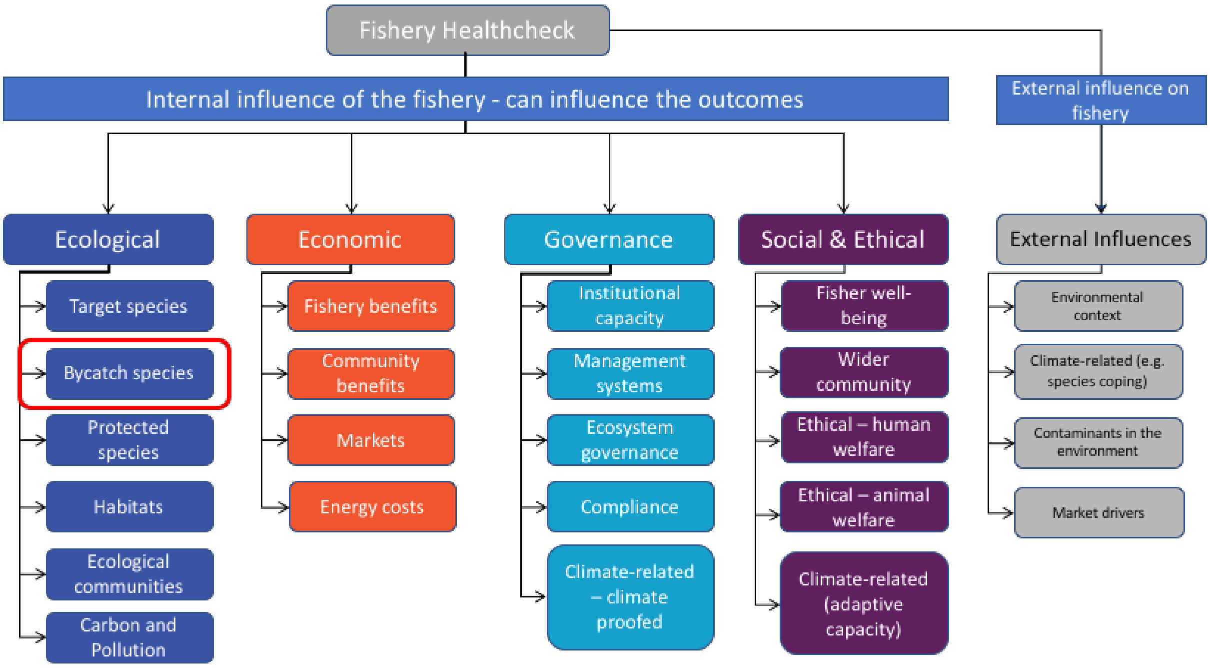
The Western Australia Southern and West Coast demersal gillnet and longline Fishery fisheries operate in continental shelf waters along the south and lower west coasts and the majority of operators use demersal gillnets and power-hauled reels to target sharks, with scalefish also being a legitimate component of the catch. The main shark species are gummy shark (Mustelus antarcticus), dusky shark (Carcharhinus obscurus), whiskery shark (Furgaleus macki) and sandbar shark (Carcharhinus plumbeus). A suite of management arrangements are in place to ensure sustainable catches of target, byproduct and bycatch species, to assist in the recovery of historically over-exploited whiskery, dusky and sandbar shark stocks and to maintain acceptably low risks to endangered, threatened and protected species. (Source: http://www.wafic.org.au/fishery/temperate-demersal-gillnet-and-demersal-longline-fishery/)



(Map from https://www.researchgate.net/publication/308152898_Review_of_potential_fisheries_and_marine_management_impacts_on_the_south-western_Australian_white_shark_population/figures?lo=1)

Case Study Presentation Format

The case study documents are a collection of metrics, organised by the healthcheck structure:



The presentation of metrics will follow the following heading format:

Ecological > Bycatch species > Bycatch composition > Mean Trophic Level

Understand this to be an indicator (**Bycatch composition**) of the **Ecological** Component, **Bycatch species** subcomponent where the (in the figure and heading example above, is being measured by presenting Mean Trophic Level as the metric.

Ecological > Target species > Stock Status > Status of Australian Fish Stocks (SAFS)

Target species in each fishery are the primary focus for this indicator. Status of these species is ideally assessed with the SAFS approach, however this may not cover all target species for each fishery. In that case, we indicate the number of unassessed species. These species could also be assessed by individual states or by alternative methods.

SpeciesName	StockName	StockStatus	Year
Blue-eye Trevalla	Western Australia	Sustainable	2016
CORAL TROUTS	Western Australia	Sustainable	2016
Dusky Whaler	Western Australia	Transitional-recovering	2016
Goldband Snapper	Gascoyne	Sustainable	2016
Grey Mackerel	Western Australia	Sustainable	2016
Gummy Shark	Southern Australia	Sustainable	2016
Mulloway	Western Australia	Sustainable	2016

Red Emperor	Gascoyne	Sustainable	2016
Redthroat Emperor	Western Australia	Transitional-recovering	2016
Sandbar Shark	Western Australia	Transitional-recovering	2016
School Shark	Southern Australia	Overfished	2016
Silver Trevally	Western Australia	Sustainable	2016
Spot-Tail Shark	North and West Coast	Sustainable	2016
Tailor	Western Australia	Sustainable	2016
West Australian Dhufish	Western Australia	Transitional-recovering	2016
Western Australian Salmon	Western Australia	Sustainable	2016
Yellowtail Kingfish	Western Australia	Sustainable	2016

Data Quality: Gold

Ecological > Target Species > Harvest Level > Catch weight

This metric is a proxy for harvest level. The harvested biomass for each species, provides information on the level of the catch. Trends in this metric over time can indicate declining availability of fish, quota restrictions, or changes in market demand. For Australian fisheries, trends are expected to be stable for most species.

Data quality: Not found

Ecological > Bycatch species > Bycatch composition > Mean Trophic Level

The trophic level is a measure of the position of an organism in a food web, starting at level 1 with primary producers, such as phytoplankton, then moving through the primary consumers at level **2** that eat the primary producers to the secondary consumers at level **3** that eat the primary consumers, and so on. The **bycatch mean trophic level** is an indicator of the mean level of the food chain for bycatch in a fishery. **Data Quality:** Not organised/analysed

Ecological > Bycatch species > Bycatch amount > Total weight of bycatch

Bycatch weights for fishery are typically developed by specific projects, and require a range of assumptions due to issues with reporting and retention of bycatch. **Bycatch** estimates typically cover species that are not target species, while **discard** rates may also include undersized individuals of the target species. Kennelly (2018) provides estimates of discard rates, which include both target and bycatch species, and when discard rates are used, that information is noted for each fishery. Animals can be returned to the ocean alive or dead. The intention of this metric is to provide information on animals that are dead on return to the ocean.

Reference:

Kennelly, S.J., 2018. *Developing a National Bycatch Reporting System.* Final FRDC Report, ISBN 978-0-9924930-5-9, March, 2018. 99 pp.

Data Quality: Not found

Ecological > Protected species > Capture amount > Captures

The number and diversity of TEP species captured by a fishery in the most recent year, provided as annual numbers.

The following list of species interaction is for all of Western Australia's fisheries obtained from the states fisheries status report[376]:

[376] Fletcher WJ, Mumme MD and Webster FJ. (eds). 2017. *Status Reports of the Fisheries and Aquatic Resources of Western Australia 2015/16: The State of the Fisheries.* Department of Fisheries, Western Australia.

APPENDIX 3

Table of reported bycatch of protected and listed species from commercial fisheries for 2015

This table contains the numbers of accidental captures of protected and listed animals by commercial fishers, as reported in statutory fishing returns and Catch Disposal Records, during calendar year 2015[1]. To the extent possible, other types of recorded interactions with protected and listed species[2] have been excluded. For the purpose of this report, protected and listed species (or taxa) are defined as those listed as: Totally Protected Fish[3] under the WA Fish Resources Management Act 1994 (FRMA); Specially Protected Fauna under the WA Wildlife Conservation Act 1950 (WCA) and Threatened species and cetaceans for which it is an offence to harm under the Australian Environment Protection and Biodiversity Conservation Act 1999 (EPBC). These data do not include interactions with species that may be afforded other forms of general protection or conditions under these (or other) Acts, international agreements or conventions[4]. As other reports may include records that do not meet these definitions, these data may differ from other accounts.

Class	Common Name	Scientific Name	Release Condition ALIVE (number)	DEAD (number)	UNKNOWN (number)
Birds	Shearwater (unspecified)		178	18	-
Fishes	Sawfish (unspecified)	Family Pristidae	11	3	-
	Green sawfish	*Pristis zijsron*	28	13	-
	Narrow sawfish	*Anoxypristis cuspidata*	9	7	-
	White shark	*Carcharodon carcharias*	9	2	-
	Grey nurse shark	*Carcharias taurus*	12	3	-
	Seahorses, seadragons & pipefish	Family Syngnathidae	28	45	-
Reptiles	Crocodile (unspecified)	*Crocodylus* spp.	8	2	-
	Freshwater crocodile	*Crocodylus johnstoni*	6	4	-
	Freshwater turtle (unspecified)		9	10	-
	Sea snake (unspecified)		2174	255	-
	Turtle (unspecified)		37	-	-
	Green turtle	*Chelonia mydas*	12	-	-
	Loggerhead turtle	*Caretta caretta*	8	-	-
	Olive Ridley turtle	*Lepidochelys olivacea*	1	-	-
Mammals	Bottlenose dolphin	*Tursiops spp.*	2	16	-
	Australian sea lion	*Neophoca cinerea*	2	-	-
	Total all species		**2534**	**378**	-

Data quality: Silver

Ecological > Protected species > Reporting > Level of monitoring

This indicator is to provide information on the level of coverage for a fishery. Annual measures are preferred.

Data quality: Not found

Ecological > Habitats > Habitat impact > Impact score

The habitat impact is an indicator of the effect the fishing gear has on the habitat. Different gear types have different impacts. See the scoring rubric.

Habitat Impact: Minor

Data quality: Bronze

Ecological > Habitats > Habitat impact > Habitat status

The status of the habitat types is a measure of the condition relative to a pristine state. Fishing may not be responsible for that habitat status, but it is important to note if fishing is taking place in pristine or disturbed habitats.

Habitat status: Good

Data quality: Bronze

Ecological > Ecological communities > Ecosystem status > Ecosystem status

This metric reports the ecosystem status in the region of the fishery.

Ecosystem Status: Good

Reefs around the southwest coast of Western Australia are subject to a range of recreational and commercial fisheries, coastal development and estuarine modification has impacted water quality in some regions.

Data Quality: Bronze

Ecological > Ecological communities > Ecosystem status > Species diversity

The measure of species diversity as a ratio between fished and unfished states.

Data quality: Not found

Ecological > Carbon and Pollution > Macro-plastics > Plastic code of conduct

Macro-plastics are plastics that are visible to the naked eye, such as food containers and wrapping, equipment packaging, and fishing equipment. The metric notes a commitment to a zero waste overboard code of conduct to assess attempts to reduce accidental or intentional introduction of macro-plastics to the ocean. There are stated guidelines detailing Australia's guidelines regarding marine pollution from the Australian Maritime Safety Authority[377]:

[377] https://www.amsa.gov.au/marine-environment/marine-pollution/pollution-fishing-vessels
https://www.amsa.gov.au/marine-environment/marine-pollution/marpol-and-its-implementation-australia

Pollution of the marine environment by ships, including fishing vessels, is strictly controlled by the International Convention for the Prevention of Pollution from Ships (known as MARPOL).

To minimise pollution, MARPOL prohibits ships from discharging garbage into the sea except in very limited circumstances.

Australian MARPOL regulations apply to Australian fishing vessels wherever they are operating.

Data Quality: Bronze

Ecological > Carbon and Pollution > Carbon footprint > CO_2-equivalents

The emissions of climate forcing gases in kg CO_2-equivalents (CO_2e) per kg live weight fish caught, not including the supply chain after landing.

Data Quality	Gear	Target species	Min (kg CO_2e/kg)	Average (kg CO_2e/kg)	Max (kg CO_2e/kg)	Reference	Description
Gold							
Silver							
Bronze	Gillnet	Finfish	0.7		3.9	Parker and Tyedmers 2015	Global, year and fuel type not specified, refrigerants not included.
Bronze	Hooks and lines	Finfish	0.3		10.7	Parker and Tyedmers 2015	Global, year and fuel type not specified, unclear if bait fishing is included, refrigerants not included.

Economic > Fishery Benefits > Net Economic Returns > Economic Rent

Net Economic Returns (NER) is equal to fishing revenue less fishing costs and measures the economic profit that is derived from fishing activity, it is measured by the Commonwealth as Net Economic Returns and by some States as Economic Rent.
Data Quality: Not found

Economic > Fishery Benefits > Gross Value of Production > Gross Value of Production

GVP calculated as the volume of catch multiplied by the average per unit beach price (AUD$).

Data Quality	**Species/Fishery**	**Year**	**Amount**	**Reference**	**Note/Comment**
Gold	West Coast Demersal scalefish	2015	$1.5-2million	Fairclough, D and Holtz, M (2017) West Coast Demersal Scalefish Resource Status Report 2016. In In: Status Reports of the Fisheries and	West Coast Bioregion

				Aquatic Resources of Western Australia 2015/16: The State of the Fisheries eds. WJ Fletcher, MD Mumme and FJ Webster Department of Fisheries, Western Australia. pp. 66-71	
Gold	Joint Authority Southern Demersal Gillnet and Demersal Longline Managed Fishery	2014-2015	$4.7 million	Braccini, M and O'Malley, J (2017) Temperate Demersal Gillnet and Demersal Longline Resource Status Report 2016. In: Status Reports of the Fisheries and Aquatic Resources of Western Australia 2015/16: The State of the Fisheries eds. WJ Fletcher, MD Mumme and FJ Webster Department of Fisheries, Western Australia. pp. 202-206	One part of the Temperate Demersal Gillnet and Demersal Longline
Gold	West Coast Demersal Gillnet and Demersal Longline Fishery	2014-2015	$0.7 million	Braccini, M and O'Malley, J (2017) Temperate Demersal Gillnet and Demersal Longline Resource Status Report 2016. In: Status Reports of the Fisheries and Aquatic Resources of Western Australia 2015/16: The State of the Fisheries eds. WJ Fletcher, MD Mumme and FJ Webster Department of Fisheries, Western Australia. pp. 202-206	One part of the Temperate Demersal Gillnet and Demersal Longline

Economic > Fishery Benefits > Profitability > Financial Performance

Economic health of a fishery can be measured by the financial performance of the operators in the fleet. Fleet wide averages or distributions of levels of profitability indicate the extent to which the fishery is generating economic benefits for fishers.

Data Quality: Not found

Economic > Fishery Benefits > Latency > Underutilised Effort

Latency is fishery concessions that are not being fully utilised by fishers, for example, often the annual total allowable catch is left partially or largely uncaught for a fishery. Latency may appear as effort or uncaught TAC or inactive licences.

Data Quality	Indicator used	Year	Amount	Reference	Note
Gold	uncaught quota	2015-2016	43% of TAC	Fairclough, D and Holtz, M (2017). West Coast Demersal Scalefish Resource Status Report 2016. In In: Status Reports of the Fisheries and Aquatic Resources of Western Australia 2015/16: The State of the Fisheries eds. WJ Fletcher, MD Mumme and FJ Webster Department of Fisheries, Western Australia. pp. 66-71	West Coast Demersal scalefish TAC is set at <450t due to recovery and allocation benchmarks

Economic > Community benefits > Value to community > GDP or GSP value

A fisheries contribution to Gross Domestic Production (GDP)/Gross State Product (GSP) is the total economic value that it generates directly, plus the indirect contribution made to other industries, which is also measured in value-add terms.

Data Quality	Indicator used	Year	Amount	Reference	Note
Bronze	GSP	2016-2017	$6.8 billion	Western Australian Government (2018) Western Australia Economic Profile May 2018. Department of Jobs, Tourism, Science and Innovation. Date released:	Agriculture, forestry and fishing combined

Economic > Community benefits > Wealth Spread > Distribution of fishing firm size

The spread of profits to owners and crew members indicates how widely benefits of fishing are distributed across the fishing community. A wide spread of benefits may be important to some fishery stakeholders. A narrow spread may not indicate a lack of distribution of benefits in the case where all participating businesses are the same size, or if other mechanisms are present to capture and distribute benefits such as high levels of employment of crew. The number of large business versus small business, classified by turnover (direct measure) or catch volume (proxy) may provide an indirect indicator: i.e. are economic returns from commercial fishing gained by one or two large businesses or a spread over many smaller businesses?

Data Quality: Not organised/analysed

Economic > Markets > Fish distribution > Fish receivers

One way of measuring benefits from a fishery is by assessing the flow of seafood through the supply chain. In many fishery jurisdictions, the first step in the supply chain is via licensed fish receivers who are allowed to receive fish for sale. They can also trade fish with other receivers. In some jurisdictions, commercial fishers must sell their catch to a receiver (although they can sell small amounts on wharves). While this restricts fishers' options for landing their catch, it means that fish can be tracked, reduces illegal fish trading and ensures that the Quota Management Systems (QMS) work effectively by ensuring catches do not exceed the total allowable catch or quota amounts for individual species. Receivers of fish may be fish processors, wholesalers or retailers.

In some jurisdictions, the fishers and fish receivers are integrated, such that they are effectively the same "business". In Commonwealth fisheries, the total number of fish receivers per year may differ to the sum of the fish receivers per fishery because some receivers operate in more than one fishery.
Data Quality: Not found

Economic > Markets > Volatility in market price > Price volatility

Price volatility is the mean beach price for the target species (top one or five depending on price) over the given period (most recent ten years). The level of volatility is the standard deviation in mean price over this period.
Data Quality: Not found

Economics > Energy costs > Energy Use > Fuel use per kg of fish harvested

Fuel use varies over time and between stocks and are best collected from industry on a yearly basis. Estimates for different fisheries should be compared with caution, and in particular comparing energy use between fisheries with different data quality which is not recommended (different data availability, may be e.g. old or not fisheries-specific). Estimates are provided for all levels of data quality if available and are given in L per kg live-weight.

Data Quality	Gear	Target species	Min (L/kg)	Average (L/kg)	Max (L/kg)	Reference	Description
Gold							
Silver							
Bronze	Gillnet	Finfish	0.3		1.5	Parker and Tyedmers 2015	Global
Bronze	Hooks and lines	Finfish	0.1		4.2	Parker and Tyedmers 2015	Global, unclear if bait fishing is included

Economic > Energy costs > Fossil fuel subsidies > Fuel subsidies directed to the fishery

Fossil fuel subsidies (fuel rebates) illustrate to which extent the fuel cost is reduced in the fishery, measured in AUD/kg live weight fish. Note that this form of tax exemption for fisheries is in Australia motivated from the sector not using roads (i.e. costs embedded in fuel price for road construction and maintenance), and are not formally reported as fuel subsidies in Australia.

Data Quality	Gear	Target species	Subsidy (AUD/kg)	Reference	Description
Gold					
Silver					
Bronze	All WA	All WA	0.46	Total tax claims per total landings in WA	Assuming WA (closest), 2015-16 (2016-17 also available), state level figures on landings are preliminary for 2015-16

Governance > Ecosystem governance > Bycatch mitigation > Description of the bycatch mitigation measures

Bycatch measures can be spatial (e.g. area closure), temporal (time closure, e.g. night setting only) or technical (bycatch reduction devices, hook size). This indicator describes the measures that are in place for a fishery – but not the rates of compliance. For example, spatial closures for different gear types are shown here for AFMA fisheries http://www.afma.gov.au/sustainability-environment/fishing-closures/. **Data Quality:** Not found

Governance > Ecosystem governance > Protected species mitigation > Description of the protected species mitigation measures

TEP mitigation measures can be spatial (e.g. area closure), temporal (time closure, e.g. night setting only) or technical (bycatch reduction devices, hook size). This indicator describes the measures that are in place for a fishery – but not the rates of compliance. **Data Quality:** Not found

Governance > Management system > Harvest strategy > Scope of the harvest strategy

Assessment can be based on scoring presence of the following: a harvest strategy designed to achieve management objectives; harvest control rules and tools; collection of relevant information to support the harvest strategy; and, assessment of stock status or the presence of the following key elements: Defined operational objectives for the fishery; Indicators of fishery performance related to the objectives; Reference points for performance indicators; A statement defining acceptable levels of risk to meeting objectives; A monitoring strategy to collect relevant data to assess fishery performance; A process for conducting assessment of fishery performance relative to objectives; and; Decision rules that control the intensity of fishing activity and/or catch.

The commercial wetline sector is not subject to specific legislative management arrangements (Notice or Management Plan) although this is currently under review. The recreational sector is managed through a range of input and output controls such as bag and size limits authorised under the Fish Resources Management Act 1994 and Fish Resources Management Regulations 1995. A formal harvest strategy has not been developed for this resource.[378]

Data Quality: Bronze

[378] Fletcher WJ, Mumme MD and Webster FJ. (eds). (2017). Status Reports of the Fisheries and Aquatic Resources of Western Australia 2015/16: The State of the Fisheries. Department of Fisheries, Western Australia.

Governance > Management system > Management plans > Scope of management plan

Management plans can be assessed by evaluating the presence of minimum requirements, as follows: a description of the fishery, especially its current status and any established user rights: the management objectives; how these objectives are to be achieved; how the plan is to be reviewed and/or appealed, as well as the consultation process for review and appeal.

The West Coast Demersal Scalefish (Interim) Managed Fishery is managed by the Minister for Fisheries and the Department of Fisheries under the Fish Resources Management Act 1994[379]. The current management goal is to reduce the catch of demersal scalefish (across all sectors and by individual management areas of the commercial fishery) on the west coast by at least 50 per cent of the 2005/06 levels, with a complete closure to pink snapper fishing within Cockburn Sound from 1 October to 31 January each year. [380]

Data Quality: Gold

Governance > Institutional capacity > Accountability of decision making bodies > Level of Accountability

Accountability of Decision-making bodies. Performance of a fisheries management agency is based on the degree to which decision-making processes are consultative, the basis for decisions are fully explained, and information about decision making is publicly available. The assessment applied the three tiers of Principle 3.2.2 (d) 'Decision-making process' of the MSC Fisheries Standard v2.0 (2014) to determine whether the level of accountability was low, medium or high.

Medium level of accountability. This is demonstrated by the public availability of fishery assessment report, public register of authorisations (licenses), rules and regulations as subsidiary legislation, and resource allocation decisions. Information on the decision-making framework and any stakeholder or consultative process is not publicly available online.

Data Quality: Silver

Governance > Institutional capacity > Uncertainty management > Extent of incorporation of uncertainty in management of the targeted stock

This metric reports on the explicit incorporation of uncertainties in decision support processes used to inform and make appropriate choices of management actions. We recognise three levels of uncertainty: Low level of incorporation of uncertainty; Medium level of incorporation of uncertainty; High level of incorporation of uncertainty. These are based on: Major sources of uncertainty are identified; Assessment takes uncertainty into account; Frequency of monitoring of indicators is high; Monitoring of more than one indicator to support management decisions; Assessment evaluates stock status relative to reference points in a probabilistic way; Robustness of assessments are tested, Alternative hypotheses and assessment approaches are rigorously explored.

Medium level of incorporation of uncertainty in management of the targeted stock, noting that this is a	The assessment applied Principle 1.2.4 (c & d) 'Assessment of stock

379 https://www.legislation.wa.gov.au/legislation/prod/filestore.nsf/FileURL/mrdoc_29426.pdf/$FILE/Fish%20Resources%20Management%20Act%201994%20-%20%5B05-d0-00%5D.pdf?OpenElement

380 http://www.fish.wa.gov.au/Documents/management_papers/fmp247.pdf

multi species multi gear fishery and the extent of incorporation of uncertainty varies across species.	status: Uncertainty in the Assessment' of the MSC Fisheries Standard v2.0 (2014) to assess extent of incorporation of uncertainty in management of the targeted stock.

Data Quality: Silver

Governance > Compliance > Compliance regime > Level of Compliance

Level of compliance with rules and regulations controlling catch can be assessed by audits that measure the agreement between 1) logbook and observer records; 2) catch disposal records submitted by fishers and fish receivers. It might also be assessed by counting the annual number of breaches/observed offences or enforcement actions, preferably scaled to the level of enforcement effort (e.g. $). This indicator can be scored on the basis of the presence of key monitoring, control and surveillance elements and capacities.

The Department undertakes regular compliance inspections to ensure fishing is being undertaken in accordance with the governing legislation and runs education programs with various stakeholder groups to increase the levels of voluntary compliance.[381]

Data quality: Bronze

Governance > Compliance > Surveillance > Surveillance Effort

Regulatory controls include logs and catch reporting, on-board observer programs, vessel inspections, vessel monitoring systems, and visual or electronic surveillance using radar or satellite by boat or by air. Higher degrees of surveillance, or coverage using multiple methods, provide greater levels of certainty in estimates of effort, fishing mortality, bycatch and discard levels, and interactions with protected/listed species. Report on the surveillance carried out on the fishery, as reported by the compliance branch responsible for the fishery

Surveillance effort score: undefined
Temperate Demersal Gillnet and Demersal Longline Fishery vessels are fitted with an Automatic Location Communicator (ALC) that enables the Department to monitor vessels using a Vessel Monitoring System (VMS) and manage compliance with temporal and spatial closures. The Department also undertakes regular vessel inspections to ensure fishing is being undertaken in accordance with the governing legislation.
Fishers in the South Coast Demersal Scalefish fishery have both at sea and on land inspections conducted by Fisheries and Marine Officers.[382]

Data Quality: Bronze

381 http://www.fish.wa.gov.au/Documents/sofar/status_reports_of_the_fisheries_and_aquatic_resources_2016-17.pdf

382 http://www.fish.wa.gov.au/Documents/sofar/status_reports_of_the_fisheries_and_aquatic_resources_2016-17.pdf

Governance > Adaptive capacity > Governance arrangements > Climate change recognition

Governance arrangements relevant to the fishery consider the impact of climate change on the fishery, as evidenced by documentation, policies and plans that describe how management is addressing climate change impacts. Does the fishery management plan, harvest strategy or research activity suggest that climate change is recognised, and integrated into management planning?

There is not explicit recognition for climate responses in the fishery-specific documents.

There is general recognition for the need for climate response preparation in Western Australian government reports, but fisheries are not singled out[383]

The National Harvest Strategy also recognizes that "*Variability in ocean conditions, due to natural variability, climate change or other factors, can affect the productivity of stocks. Fisheries should seek to account for that variability when developing and implementing harvest strategies*"[384]. The Guidelines for the Harvest Strategy provide explicit approaches for fisheries[385]. The strategy and guidelines do not explicitly apply to state fisheries, but will provide guidance.
Data quality: Bronze

Governance > Adaptive capacity > Coping strategies > Climate responses

The fishery has initiated coping strategies (directed) to reduce the impacts of climate change. Evidence of strategies that have been specifically implemented for the fishery might include codes of practice, restocking programs, early warning systems, and so on. The coping strategies may be for long-term change or for extreme events. A description of the climate change responses that have been implemented or explored in research or application are provided.

There are no management actions currently implemented that address climate change impacts in the fishery.

Data quality: Bronze

Social and Ethical > Fishers wellbeing > Fisher satisfaction > Satisfaction scores

If available, fishery specific surveys of well-being or satisfaction, with interpretation required for the types of questions and sample. When surveys are not available other sources of data may need to include broader surveys (e.g. not fishery specific) or discussions with industry representatives, managers or fishers about the industry and their opinion of general fisher-wellbeing (note this will be subjective).

Data Quality: Not found

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383 https://www.der.wa.gov.au/your-environment/climate-change/254-adapting-to-climate-change?showall=&start=2
384 Department of Agriculture and Water Resources 2018, *Commonwealth Fisheries Harvest Strategy Policy*, Canberra, June. CC BY 4.0.
385 Department of Agriculture and Water Resources 2018, *Guidelines for the Implementation of the Commonwealth Fisheries Harvest Strategy Policy*, Canberra, June. CC BY 4.0.

Social and Ethical > Fishers wellbeing > Age Structure > Proportion of fishers in standard age cohorts

Proportion of fishers in standard age cohorts that were involved in the fishery at any point in the previous 5 years. If the fishery is not attractive or difficult to enter, the age distribution will be skewed to older ages.
Data Quality: Not released

Social and Ethical > Wider community > Community satisfaction with fishery > Community feedback

Evidence of processes in place to gather direct engagement with the community (diversely represented) to listen and respond to feedback. This may be through a range of means including formal and informal processes and may not be appropriate to all fisheries in the same way. In some cases Marine Stewardship Council accreditation may demonstrate some evidence of community engagement.

Community feedback: Medium.

There is a management advisory committee, which could oversee a feedback process. Based on general FRDC community perception surveys, satisfaction with Australian fisheries is rated at 42%.

Data quality: Bronze.

Social and Ethical > Wider Community > Level of local employment > Percentage of local employment

The communities surrounding and supporting fisheries benefit from those fisheries when the majority of employees (direct and indirect) associated with the fishery activity are local. Can be reported as direct, indirect and downstream levels.

Indicator	Year	Amount	Reference	Note
Estimated employment	2016	3 people	Mobsby, D & Koduah, A (2017) Australian fisheries and aquaculture statistics 2016, Fisheries Research and Development Corporation project 2017-095. ABARES, Canberra, December. CC BY 4.0.	Fish trawling, seining and netting for WA

Data Quality: Silver

Social and Ethical > Ethical - Human welfare > Protections in place > Legislation exists

Although all workers are automatically operating under legislation according to their state or territory to a safe work place, the extent to which there is awareness of the relevant Acts, and use of these if required, is highly variable and may be different for each business or individual operation within each fishery. See http://workplaceohs.com.au/legislation for a list of state acts and regulations.

Protections in Place: Low

The Southern and West Coast Demersal fishery operates under Western Australia (Worksafe) – Occupational Safety and Health Act 1984 and Occupational Safety and Health Regulations 1996.

Data Quality: Silver

Social and Ethical > Ethical > Human welfare > Levels of compliance

Levels of compliance (or violations of) with Workplace Health and Safety. If references to Workplace Health and Safety exist in relation to the specific fishery, determine whether these are voluntary or recorded in anyway. If they are recorded, note the level of compliance. As they are likely to be voluntary, there will not likely be a record of compliance, but this may become more readily available in the future.
Data Quality: Not found

Social and Ethical > Ethical-animal welfare > Animal welfare protections > Protections in place

At this early stage of development of animal welfare, any type of mention of animal welfare exists, it is probably the most appropriate. As this develops in to the future, assessments as to the level of engagement may become more relevant.
Data Quality: Not found.

Social and Ethical > Ethical-animal welfare > Level of Compliance > Levels of compliance or violations of animal welfare

If there are any references to animal welfare protections or guidelines in fishery management plans and if reports exist, the indicator reports on the level of compliance or violations with welfare provisions.

Data Quality: Not found.

Social and Ethical > Climate-related > Access to information > Availability of information

This indicator describes available information that will help participants in the fishery adapt to changes. The assumption behind this indicator is that good information availability and flow will help fishers to adapt.

Data Quality: Not found.

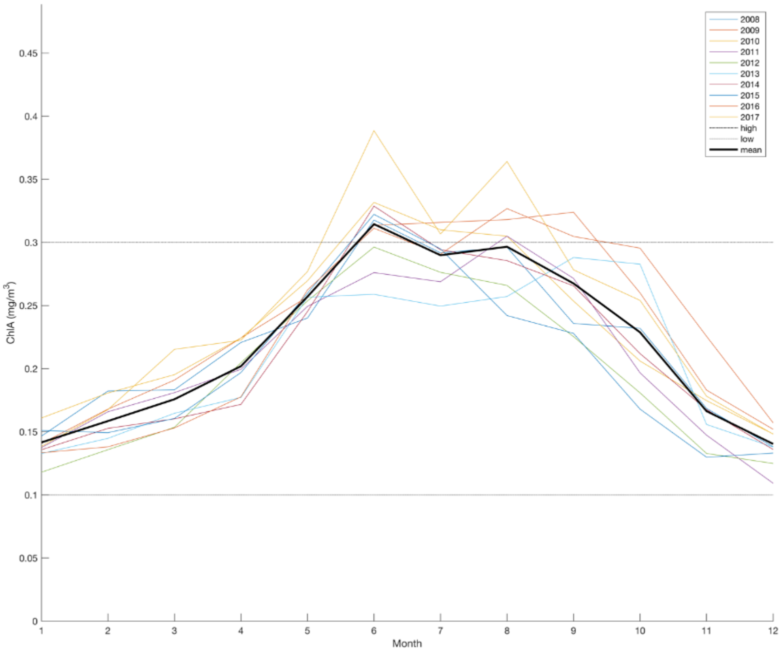
Social and Ethical > Climate-related > Access to networks > Level of membership of industry association

This metric assesses the presence or absence of a dedicated social media or social network group for the fishery. The fishery may still have a strong social network without a social media presence.

Data Quality: Not found.

External > Environmental Context > Productivity > Mean chlorophyll

A measure of environmental productivity is the biomass of phytoplankton, which in oceanic waters can be approximated by chlorophyll a concentration, as estimated from satellite (MODIS, oceandata.sci.gsfc.nasa.gov). Monthly chlorophyll values for a representative area of the fishery are shown with the mean productivity shown in solid black and references levels of low chlorophyll at 0.1 mg m^{-3}and high chlorophyll levels at 0.3 mg m^{-3}. This indicator shows the mean chlorophyll by month for the years 2008-2017. These data provide information on the relative environmental productivity in the fishery area. Missing data for some months can be due to ice cover. Variability in chlorophyll a concentration between years can indicate high environmental variability, while similar seasonal patterns indicate relative environmental stability.



Data Quality: Gold

External > Environmental Context > Environmental character > Description of the ecosystems

This metric provides a qualitative description of the ecosystem(s) in which the fishery occurs. The goal is to provide a general overview of these environments. The knowledge about which ecosystems are encountered during fishing activity is the indicator (rather than the response of the ecosystems to fishing).

Marine ecosystems are defined for the purposes of this indicator as the composition of plants, animals, and the marine environment (water masses, geomorphology). Types of marine ecosystems include estuaries, the sea floor, the mesopelagic zone, the pelagic zone, the inter-tidal zones, coral reefs, lagoons, and mangroves. A pelagic zone ecosystem for example, is defined by physical, chemical and biological features of the marine water column of the open ocean[386].

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[386] Game, E. T., H. S. Grantham, A. J. Hobday, R. L. Pressey, A. T. Lombard, L. E. Beckley, K. Gjerde, R. H. Bustamante, H. P. Possingham and A. J. Richardson (2009). Pelagic protected areas: the missing dimension in ocean conservation. Trends in Ecology and Evolution **24**(7): 360-369 doi:310.1016/j.tree.2009.1001.1011.

Description of the ecosystems: Medium

This fishery takes place in coastal and deep waters, predominately over rocky reefs and adjacent soft sediments. Effort data to locate fishing effort were not publically available.

Data Quality: Silver

External > Climate related > Susceptibility of target species > Impacts on target species

Climate change directly affects the distribution, abundance and phenology of individual species. These changes then affect the fisheries that harvest these species, and can be a strong external influence on the fishery. These impacts can be positive (e.g. increased abundance), or negative (e.g. movements further from fishing ports), and to long-term warming, or short-term extreme events such as marine heatwaves.

Sensitivity of the target species to climate change has been assessed[387]. Species in this fishery have a sensitivity ranging from moderately high to high.

Common name	Species	Fishery	Score	Sensitivity
Snapper	Chrysophrys auratus	Joint Authority Southern Demersal Gillnet and Demersal Longline Managed Fishery (Zone 1 & Zone 2)	6	MODERATELY HIGH
Tailor	Pomatomus saltatrix	West Coast Demersal Gillnet and Demersal Longline (Interim) Managed Fishery	5.5	MODERATELY HIGH
Thickskin	Carcharhinus plumbeus	Joint Authority Southern Demersal Gillnet and Demersal Longline Managed Fishery (Zone 1 & Zone 2)	6	MODERATELY HIGH
Thickskin	Carcharhinus plumbeus	West Coast Demersal Gillnet and Demersal Longline (Interim) Managed Fishery	6	MODERATELY HIGH
WA Dhudish	Glaucosoma hebraicum	Joint Authority Southern Demersal Gillnet and Demersal Longline Managed Fishery (Zone 1 & Zone 2)	6.25	HIGH
WA Dhudish	Glaucosoma hebraicum	West Coast Demersal Gillnet and Demersal Longline (Interim) Managed Fishery	6.25	HIGH

Data Quality: Silver

387 Fulton EA, Hobday AJ, Pethybridge H, Blanchard J, Bulman C, Butler I, Cheung W, Gorton B, Hutton T, Lozano- Montes H, Matear R, Pecl G, Villanueva C, Zhang X (2018). *Decadal scale projection of changes in Australian fisheries stocks under climate change.* CSIRO Report to FRDC. FRDC Project No: 2016/139 – ONLINE.

External > Climate related > Susceptibility of key habitats > Habitat Impacts

Habitat impact: Low

Data Quality: Bronze

External > Contaminants in the environment > Detection system for seafood contaminants > Risk of contaminants

Potential risk for contamination from the marine environment combined with monitoring arrangements to be able to address risks needed to ensure food safety. Contaminants include those with maximum levels set for by Food Standards Code Australia: metal contaminants, non-metal contaminants, natural toxicants, and average and maximum levels of mercury in fish. Contaminants from poor handling after landing are not assessed but may be indirectly addressed.

Rubric for risk level:

Low risk	Medium risk	High risk
There are no documented levels of contaminants from the marine environment causing risk/diet restrictions to any consumer group in the fishery.	There may be seasonal/area/species/size-based risks of contaminants for some species.	Permanent diet restrictions of species caught to vulnerable consumers such as children or pregnant women.

Risk of Contaminants: High

No specific monitoring arrangements for food safety found for marine contaminants: http://www.fish.wa.gov.au/Sustainability-and-Environment/Aquatic-Biosecurity/Pages/default.aspx . High potential risk, several large pelagics (e.g. sharks, tunas) have high levels of mercury which cause diet restrictions to women and children.

Data Quality: Silver

External > Contaminants in the environment > Management arrangements to ensure food safety related to contaminants > Evidence for arrangements

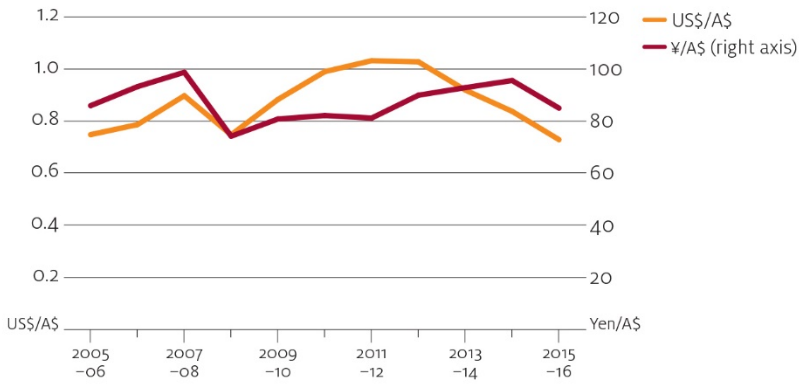
There is evidence of management arrangements to ensure food safety related to contaminants and food safety from the marine environment. No supply chain risks from poor handling are considered. Food standard 4.2.1 requires all seafood business in Australia to identify potential seafood safety hazards and put controls in place that are consistent with the risk.

Data Quality: Not found

External > Market Drivers > Macroeconomic factors > Exchange Rates

A depreciating Australian dollar (or, increasing exchange rate) generally results in producers receiving a higher export price in Australian dollar terms, while an appreciating Australian dollar (or, decreasing exchange rate) results in a lower export price. Domestically, a depreciation of the Australian dollar encourages substitution from imported seafood to domestically produced seafood, as imported products become relatively more expensive. A lower exchange rate also makes Australian exports more competitive in world markets, as exported seafood become relatively cheaper in foreign currency terms.

National export trends are negatively related to exchange rate movements— the Australian dollar declined against the US dollar and Japanese yen from 1990–91 to 2000–01, with exports increasing in volume and value. Exchange rates for the Australian dollar increased against those currencies from 2001–02 to 2015–16. The real export value and volume of Australia's seafood exports decreased between 2005–06 and 2012–13 and then increased between 2012–13 and 2015–16—with a noticeable rise (43 per cent) in volume between 2014–15 and 2015–16.[388]



Data Quality: Gold

External > Market Drivers > Consumer Trends > Per person annual apparent consumption of seafood (kg)

Annual apparent consumption is estimated by adding the total edible quantity of seafood supplied domestically—that is, total production plus imported seafood— less exports of seafood. Apparent consumption provides an estimate of the total amount of seafood consumed in Australia assuming zero change in stocks.

The production quantity of Australian fishery and aquaculture products is reported by ABARES on a whole weight basis, whereas trade data are reported on a processed basis. To align the units of measurement between production and trade data, it is necessary to convert production volume to a processed edible equivalent.

Production volumes are adjusted to an edible quantity basis using species-specific conversion rates and excluding species that are known to be predominantly supplied for non-human consumption purposes, such as for aquaculture feed or bait. Imports and exports of seafood are sourced from Australian Bureau of Statistics (ABS) trade data and are reported as edible weight. The apparent consumption per person is calculated as the total apparent consumption divided by the total Australian population in each year. The method applied here is consistent with that used by ABARES to estimate apparent consumption of other agricultural commodities produced in Australia.

The FAO also compiles statistics on apparent consumption of seafood, applying a consistent method across all countries. FAO estimates indicate that annual consumption of seafood in Australia is around 26 kilograms per person in 2013 (FAO 2016[389]). The discrepancy between FAO and ABARES

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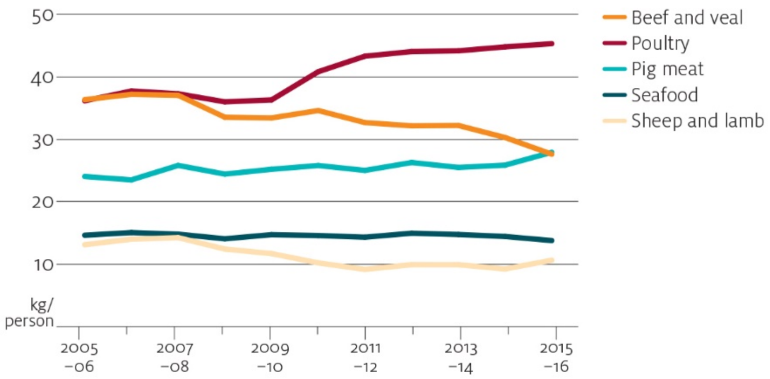
[388] Mobsby, D and Koduah, A 2017, Australian fisheries and aquaculture statistics 2016, FRDC project 2017-095. ABARES, Canberra, December. CC BY 4.0.
[389] The state of world fisheries and aquaculture 2016—opportunities and challenges, Food and Agriculture Organization of the United Nations, Rome.

estimates reflects differences in methodological approaches to estimating consumption. Moreover, ABARES estimates seafood consumption on a processed edible basis, whereas the FAO provides its estimates on a whole weight basis.

In Australia, apparent consumption of seafood per person (edible equivalent) decreased, on average, at an annual rate of 0.6 per cent, from 14.6 kilograms in 2005– 06 to 13.8 kilograms per person in 2015–16. Annual apparent consumption is estimated by the Australian Bureau of Agricultural and Resource Economics and Sciences by adding the total edible quantity of seafood supplied domestically—that is, total production plus imported seafood— less exports of seafood[390]

In comparison, global per capita apparent fish consumption increased from an average of 9.9 kg in the 1960s to 14.4 kg in the 1990s and 20.1 kg in 2014, with preliminary estimates for 2015 indicating further growth, exceeding 20 kg (FAO 2016). Australia's per person seafood consumption in 2013 was estimated by the FAO to be 26kg. The differences in estimates are accounted for by varying methods for calculating consumption. ABARES estimates seafood consumption on a processed edible basis, whereas the FAO provides its estimates on a whole weight basis.



Data quality: Gold

[390] Mobsby, D and Koduah, A 2017, *Australian fisheries and aquaculture statistics 2016*, FRDC 2017-095. ABARES, Canberra, December. CC BY 4.0

Appendix 5 – Mapping to SDGs

The following tables show how each of the Healthcheck indicators mapped to a sustainable development goal target, with a qualitative estimate of the link (strong or weak). On some occasions, the SDG-target is blank because the Healthcheck indicator is not exactly aligned to a specific SDG indicator but still strongly aligned to the overarching intent of that SDG.

Table 2 SDGs mapping to the fishery Healthcheck indicators.

Biological indicators	SDGs	SDG-target	Strength
Stock status	SDG14	14.4	Strong
Harvest level	SDG14	14.4	Strong
Size composition	SDG14	14.4	Strong
Bycatch composition	SDG14	14.4	Strong
Bycatch amount	SDG14	14.4	Strong
Bycatch status	SDG14	14.4	Strong
Capture amount	SDG14	14.4	Strong
Reporting	SDG14	14.4	Strong
Status of TEP species	SDG14	14.4	Strong
Habitat impact	SDG14	14.2	Strong
Habitat status	SDG14	14.2	Strong
Ecosystem status	SDG14	14.2	Strong
Ecosystem structure	SDG14	14.2	Strong
Macro plastic	SDG14	14.1	Strong
Carbon footprint	SDG14		Strong
Toxicity	SDG14	14.1	Weak
Economic indicators			
Net economic returns	SDG8		Strong
Gross value of Production	SDG8		Strong
Profitability	SDG8		Strong

Latency	SDG8		Strong
Investment	SDG8		Strong
GDP value to communities	SDG8		Strong
Wealth spread	SDG8		Weak
Wholesale market choice	SDG8		Weak
Volatility in market price	SDG8		Weak
Energy use	SDG7		Weak
Fossil fuel subsidies	SDG7		Weak
Governance indicators			
Bycatch mitigation	SDG14	14.2	Strong
Protected species mitigation	SDG14	14.2	Strong
Harvest strategy	SDG14	14.4	Strong
Management plans	SDG14	14.2	Strong
Reference points	SDG14	14.2	Strong
Accountability of decision making bodies	SDG16	16.7	Strong
Uncertainty management	SDG16	16.7	Weak
Compliance regime	SDG16		Weak
Surveillance	SDG16		Weak
Governance arrangements	SDG13	13.2	Strong
Coping strategies	SDG13	13.3	Strong
Social & Ethical indicators			
Fisher satisfaction	SDG3		Weak
Age structure	SDG3		Weak
Fisher retention	SDG3		Weak

Community satisfaction with fishery	SDG9		Weak
Other human use	SDG14		Weak
Level of local employment	SDG8		Strong
Protection in place	SDG8	8.8	Strong
Level of compliance	SDG8	8.8	Strong
Animal welfare protection	SDG12	12.6	Strong
Level of compliance	SDG12	12.6	Strong
Access to information	SDG13	13.3	Strong
Access to networks	SDG13	13.3	Weak
External influence categories			
Environmental productivity	SDG14	14.2	Strong
Ecosystem character	SDG14	14.2	Strong
Susceptibility of target species captured by the fishery to climate change	SDG14	14.2	Strong
Susceptibility of ley habitats to climate change	SDG14	14.2	Strong
Costs imposed on fishery by climate change	SDG14	14.2	Strong
Detection system for seafood contaminants	SDG14	14.1	Weak
Management arrangements to ensure food safety related to contaminants	SDG14	14.2	Weak
Litigation against fishery body	SDG14		Weak
Reports in the media	SDG14		Weak
Direct measure of satisfaction	SDG14		Weak

Term of trade, exchange rates	SDG8		Strong
Consumer trends	SDG8		Weak

Table 3: SDGs that we not mapped to the fishery Healthcheck indicators.

Missing SDGs
SDG 1 – No Poverty
SDG 2 – Zero Hunger
SDG 4 – Quality Education
SDG 5 – Gender Equity
SDG 6 – Clean Water and Sanitation
SDG 10 – Reduced Inequalities
SDG 11 – Sustainable Cities and Communities
SDG 15 – Life in Land
SDG 17 – Partnership for the Goals

Appendix 6 – Project materials

Project updates (4)

Published paper (2)

FRDC Project 2016/060

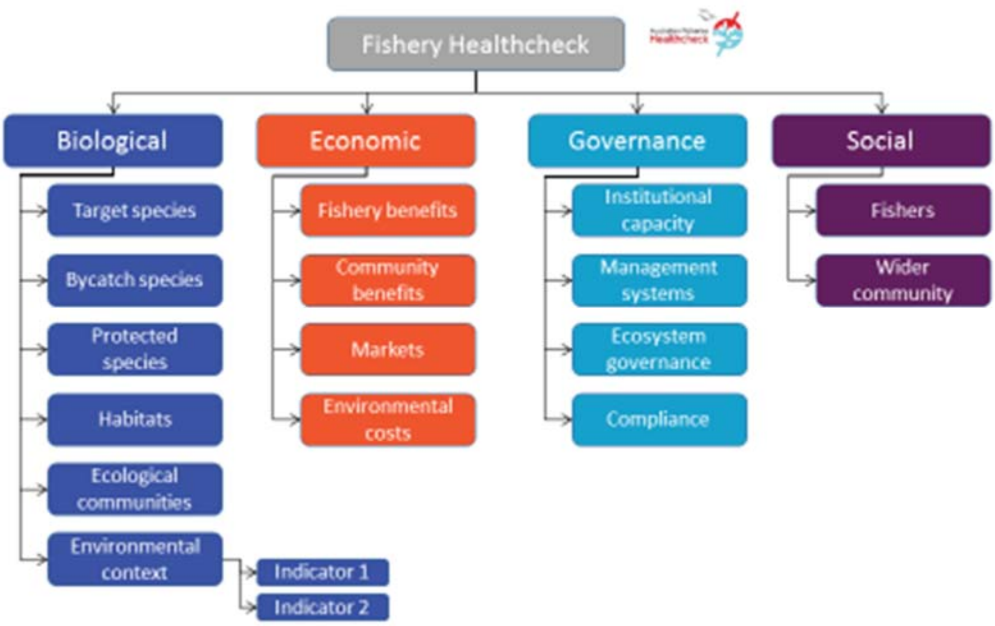
Healthcheck Phase II

Update No.1
June 2017

Project Team: Alistair Hobday, Jason Hartog, Aysha Fleming, Linda Thomas (CSIRO), Emily Ogier (IMAS)

Steering Committee: Tony Smith, Nick Rayns, Sevaly Sen, Bryan McDonald, Jo McCrea, Josh Fielding

The first Healthcheck project (FRDC 2014-008) developed an approach to provide information on the performance of Australian commercial fisheries in four categories (biological, economic, governance and social) using a total of 32 indicators. The first Healthcheck also developed the mechanics to support a data repository and a draft web-portal providing the indicator data for Australian fisheries. The goal was to transparently and comprehensively support reporting on a broad range of issues relevant to Australian fishery stakeholders. The approach was tested on three fishery case studies which revealed some difficulty with obtaining data on all indicators, and a need for more work on the coverage of categories and indicators.



Phase II of the project will run for two years, until November 2018. We will further explore the appetite for reporting on commercial fishery indicators that are broader than stock status. The outcome of this reporting will show that Australian fisheries consider and respond to a range of issues beyond target species. This recognition is important for the seafood industry and for customers nationally and internationally. Consistent comparative treatment of Australia's national and state fisheries is important, and will also allow comparisons with international fisheries. Without proactive reporting on the health of our fisheries, third party reports (e.g. seafood guides) will be the only "comprehensive" source of information for Australian seafood. These third party reports tend to consider only a limited range of issues, and draw on a range of data that may not be the most up-to-date or representative for a fishery. The main output from Phase II of the Healthcheck project will be development of a reporting framework across a range of categories, application of the approach to a larger number of case studies, and development of a cost-effective and enduring system for regular updating.

Project Objectives

1. In consultation with fisheries stakeholders refine a broad range of criteria and indicators for reporting the status of Australian fisheries
2. Complete case studies for Australian fisheries drawn from all jurisdictions and upload to web-based application
3. Refine the pathway for linking these fishery-level reports with the stock status reports (SAFS) and handing over methods to appropriate jurisdictions for updating the reports into the future
4. With the expert group provide input into sustainability discussions relating to this project and broader national initiatives

Current effort in the project

The team is reviewing the categories, subcategories and indicators developed as part of Healthcheck Phase 1 to check for potential new categories, subcategories and indicators with particular focus on the social and economic areas. The following specific issues are also important:

- How does the Healthcheck interface with a range of other "sustainability" initiatives in Australia and elsewhere?
- What is the demand for a Healthcheck, and how do we meet end user needs? We are engaging with a range of stakeholders and end users to understand current views.
- Is a consistent set of indicators (e.g. n=32) sufficient? Can we suggest a number of core indicators (e.g. 16) plus a number of bespoke indicators (e.g. 16) that are specific to a fishery?
- Should the fishery Healthcheck focus on common and quantitative indicators only or can the set of indicators be mixed? There are strengths and weaknesses for each of these options!

Indicators

	Common (required/essential) (n=32)	Bespoke (select from 50 possible choices)
Quantitative	Core - technically easy - simple - missing data - general	"Technically hard" Biased
Qualitative	needs structure	"BAD"

For further information, please contact project co-leaders Alistair Hobday (alistair.hobday@csiro.au) or Jason Hartog (jason.hartog@csiro.au)

Healthcheck Phase II

Update No.2
September 2017

Project Team: Alistair Hobday, Jason Hartog, Aysha Fleming, Linda Thomas (CSIRO), Emily Ogier (IMAS)

Steering committee: Tony Smith, Nick Rayns, Sevaly Sen, Bryan McDonald, Jo McCrea, Josh Fielding

Phase II of the project will run for two years, until November 2018. We will further explore the appetite for reporting on commercial fishery indicators that are broader than stock status. The outcome of this reporting will show that Australian fisheries consider and respond to a range of issues beyond target species. This recognition is important for the seafood industry and for customers nationally and internationally. Consistent comparative treatment of Australia's national and state fisheries is important, and will also allow comparisons with international fisheries. Without proactive reporting on the health of our fisheries, third party reports (e.g. seafood guides) will be the only "comprehensive" source of information for Australian seafood. These third party reports tend to consider only a limited range of issues, and draw on a range of data that may not be the most up-to-date or representative for a fishery. The main output from Phase II of the Healthcheck project will be development of a reporting framework across a range of categories, application of the approach to a larger number of case studies, and development of a cost-effective and enduring system for regular updating.

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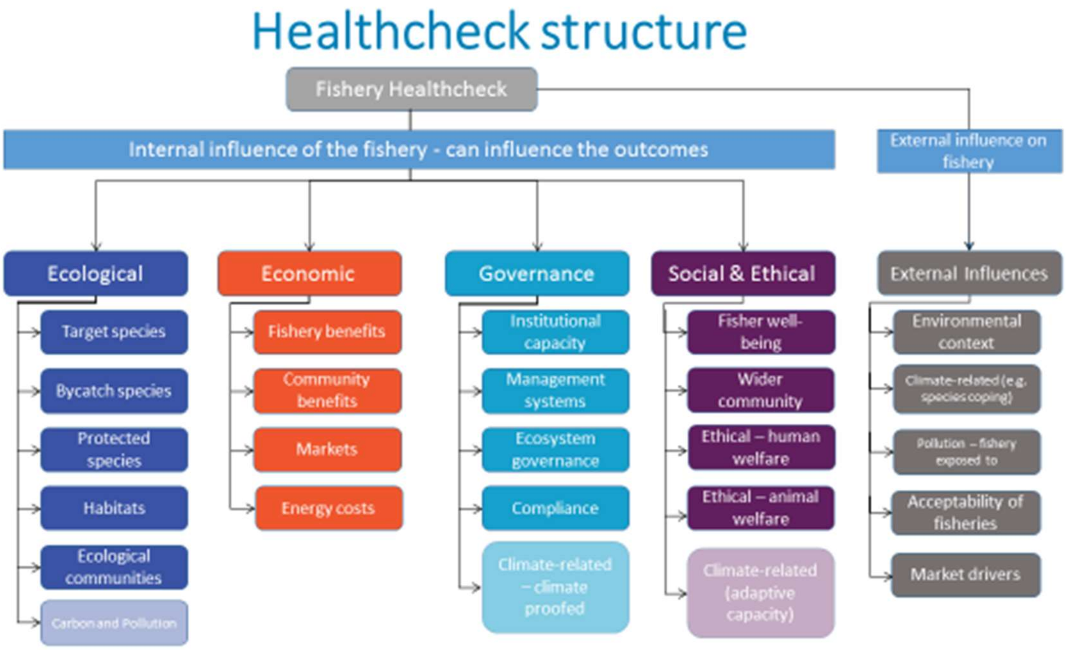
4. With the expert group provide input into sustainability discussions relating to this project and broader national initiatives

Progress to date

Visiting scientist Dr. Sara Hornborg (Sweden) has also joined our team for 12 months, bringing expertise in indicators used as part of Life Cycle Assessment methods.

The team has reviewed the categories, subcategories and indicators used for Healthcheck Phase I to identify potential new categories, sub-categories and indicators with a particular focus on the social and economic areas. Indicators representing external influences on the fishery are now proposed in a separate category, while animal and human welfare sub-categories have been added to existing categories. Climate change related sub-categories appear in several categories, due to different influences (see **Figure**). An expanded set of draft indicators for each sub-category have been revised, together with potential measurement metrics. We are generally confident that the structure is balanced, and reflects required and likely information needs.



Current focus of the project team

Between 2 and 4 draft indicators in each of the sub-categories are now being prioritized for inclusion, based on eight criteria (see **Table**) to assess their suitability. Once completed, the draft categories, sub-categories and indicators will be widely discussed with stakeholders, and the project team will develop the guide to collecting the data for the indicators, prior to testing the Healthcheck on a range of fisheries.

Indicator will be useful if it is…	**…which is interpreted as:**
1. Objective	**Indicator** is directly related to the sub-component (transparent).
2. Established	**Indicator** is generally accepted as appropriate by general stakeholders (e.g. stock status, vs ecosystem structure)
3. Interpretable	**Indicator** can be clearly interpreted with respect to trends or values, and not be able to be interpreted in multiple ways (e.g. up is good, down is bad)
4. Important/Relevant	**Indicator** is important and relevant (connected) to the management and policy goals under existing processes, or on the horizon (noting that the Healthcheck will be ahead in some cases). The indicator should have significance not just readily/easily obtainable.
5. Available	**Data** for the indicator are readily available from existing reports, datasets, or online databases. OR **Data** for the indicator should be possible to measure using existing methods, technologies or data sources.
6. Inexpensive	**Data** for the indicator are inexpensive with respect to time & money to obtain if they are available (#5a) or to collect if not available (#5b).
7. Direct	**Data** are a direct measure of the desired indicator (e.g. population size), rather than a proxy (e.g. frequency in catch).
8. Consistency of responses to above	Criteria for these **indicators** would be scored similarly for most fisheries we are considering and **data** for the indicators are similarly available across fisheries.

For further information, please contact project co-leaders Alistair Hobday (alistair.hobday@csiro.au) or Jason Hartog (jason.hartog@csiro.au)

FRDC Project 2016/060

Australian Fisheries Healthcheck

Healthcheck Phase II

Update No.3
July 2018

Project Team: Alistair Hobday, Jason Hartog, Aysha Fleming, Linda Thomas (CSIRO), Emily Ogier (IMAS), Sara Hornborg (Sweden)

Expert panel/Steering Committee: Tony Smith, Nick Rayns, Sevaly Sen, Bryan McDonald, Jo McCrea, Josh Fielding

Phase II of the project will run for two years, until November 2018. We will further explore the appetite for reporting on commercial fishery indicators that are broader than stock status. The outcome of this reporting will show that Australian fisheries consider and respond to a range of issues beyond target species. This recognition is important for the seafood industry and for customers nationally and internationally. Consistent comparative treatment of Australia's national and state fisheries is important, and will also allow comparisons with international fisheries. Without proactive reporting on the health of our fisheries, third party reports (e.g. seafood guides) will be the only "comprehensive" source of information for Australian seafood. These third party reports tend to consider only a limited range of issues, and draw on a range of data that may not be the most up-to-date or representative for a fishery. The main output from Phase II of the Healthcheck project will be development of a reporting framework across a range of categories, application of the approach to a larger number of case studies, and development of a cost-effective and enduring system for regular updating.

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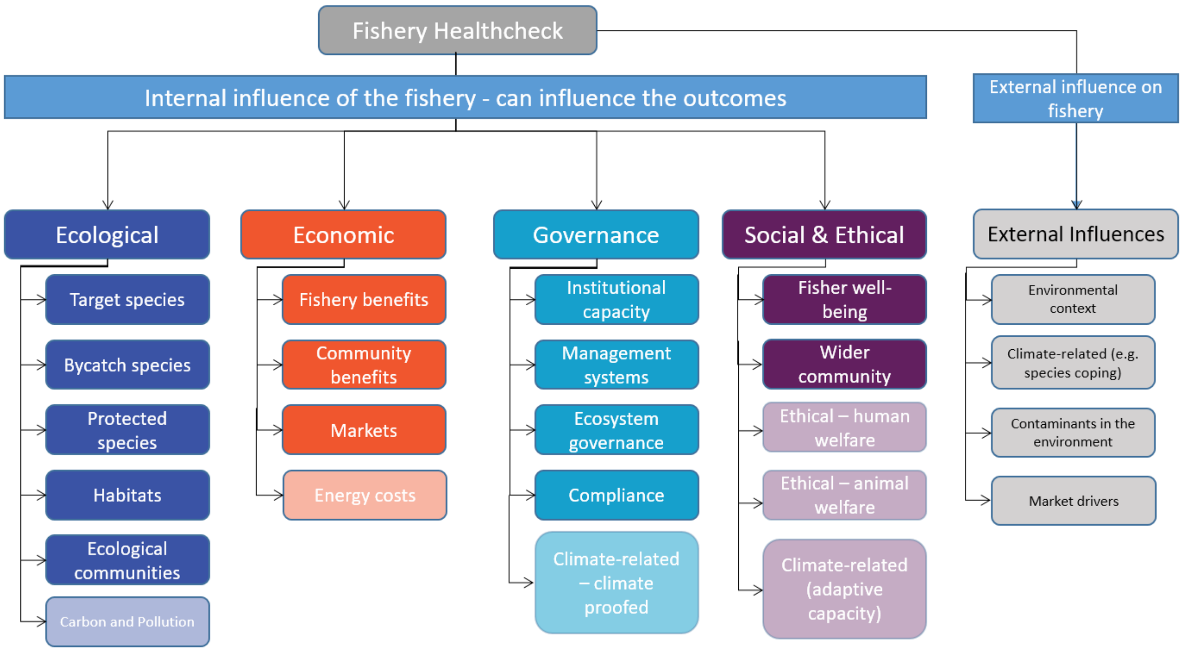
Progress to date

The project team has continued to advance the development of the Healthcheck structure, with some modifications to sub-categories and indicators (**Figure 1)**. We have selected a metric for each of the indicators, and have written a series of recipes for collating the data for each of the metrics. A set of 20 case studies have been drafted, representing a range of fisheries (**Box 1**). The data quality available for a metric can vary, and so we have developed a rating system (Gold/Silver/Bronze) for the data quality, and used this for each of the 20 case studies. Where there was missing data, we have noted if data were not found, not processed, not available, or not collected.

The second milestone report was delivered on time to FRDC, June 30, 2018. Sara Hornborg has returned to Sweden after finishing her twelve month sabbatical in Australia. She provided the project with expertise in Life Cycle Assessment methods.

Figure 1. The Healthcheck framework has been updated in recent months (shadowed boxes).



Box 1. Case studies to test the Healthcheck: Fisheries from all Australian jurisdictions were included. The 20 fisheries are the Northern Prawn; Heard Island and McDonald Island; ETBF; SESSF Trawl; NSW Spanner Crab; NSW Ocean Haul; NT Mud Crab; NT Offshore Snapper; QLD Coral Reef Finfish; QLD Blue Swimmer Crab; SA Spencer Gulf Prawn; SA Lakes and Coorong – Pipi; SA Lakes and Coorong – Net; SA Turbo; TAS Abalone; TAS Scalefish; VIC Rock Lobster; VIC Scallop; WA Abalone; and WA Southern and West Coast Demersal Gillnet and Longline Fisheries.

We examined the availability and quality of data for each of 50 indicators for each fishery.

Current focus of the project team

1. **Seeking feedback from Fishery Managers on the case studies.**
   - We wish to know if we have missed critical information that could be used for indicators, and if the data that are available are seen as useful by the fisheries managers.
2. **Engagement with stakeholders – interviews – contributing to Objective 4.**
   - This project component seeks to conduct 20 interviews with a range of stakeholders supplementing Phase 1, targeting media, eNGOs and fishery managers not captured in Phase 1. The interviews canvass a wide range of ideas about the use and purpose of the Healthcheck, the risks and opportunities and the process of establishing the Healthcheck. We are seeking to conclude all 20 interviews by August 30, 2018.
3. **Finalising the Healthcheck system.**
   - In discussion with NP1 coordinators and FRDC we have agreed that a Healthcheck website was not needed, as if the Healthcheck is adopted, the data will be hosted and served by FRDC as part of the series of platforms under revision. We are exploring the format of data to be delivered to FRDC that will be comparable to the data delivery systems for the SAFS process.

For further information, please contact project co-leaders Alistair Hobday (alistair.hobday@csiro.au) or Jason Hartog (jason.hartog@csiro.au)

FRDC Project 2016/060

Healthcheck Phase II

Update No.4
November 2018

Project Team: Alistair Hobday, Jason Hartog, Aysha Fleming, Linda Thomas (CSIRO), Emily Ogier (IMAS)

Expert panel/Steering Committee: Tony Smith, Nick Rayns, Sevaly Sen, Bryan McDonald, Jo McCrea, Josh Fielding

Phase II of the project wrap up by March 2019. We will further explore the appetite for reporting on commercial fishery indicators that are broader than stock status. The outcome of this reporting will show that Australian fisheries consider and respond to a range of issues beyond target species. This recognition is important for the seafood industry and for customers nationally and internationally. Consistent comparative treatment of Australia's national and state fisheries is important, and will also allow comparisons with international fisheries. Without proactive reporting on the health of our fisheries, third party reports (e.g. seafood guides) will be the only "comprehensive" source of information for Australian seafood. These third party reports tend to consider only a limited range of issues, and draw on a range of data that may not be the most up-to-date or representative for a fishery. The main output from Phase II of the Healthcheck project will be development of a reporting framework across a range of categories, application of the approach to a larger number of case studies, and development of a cost-effective and enduring system for regular updating.

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1. In consultation with fisheries stakeholders refine a broad range of criteria and indicators for reporting the status of Australian fisheries
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4. With the expert group provide input into sustainability discussions relating to this project and broader national initiatives

Progress to date

A summary of interview results on attitudes to a Healthcheck for Australian fisheries is the focus of this update.

For further information, please contact project co-leaders Alistair Hobday (alistair.hobday@csiro.au) or Jason Hartog (jason.hartog@csiro.au)

Summary of interview results on attitudes to a Healthcheck for Australian fisheries

This CSIRO research is investigating the development of a set of wider indicators for Australian fisheries to report on social, economic and governance as well as biological and ecological information.

Research aim

The aim of this FRDC funded research is to develop a broader suite of indicators to assess Australian fisheries, including a wider range of issues and horizon issues that may be increasingly relevant for stakeholders to know about in the future, such as ethical considerations and climate change. To assist us in developing the indicators, we conducted 21 interviewees with stakeholders who may use a Healthcheck in the future. The interviewees asked about key issues of interest and current information sources, potential risks and any other suggestions for how a potential Healthcheck might be developed and presented, who the Healthcheck would be best tailored to and how it might be best used.

Method

21 phone interviews with participants from Marine Parks, the media, indigenous representatives and eNGOs and fishery managers not captured previously (paper attached), were interviewed by phone for approximately 30 minutes. The interviews were purposefully kept to this time whenever possible to minimise the time taken.

Key findings

A 'Healthcheck' approach that reported on different indicators of fisheries had support or qualified support from all interviewees

All the interviewees supported the concept of the Healthcheck although some noted that they may not use it themselves and many noted that they might use it once they had more of a chance to see what it did and how it worked.

CSIRO and is trusted

The Healthcheck was generally likely to be trusted based on perceptions that CSIRO was a credible and objective source, and on the understanding that there would be transparency of method and process of data collection and interpretation so that people could 'see for themselves' how interpretations were made.

Clarity of objectives and of audience were identified as critical

Who the Healthcheck is aimed at and why they should use it were nominated as the most important aspects to communicate clearly in the Healthcheck and there was general disagreement that the Healthcheck could successfully be used by different audiences for different purposes.

Involving the targeted end user in the design of the Healthcheck is important to build trust, usefulness and uptake.

The risk of all of the work involved in developing the Healthcheck being wasted if it is not used was commonly identified and the process to ensure uptake was identified as early and continuous engagement.

Risks identified included the misuse or misinterpretation of information or the Healthcheck never being used.

It was noted that there are always risks, and that more information is usually better, but it is not possible to control how information is used once it is in the public domain and there should be a clear strategy to manage that. Another key risk was the that Healthcheck might never be used, if it didn't sufficiently work with end-users through its development.

Sustainability is recognised to be much broader than biological or environmental factors but data is lacking for broader considerations.

A number of interviewees noted that sustainability had become a meaningless term because it had now become so complex and uncertain and information to assess sustainability in broader terms was often not available. Further, information for factors such as fisher well-being, community satisfaction, eco-system status and climate change impacts were not necessarily seen as feasible to obtain (or easy to interpret), limiting how useful information can ever be to inform decisions.

Opportunities identified:

- The potential for online, interactive presentation so that people can access up to date information that is relevant to them.
- The potential for graphs, maps and infographics to help communicate information simply.
- Collating background information on fisheries were seen to be broadly useful.
- An annual report could be released to engage the public, minister and the media.
- Fisheries were noted as being inherently political and the Healthcheck was welcomed as a way to increase transparency.
- Community awareness and recognition of fisheries was perceived to be low and the Healthcheck could potentially help to raise awareness and social license of Australian fisheries.

Challenges identified:

- Different audiences have different needs and it will be difficult for the Healthcheck to service the general public, fishery managers, eNGOs and the media effectively.
- The areas of most interest are likely to be the most contested or lack the most data, for example recreational fishing, indigenous fishing, aquaculture and climate change.
- Whether the Healthcheck is accepted and used by industry, given the range and differences across different sectors and the difficulty working together.
- People source a lot of information through networks and by talking to each other, as CSIRO is already broadly trusted, the challenge is more about having more conversations with more people, to raise awareness.
- The Healthcheck will have to capture and report on information in a time of significant and uncertain change. Fishers and fishery communities in some regions are under pressure and struggling and there may need to be significant changes to the industry overall which may be challenging to implement, for example in terms of occupational health and safety, increasing conflicts over resources (e.g. new blue economy industries), climate change impacts, social demographic changes (e.g. ageing fishers) and increasing social demands and digital technology leading to a need for more communication, digital record keeping, transparency and public engagement.

Recommendations

There is a clear interest and need for broader reporting on sustainability issues for Australian fisheries. The Healthcheck has potential to be useful to a wide range of people and be important for Australian fisheries in a range of ways, including to improve transparency and communication and raise public awareness of good practice. However, finalising those end users who will actually use the Healthcheck and involving them directly in the processes of how the Healthcheck looks and works will be important to guarantee useability and adoption. This requires being clear about the purpose of the Healthcheck and making sure that these match with the targeted users' needs and ways of working.

Quotes of interest from interviews

Who might use a Healthcheck

'I believe that, as an Indigenous person working in fisheries, there's not too many of us in Australia, and so I believe that my perspective is born of working with communities for a very long time, could actually help contribute to populating a health check, to opening up lines of discussion, communication, to helping network and collaborate between Indigenous communities and others, so I would not only see myself as a user, but as an active participant in shaping those key areas out of the health check.'

'So if a state minister and state department doesn't have the data but they're making decisions about fisheries I wouldn't be the only one who'd use it, I would have thought.'

'In terms of making assessments and fighting managers on how fisheries are travelling and that, the more information I can get the better.'

'I'm not really interested in accessing the horrendous complexity of fishery management, and I don't think most of the other people who want to eat Australian seafood are, either.'

'Just having that really nice little picture of all the bits and pieces about a particular fishery is really useful.'

'So I would be saying the Australian public and ENGOs are your primary stakeholders. Government is the secondary stakeholder who is the delivery vehicle.'

On the difficulties of data

'Integrated management is one that is a real challenge for us, and it's not going to go away, and that's sort of that crowded space that we're in at the moment. So I think, sustainability, in terms of are we, do we have the best data, are we making the best decisions, all of those sorts of things are still front and centre going forward.'

'I think the stuff that's really going to be important is it's on the edge of our understanding at the moment. We probably don't even know what it's going to be.'

'There's always better data - like more data we could collect but that's a balance with the value of the fishery and that's a hard balance to make. There's a national bycatch report being considered at the moment. Do we publicly report on bycatch and things at the moment? No, but that's a hard - an easy answer would be to say, yeah, it would be great to have information on all of that. The real answer to that is that that's a balance with the value of the fisheries and how much - we operate our fisheries, our commercial fisheries under a cost recovery system - so how much information can we collect and how much can we do that cost effectively, balanced with the risk.'

The future

'It's inevitable that we're going to see community changes and structural changes in our fish communities.'

'I think what is valuable is the fundamental obviously, is the outputs for fisheries in sustainable healthy seafood and recreational experiences, so the recreational, healthy outdoors experience that people get from fishing, combined with the provision of seafood, so that combination. In a way that, for the future, so that - delivery of that in a way that has the broader social permission that allows - that's done in a sustainable way, one, and two, for the long-term and also has the permission, if you like, of the wider community and custodians of the fish as a public resource so that it can continue into the future.'

'I think overall everyone's trying to do the best they can and has a similar understanding of what sustainability is and how to try and get there. And doing the best they can with often limited resources. So the intent is spot on, I reckon. And the systems we've got and, I guess, the work that's been done to help guide the way we assess and provide management advice is pretty highly up there in terms of the global way things are done. Everyone's pushing to have more formal arrangements in terms of harvest management, harvest strategies, et cetera. Defensible assessment approaches. So it's been continuous improvement and not just sitting on our laurels.'

'What I value about Australian fisheries is that, at this point in time, it is generally egalitarian, it is highly cultural, significant to Indigenous peoples, that fisheries speak to us as a national characteristic, given our island continental status, that Australia has the most amazing opportunity to be a world leader in sustainability, particularly from a broad base Indigenous perspective, engagement, participation, and access to a resource. We have some of the most fabulous credible scientists in Australia and so for me there is a great future of hope.'

'So, I think if there was some way that they could assist regional centres with their fishing enterprises that would be terrific.'

Future work and an invitation

The Healthcheck is currently building case study prototypes and trialling them with industry experts. We are also in discussions with FRDC for how the information will be housed and supported. You are invited to stay connected with how the project progresses and we will inform you of any updates. If you no longer wish to receive the updates or you have any other feedback or questions please contact Aysha.Fleming@csiro.au. Sincere thanks to everyone who participated in an interview.

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Perceptions regarding the need for broad sustainability assessments of Australian fisheries

Alistair J. Hobday[a,b,*], Aysha Fleming[a,b,c], Emily M. Ogier[b,d], Linda Thomas[a], Jason R. Hartog[a], Sara Hornborg[a,b,c,e], Robert L. Stephenson[a,b,f]

[a] CSIRO Oceans and Atmosphere, Hobart, Tasmania, 7000, Australia
[b] Centre for Marine Socioecology, University of Tasmania, Hobart, Tasmania, 7000, Australia
[c] CSIRO Land and Water, Hobart, Tasmania, 7000, Australia
[d] Institute for Marine and Antarctic Studies, University of Tasmania, Hobart, Tasmania, 7001, Australia
[e] RISE Research Institutes of Sweden, Agrifood and Bioscience, PO Box 5401, SE-402 29, Gothenburg, Sweden
[f] Canadian Fisheries Research Network, Fisheries and Oceans Canada, St. Andrews Biological Station, St. Andrews, NB, E5B 2L9, Canada

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ABSTRACT

Demonstration of fishery sustainability has expanded from a relatively narrow biological focus to one that includes a wide range of issues in response to environmental legislation, social factors, and demands from markets and consumers. The Healthcheck for Australian Fisheries Sustainability (Healthcheck) is a new initiative designed to be comprehensive with regard to ecological, economic, social and governance aspects, presenting available information about a fishery for easy access and use. Here we report on the framework development process, including engagement with fishery managers, environmental non-government organisations, and fishery participants. All participants emphasized the need for a broad sustainability assessment with timely reporting, easy availability, and wider coverage of seafood sustainability information than is currently accessible, and expressed the importance of trustworthy and transparent information. Differences were found when comparing sustainability issues generally reported and issues of main concern to stakeholders. Subsequent refinement of the Healthcheck extended coverage into issues that are on the horizon for fishery reporting, but may soon be of interest to a wide range of stakeholders.

1. Introduction

The traditional focus of fisheries management on ensuring biologically sustainable harvest of target species has broadened to an ecosystem-based approach over recent decades (Link et al., 2002, 2017; Pikitch et al., 2004; Smith et al., 2007, 2017). This has resulted in the need for research and information on sustainability issues associated with bycatch species, protected species, habitats, and ecological communities (Hiddink et al., 2007; Hobday et al., 2011; Heupel and Auster, 2013). Eco-certification programs have endorsed this environmental focus (Kaiser and Edward-Jones, 2006), as have more general seafood assessment programs (Jacquet and Pauly, 2007; Roheim, 2009; Anderson et al., 2015), which, due to market opportunities may have strong effects on industry activities (Ziegler et al., 2016). In addition to environmental issues, there are a range of economic and social sustainability concerns, as well as linkages between policy, governance and community decision-makers that have only recently been considered as part of fisheries sustainability assessment and reporting (van Holt et al., 2016; Benson and Stephenson, 2017; Anderson et al., 2015; but see Pitcher and Preikshot, 2001). Attention to integrating information from many sources (e.g., economic, social, cultural/political and ecological) has increased the complexity of fishery management (Smith et al., 2007; Anderson et al., 2015; Rindorf et al., 2017), as fisheries assessments require new sources of information, types of data and analysis, and ways of integrating results to guide science-based policy in addition to traditional biological information (Link et al., 2002; Smith et al., 2007). Fishery managers also have to grapple with different data scales, temporal ranges, descriptions and interpretations, and different levels of uncertainty (Link et al., 2018).

At the same time, there has been a trend for more inclusive and participatory processes to shape fishery objectives and performance (Pita et al., 2012; Pascoe et al., 2016; Link et al., 2018). This discussion of a wider set of indicators with diverse stakeholders also needs to be integrated rather than sector-specific (Pascoe et al., 2009; Stephenson

* Corresponding author at: CSIRO Oceans and Atmosphere, Hobart, Tasmania, 7000, Australia.
E-mail address: alistair.hobday@csiro.au (A.J. Hobday).

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0165-7836/

et al., 2017). Demand from a range of public sector stakeholders for a more comprehensive suite of information on sustainability (including public access to this information) can exert considerable influence. Events such as the Australian public backlash in 2012-13 against the arrival of the supertrawler *FV Margiris* (Tracey et al., 2013; Haward et al., 2013) have shown that biological information about target species is no longer sufficient and exposed the lack of information, misinformation, widespread confusion and distrust amongst the Australian public with regard to fisheries (Brookes, 2009; Sparks, 2013; Mazur and Curtis, 2014; Cullen-Knox et al., 2017), despite Australian fisheries being recognized as world leading with regard to stock status, research and management (Pitcher et al., 2009; Alder et al., 2010; Costello et al., 2012).

Public interest and media attention now consider a range of fishery issues beyond stock levels, from bycatch and economic performance, to social and governance concerns such as work standards, distribution of benefits, global issues including ethical employment and slavery, and climate change (van Holt et al., 2016; Mazur and Curtis, 2014; Fleming et al., 2014). Thus, for many fisheries, claiming sustainability now requires a suitable accounting format for more holistic reporting on all aspects of fisheries to meet the social expectations of consumers and a wider array of stakeholders (Barclay, 2012; Anderson et al., 2015; Stephenson et al., 2018a). The need for a broader view of fishery sustainability has been widely recognised, including by the United Nations (UN, 2017; UNESCO, 2017; Visbeck, 2018). This need also aligns with a trend towards interdisciplinary research in fisheries (Hollowed et al., 2013; van Putten et al., 2013; Frusher et al., 2014; Alexander et al., 2018) and environmental science in general (Markus et al., 2018). Fishery managers are often aware of social and economic objectives, yet environmental issues are still given primary focus (Barclay, 2012; Hobday et al., 2016; Stephenson et al., 2018a). Social and governance performance measures remain underdeveloped, despite rising awareness of the importance of community attitudes and “social licence” (Clarke, 2010; Barclay, 2012; Mazur and Curtis, 2014; Kelly et al., 2017), and especially relative to metrics describing the status of target species and overall economic performance (e.g., ABARES, 2013).

There are two related, but distinct challenges with this increased scope (i) lack of collated verified, and trusted information across ecological, economic, social and governance aspects of a fishery available for management decisions (Hobday et al., 2016) and (ii) lack of an appropriate form of that information available to the public (FAO, 2016, pp 40–41; McClenachan et al., 2016). Importantly, aligning societal demand for (and availability of) a broader suite of sustainability indicators while also achieving public consideration and debate associated with sustainability issues is difficult (Tracey et al., 2013). There are also limited opportunities for engaging the public in discussions around the trade-offs between issues that are inevitable in any type of food production (Brander, 2010; Rice and Garcia, 2011; Hobday et al., 2015). There is a general societal interest in sustainability assurance of food, and seafood is no exception, as seen in the increased initiatives by various actors to inform consumers (FAO, 2016). Paramount are ease of access and reliability of information (trust in the source). Since fishery conditions vary between years, up-to-date delivery is also required – web-based technology now supports frequent updates of information, including summaries of the annual reports that are common in fisheries (such as stock assessment reports; e.g., Flood et al., 2014) or apps to support individuals to make decisions on the food they purchase (Sustainable Seafood Guide; Seafood Watch; Best Fish Guide). Despite this, there is a demonstrated need for a source of collated, verified and trusted information across the ecological, economic, governance and social aspects of a fishery in Australia and elsewhere, which can be used by fisheries managers and other stakeholders. The question of how this information is best made available to all the sectors who might benefit remains open and is an area for future investigation.

Here we describe engagement with stakeholders regarding broad sustainability reporting of Australian fisheries to ascertain the level of interest in particular aspects of this reporting, and the types of information desired. Our aim was to investigate the perceptions of various stakeholder groups related to the reporting, availability, and relevance of ecological, economic, social and governance information on seafood sustainability and to determine whether there are gaps in their current information needs which a broad assessment framework (notably broader than existing assessments) could fill. The results informed the development of a reporting framework, termed the ‘Healthcheck for Australian Fisheries and Stocks’, as a companion to single stock status reporting (Flood et al., 2014). This broad assessment framework considers sustainability with respect to biological, economic, governance and social categories (overarching fishery objectives), each composed of a number of sub-categories (performance areas), each with suggested indicators. Both the approach and the outcome may be applied in other regions seeking broader seafood and environmental sustainability reporting.

2. Methods

Our approach had three main steps. We first reviewed existing assessments of marine resource status and use (Step 1), to scope a reporting framework, then identified potential stakeholders based on potential contributors of information or as end users of a broad sustainability assessment framework for Australian commercial fisheries. Broader sustainability assessments that include social, economic and governance factors go beyond species assessments, and thus it was necessary to engage with a wider array of stakeholders compared with other issue-specific assessments (e.g., habitat assessments) (Step 2). We sought information on ‘trustworthiness’, which emerges from salience, legitimacy, credibility (after Cash et al., 2003) to provide insight into how/if new assessments might be considered trustworthy. We were interested in similarities and differences among three groups expected to be primary users of fishery information: 1) fishery managers, 2) environmental non-government organisations (eNGOs), and 3) fishery participants (fishers). We describe the engagement approach with each group in the sections below. The general public represent a very large and diverse stakeholder group, with diverse perceptions based on a range of factors, and were not included in this initial engagement. Finally (Step 3), refinement and adjustment of the initial framework in response to feedback by a wider array of stakeholders and domain experts was undertaken in recognition of the adaptive learning cycle and co-produced dimensions of learning processes which Armitage et al. (2008) argue are required to support governance of complex socio-ecological systems.

2.1. Comparison with existing sustainability assessments

We used four categories (representing overarching objectives) and 16 subcategories (representing specific performance areas) based on an extensive review of 54 seafood assessment and reporting schemes from around the world (Hobday et al., 2016) (Fig.1A). The development of these sub-categories and categories drew on existing frameworks elsewhere, and aligned with Australia’s National Ecologically Sustainable Development (ESD) framework for wild-capture fisheries (Fletcher et al., 2002), which has informed the design of management goals and objectives for Australian fisheries. A total of 27 of these existing assessments were based on clearly-defined indicators. For example, stock status (e.g., overfished, not overfished) was one indicator used to assess the sustainability of target species. The number of indicators in each sub-category across all the existing assessments reviewed was used as an estimate of the perceived importance of each sub-category in seafood assessments (Hobday et al., 2016; Online Appendix 3). While importance is not directly a result of the number of indicators in the category, where there are a greater number of ‘simpler’ indicators in a particular category these tended to get a stronger weighting in terms of monitoring and reporting. Long lists of specific biological indicators

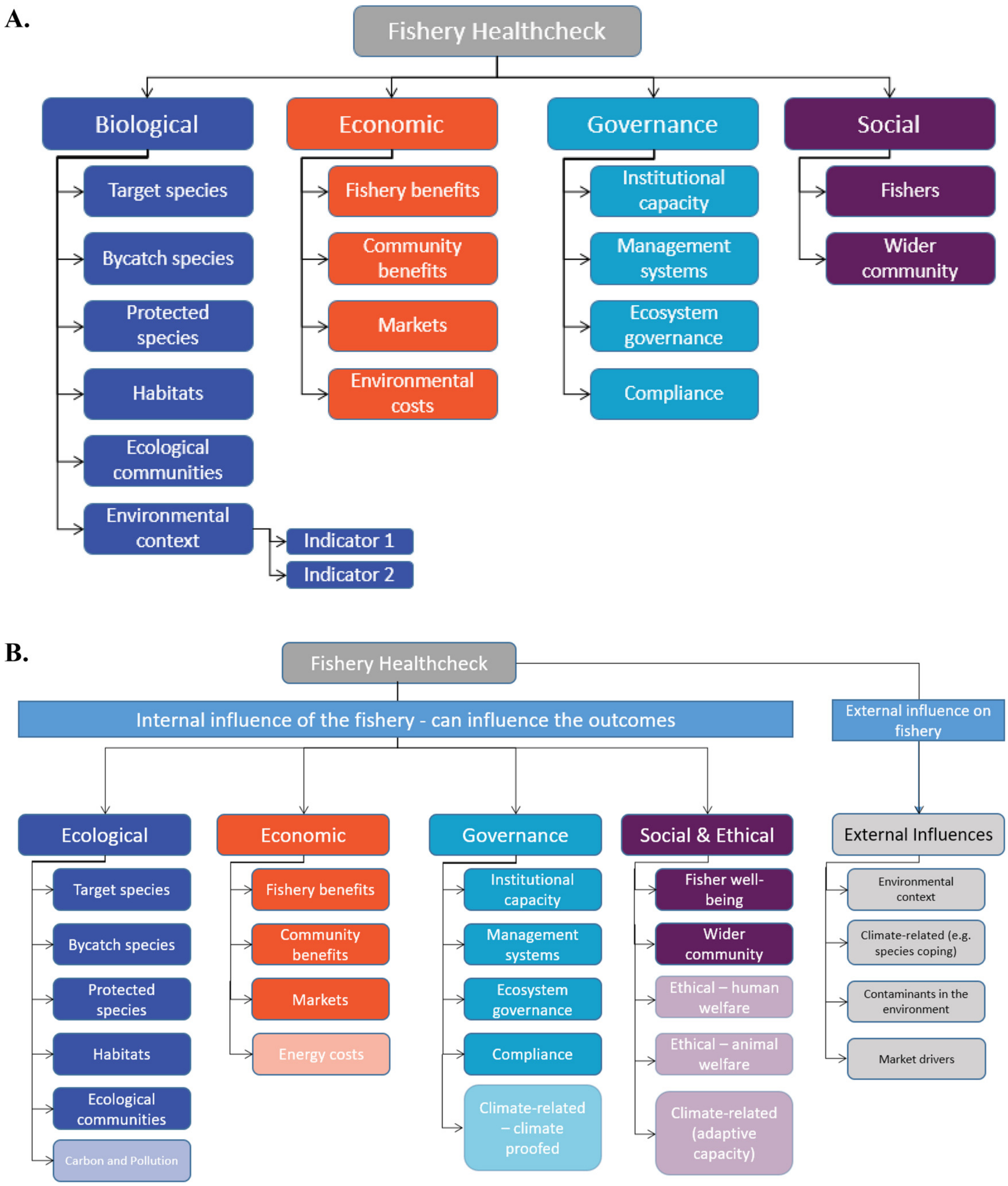

Fig. 1. A. Initial framework for a broad Australian sustainability framework, showing four categories and 16 sub-categories (source Hobday et al., 2016). B. Revised framework, showing five categories, including external influences, and 24sub-categories, with new areas indicated by a transparent background.

often received more attention than fewer, more complex social indicators, for example.

We reviewed the frequency with which particular information categories and indicators were used in existing seafood assessments applied in Australia and globally (Hobday et al., 2016) and compared these with the issues raised during the stakeholder engagement as important for inclusion in a broad sustainability assessment framework for Australian commercial fisheries.

2.2. Workshop discussions with fishery managers

Representatives from several management agencies were included in our discussions, including federal and state fishery management organisations, the Fisheries Research and Development Corporation, fisheries management consultants and academic management experts. These stakeholders were available for discussion and feedback at three opportunistic and dedicated workshops held between October 2014 and June 2015. In total, 35 unique individuals attended at least one workshop, with between 15 and 22 participants per workshop. Workshops and open discussion were considered suitable for this group (Alasuutari et al., 2008), to capitalise on their existing meetings (otherwise almost impossible to meet one-on-one) and to leverage their strong existing relationships with each other, with scientists, and common concerns about workload associated with undertaking additional sustainability assessments. A potential drawback is that strong voices may dominate in workshops, which we partially addressed by gathering written feedback during and after the workshop. The first workshop (October 2014) involved a review of existing assessments, discussion of potential approaches for Australia, and a list of interview questions to be used with eNGOs and fishery participants (see Online

Appendix 1). Two subsequent workshops (March and June 2015) sought input and feedback on the concepts and coverage of the Healthcheck categories and sub-categories (Fig. 1A). In the final workshop (June 2015), worksheets were also used to capture individual responses to the scope and range of categories and detailed notes were taken by the researchers during the meeting in order to inform later data analysis.

2.3. Interviews with eNGO and fishery participants

With eNGO and fishery participants we used one-on-one semi-structured interviews by phone or face-to-face, based on participant availability and preference, between March and June 2015. We chose one-on-one sampling for these groups, as they have less established relationships with each other, and we were concerned about issues of trust and conflict between and within the group if they were to participate in a workshop together (Alasuutari et al., 2008). Interviews generally lasted about 30 min, were audio recorded and transcribed, and participants were able to view and comment/change their transcript if desired. For the eNGO group, a list of potential participants was sourced from names of organisations of marine-relevant eNGOs engaged in fisheries issues from an internet search. From this combined list of 23 eNGOs, publically available email addresses and phone numbers were used to invite individuals to participate in an interview. Recommendations for other people to contact were also gathered (snowballing technique). In total, 15 individuals were identified, of which four did not respond to the email and one person was excluded on their request as not having any fishery experience, leaving 10 interviewees.

For fishery participants, preliminary discussion indicated a need for concrete examples of the Healthcheck to maximise interview information. We identified three Australian fisheries that would test the Healthcheck approach (and had a contrasting set of attributes, including data availability, management approaches, user base, and markets) and then interviewed two participants specific to each case study (six in total). These participants are considered as industry leaders in each of the fisheries, and had both direct fishing and representational experience. While the questions were very similar to those for eNGO participants (Online Appendix 1b), these interviews were focused on the prototype assessment categories and on the specific fishery (because of the individuals' experiences and expected knowledge, although more general comments were also captured and encouraged) compared to the eNGO interviews and manager workshops where the Healthcheck aims and the value of other existing assessments were prominent topics. Due to contractual obligations, these case study fisheries cannot be identified, but the range of fishery case studies included means that the results are likely to be generally relevant to any fishery considering a broad sustainability assessment.

Interview transcripts were coded in NVIVO (QSR International) qualitative analysis software and qualitatively coded for key themes using grounded theory methods (Charmaz, 2006). Cluster analysis based on the issues (codes) identified by each interviewee was used to examine if the two interview sample groups (fishers and eNGO representatives) could be combined for analysis (e.g., Thresher et al., 2015) and the adequacy of the sample size with regard to identifying issues was evaluated qualitatively using a saturation curve (e.g., Hagerman et al., 2010; Cvitanovic et al., 2016). After coding, the issues raised by interviewees were matched to the 16 sub-categories described above. This was to examine if there were any gaps in information needs that the Healthcheck could address.

2.4. Elicitation of feedback from broader stakeholder groups and domain experts

Following these workshops and the interviews described above, the initial Healthcheck (phase one) was discussed and presented to a wider range of stakeholders at peak body meetings, national conferences, and industry events over an 18 month period (January 2016–July 2017), before being revised and updated on the basis of feedback (phase two – August 2017–June 2018). The phase two project team, which included new members with additional expertise, then undertook an examination of newly-published assessments as well as reanalysis of the process of identifying categories and sub-categories. We reconsidered sub-categories not yet commonly included in assessments and were previously seen as 'over the horizon' in phase one. These forms of review were undertaken to address; firstly, the comprehensiveness of the categories and sub-categories in response to current and emerging challenges; and secondly, whether sub-categories of fisheries performance outside of the scope of public fisheries management and administration should be included. This process of revision also tested the flexibility of the Healthcheck framework to accommodate new issues.

3. Results

3.1. Fishery manager perceptions

Discussions in three workshops with 35 Australian fishery managers revealed that they collectively supported the need for wider reporting of sustainability issues, and supported the initial four categories (biological, economic, governance and social) proposed for the Healthcheck. Existing sustainability assessment schemes reviewed and used in the development of the Healthcheck (Online Appendix 3) were considered too onerous to be applied across the range of Australian fisheries, or lacked the detail needed to address public concerns about sustainability. Expert-based scoring of indicators, common to many existing assessments, were considered inadequate. Managers preferred to see a framework with indicators that could be represented by actual data, such as time series of bycatch numbers or number of active participants in the fishery. Thus, developing a tailored Australian reporting framework was favoured.

By the end of the final workshop, and following discussion and refinement, managers considered that the proposed sub-categories (Fig. 1A) covered the range of issues currently requiring attention due to regulatory requirements (e.g., status of target species) or accepted social norms (e.g., bycatch reduction), as well as represented necessary broader considerations, particularly in the governance and social categories that included a wider scope of ideas as succinctly as possible, with all of the expected caveats around data reliability, availability, cost, and credibility (Rice and Rochet, 2005). A major concern was the amount of time that would be required to provide information to support the comprehensive scope of the Healthcheck for Australian fisheries, and the managers emphasized the need for efficient data management systems to support any sustainability assessment. They saw benefits arising from compilation of information that was trusted, credible and salient, and could provide a holistic picture of sustainability issues associated with Australian commercial fisheries and recognized that transparent reporting of these issues was important for the seafood sector in general.

Some existing sustainability assessments (Online Appendix 3) provide scores for particular issues (indicators), or an overall rating of the fishery or target species. However, at this stage Australian fishery managers felt that provision of accurate and detailed information was more important than an overall score or rating of a fishery as 'good' or 'bad', which would also be difficult given the breadth of sustainability issues, and the likelihood of a different score for different issues as well as a different way of measuring and presenting the score. Some sustainability issues or goals, such as economic value, may also conflict with others, such as 'maximise employment', and so reporting of scores for a fishery would hide important trade-offs that society may need to understand in more depth before judging if the fishery met their sustainability standards. Finally, this group of stakeholders emphasized the need for considerable engagement with fishers and eNGOs, as well as

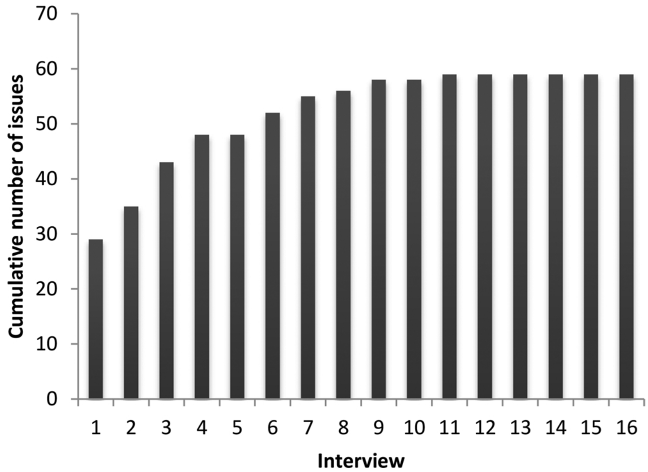

Fig. 2. Summary of the cumulative number of issues (codes) raised by eNGO and fishery interviewees.

participants in the supply chain, to develop an agreed set of sustainability indicators in each of the sub-categories, and that it was not the sole responsibility of fisheries managers. Nevertheless, it was recognized that public information needs and expectations are dynamic and are likely to change over time, and the Healthcheck (nor any other single initiative) may not assuage all public concerns or fill all information needs.

3.2. eNGO and fishery participant perceptions

A total of 16 interviews were completed with eNGO employees and fishery case study stakeholders. Cluster analysis showed that the coded concepts identified in the interviews, whether an eNGO or a fishery case study interview, were common to clusters comprised of interviewees from both groups and were relatively separate between interviewees (Online Fig. 1), so could be treated as one set for subsequent analysis. Overall, there was very high support for a broad assessment of fishery sustainability, with all six fishery case study interviewees and 8 of 10 eNGO interviewees in favour of developing a Healthcheck (or similar approach). Similarly, almost all of the interviewees (15/16) currently used an existing fisheries sustainability assessment and considered themselves likely to use a Healthcheck-type assessment in their own work. The two cases where eNGO individuals were not in favour of a new assessment framework were based on scepticism that a Healthcheck would add new information over and above what was already available in other existing assessments (such as consumer seafood guides). Despite the small sample size, due to the relatively small number of relevant participants (eNGOs who were fishery-active, or involved in the specific case study fisheries), the qualitative coding showed a plateau of novel issues was reached after around 10 interviews (Fig. 2).

The qualitative analysis resulted in a hierarchy of themes, categories, and issues (codes) (Online Appendix 2). The four major themes grouped (i) management issues related to decisions people make in various roles as consumers, fishermen, and fishery managers (22 codes); (ii) issues relating to other assessments (13 codes) such as discussion of accreditations systems like Marine Stewardship Council; (iii) issues specific to the Healthcheck (12 codes), such as the trustworthiness of organisations developing an assessment framework, particular risks identified, and the best type of format to use; and (iv) issues relating to the environmental state of ecosystems or species (10 codes).

The largest of the themes (theme i) covered a broad range of issues related to decisions people make, including government, consumers and private industries and spanning individual to cultural decisions (Online Appendix 2). These relate to how people use information, work together and make decisions in management. The other three themes were all similar in size, reflecting their more specific focus. The spread of issues indicates some of the eNGO participant focus on environmental concerns, but not as much as might have been expected, as there were more codes relating to decision-making and the active role that people (consumers, scientists, eNGOs and government) need to play in sustainable fisheries compared to environmental codes (Online Appendix 2).

In the two themes related to existing (theme ii) and the proposed (theme iii) assessments, interviewees raised several issues related to existing assessments and what they would like to see in a new Australian fishery sustainability assessment. The most prevalent of these related to discussion around how the Healthcheck could link with, or build on other successful existing assessments, such as Marine Stewardship Council certification processes, or the Australian Marine Conservation Society seafood guide. The need for transparency was also a core concern, with 8 of 10 eNGO interviewees raising this as both a criticism of current assessments and fishery decision-making processes and an important factor to include in any new assessment. Transparency relates to making sources of information clear, keeping all interpretive steps open and honest (e.g. making it explicit if any data are excluded) and providing links to the raw data or its source wherever possible. We illustrate some of the feedback with indicative quotes from the interviews.

> "*I think any level, any increased level of transparency and availability and accessibility of data, of research, of opinion, of so forth is – would be welcome*" [Interview 10].

Other interviewees talked about the need to collate and synthesise existing sources of data:

> "*I think it would be great to see a consolidation of the ways that we assess things in Australia, and all talking the same language*" [Interview 7].

One important issue raised by eNGO interviewees was the number of information gaps (including unacknowledged and excluded information) around decision-making which created a sense of distrust around sustainability reporting in general. These information gaps were more likely to be contentious when the information was collected, but then withheld from public scrutiny (e.g., commercial in-confidence), rather than when there was no information.

> "*I've heard from various people who work in government that a lot more information exists but it's simply not publically available. … So it's very difficult to get an understanding of whether things are improving in Australia or not*" [Interview 8].
> "*We very much believe in open and transparent process and data. Let's face it, we live in a rich, wealthy country, we're a developed country, we're in the western world, there's no reason why our fisheries shouldn't be up amongst the best in the world, but we have issues with data in a number of our fisheries*" [Interview 9].

Another point made by fishery interviewees was that a new comprehensive sustainability assessment framework, such as the Healthcheck, would provide a way to showcase fisheries that were doing well, particularly smaller fisheries or fisheries that were successful in one particular sustainability area. In such cases interviewees could also see a role for the specific fishery, or industry to use information presented in the Healthcheck for marketing purposes. This identified a tension between participants not wanting the Healthcheck to act as a 'scorecard' but wanting to be able to clearly interpret good and bad – as long as it was their judgement to make and use. For example:

> "*We certainly aren't trying to hide. We've got to be proud in how we operate, and how we're managed, and the science behind our industry as a whole*" [Interview14].

> "*The industry themselves are very interested in getting that information*

out there to a broader community" [Interview16].

The delivery of more information was not without some concern, however:

"*there are so many websites. You go to the home page and you look around for five minutes, and you realise that there's nothing really there that answers your questions, which is hard because there's so many different topics that come into fishing*" [Interview 12]
"*there's a fine line between too much information and not enough*" [Interview 14]

Both eNGO and fishery interviewees noted that there were likely to be data gaps, perhaps requiring additional collection efforts, and that it was essential that any data that was presented was up to date and detailed, including for example, whether a fishery was taking steps for improvement. Finally, as with fishery managers, the interviews demonstrated that development of a wide-ranging fishery-focused sustainability reporting system (such as the Healthcheck) should not be to provide an 'assessment score' per se. Thus, a new framework need not replace any of the many other assessments already existing nor provide a score or interpretation of fishery performance. Instead a holistic sustainability information system could provide a framework to collect information about fisheries and provide a portal to search for information to answer specific questions, or to collate in reports, guides and existing assessments. However, a system providing wide-ranging sustainability information across the four categories should be more than just a repository of information - it should be a benchmarking tool to highlight gaps in information, where fisheries are doing well, where resources need to be targeted to improve practices, data, or management, and where there are untold success stories to communicate.

"*You don't have to convince me that it's important to include the economic and the social issues, because we've been banging on about the fact that all three of them are important and we've got to get to the other two for years and nothing has really ever happened*" [Interview 7].

The participants also talked about issues relating to the environmental state of ecosystems and species (theme iv), particularly the need to have more data on threatened species interactions, such as seals, and the need to have more access to data in general in terms of the broader environment.

"*The impacts of trawl fisheries on albatross only really came to a fore probably five or so years ago, and we're hoping that they'll get better soon. I guess, similar with – similarly with the gillnet fisheries and the bycatch of Australian sea lions and dolphins is a big issue for us right now, that we're – that to date the fisheries have said there's no issue when they're probably or most likely is one, we just haven't had the data*" [Interview 5].

3.3. Comparison of issues and existing assessments

To determine if the issues that the interviewees raised as important were covered in existing assessments, the qualitative analysis from the interviews was compared with the frequency of indicators in the four sub-categories derived from the review of existing assessments (Hobday et al., 2016). The analysis of interviews produced 56 codes (Table 1), which aligned relatively well to the 16 sub-categories identified from the analysis of existing assessments, indicating that issues covered in existing assessments were also generally identified in the interviews. As there were more codes from the interviews than sub-categories from the assessment review, multiple codes were allocated to some sub-categories, after discussion about the best 'match' of what the codes and sub-categories covered. Only five of 56 codes were not matched, as they did not relate to existing assessments, such as those related to assessment format (e.g., web-page, app, hardcopy) and to "trust" questions related to the CSIRO (Commonwealth Scientific and Industrial Research Organisation), a potential deliverer of the Healthcheck. While most codes clearly fit to a sub-category, overlap was more difficult in some of the categories (e.g., choosing between Community and Wider community, which are clearly part of a continuum and not separate). We discussed this quandary and decided to match each code to only one category - judgments were made about where the code best matched the category (Table 1). An exploration of the differences that could result if codes from interviews were matched to multiple categories is beyond the scope of the paper, but others attempting a similar task may need to adopt a different approach to allow new hybrid or 'in-between' categories to emerge.

We also compared issues raised in the interviews to the ones covered in existing sustainability assessments by counting the number of times key terms were present in the interviewees versus the existing assessments, using the word count feature of NVIVO (Table 1). This showed that 'people issues' are more often discussed in the interviews and 'biological issues' more represented in existing assessments (Fig. 3A). For example, 'target species' was represented more in the existing assessments than in interviews, but 'management systems' was discussed more in interviews. Interestingly, 'habitats' and 'institutional capacity' were represented more in the existing assessments than in interviews, but this might be because of different words/phrasing. The result that 'fishery' and 'community' were discussed more in interviews indicates that there are several factors that are important to stakeholders that are not yet captured well in assessments, particularly around flow-on benefits of fisheries to the immediate (fisher families) and broader community. Furthermore, most sustainability assessments have global scope whereas the interviewees had a regional focus. The sustainability issues may also be correlated (e.g., if the institutional capacity is good, there may be lower concern with protected species), which can bias stakeholder perceptions in different regions and thus influence if they were discussed as important or not.

This relationship can be clearly seen in an analysis of relative importance of concepts raised in the interviews (word counts) and the importance of these issues in the existing assessments (as the number of indicators across the assessments) based on rank of each sub-category (Fig. 3B). This shows which issues are over- and under-represented relative to this set of interviewees. For example, target species, management issues, and social aspects of fisheries were considered important in both interviews and existing assessments (upper right quadrant), while protected species, economic issues related to the fishery and the community were considered more important in interviews than in existing assessments (upper left quadrant). Assessments currently provide more coverage of issues such as habitats, compliance and institutional capacity compared to the rank at which these issues were mentioned in interviews (lower right quadrant). Issues that are raised less often include the environmental cost, environmental context within which fisheries occur, the sustainability of markets, and ecosystem governance arrangements(lower left quadrant).

3.4. Revision of the Healthcheck prototype after additional engagement with end users

Following completion of the initial Healthcheck (phase one), additional issues identified for inclusion in the revised Healthcheck (phase two) included: ethical work practices and slavery, ethical animal welfare practices, fisher mental health and well-being issues, carbon and pollution contributions, energy costs and fossil fuel subsidies, adaptive capacity of fisheries management and of fishery-dependent communities. In addition, the need to include issues arising from external pressures on the state of fisheries systems (e.g., market forces, consumption patterns, pollution) was also identified. The rationale for explicit inclusion of external drivers was to make clear some issues that affect sustainability are outside direct control of a fishery governance system, yet provide context to users of the information (for example, background levels of pollution in the environment related to seafood

Table 1
Alignment of 51 qualitative codes derived from interviews that could be matched with 16 sub-categories identified from a review of existing seafood assessment schemes (Hobday et al., 2016). The numeral at the end of each code label indicates the code number. Word count terms indicate the specific content under each code that was counted. Thus, "count" indicates issues that were frequently mentioned (and so assumed to be more important to participants).

Category	Sub-category	Codes	Word count terms	Count
Biological	Target species	Mentions depletion_9	target AND stocks NOT audience	19
		Discusses stocks_14		
	Bycatch	Discusses bycatch_39	bycatch	31
	Protected species	Discusses threatened species_8	protected	23
	Habitats	Discusses pests and disease_7	habitat	14
		Discusses urchin barrens_16		
	Ecological communities	Compares different impacts on different species_43	Ecological + communities	5
	Environmental context	Discusses marine parks_2	Environmental + context	6
		Discusses environmental impacts_13		
Economic	Community	Discusses importance of participatory processes_1	community	43
		Expresses support for Healthcheck_11		
		Mentions indigenous sector_34		
		Mentions tourism_36		
		Mentions education_37		
		Talks about supply chain issues_49		
	Environmental costs	Compares land and sea_32	Environmental + costs	6
		Disagreement about 'sustainable'_54		
	Fishery	Discusses bad management_3	economic	50
		Identifies examples of successful fisheries_4		
		Highlights commercial bias_38		
		Discusses gear types_44		
		Talks about aquaculture_47		
		Talks about industry involvement and ownership_48		
	Markets	Talks about consumer pressure_20	market	16
		Discusses the role of supermarkets_52		
		Discusses marketing_56		
Governance	Compliance	Talks about data poor fisheries_46	compliance	15
	Ecosystem governance	Discusses ecological based management_6	Ecosystem + governance	4
	Institutional capacity	Notes scientific research important_5	institution OR capacity	16
		Identifies funding limitations_33		
		Difficult to do_40		
		Advocates policy change_45		
		Talks about cultural or structural barriers_50		
		Takes a long time to implement change_51		
	Management systems	Uses reports_10	management	137
		Discusses failures of existing assessments_12		
		Talks about accreditation such as MSC_19		
		Talks about the importance of transparency_27		
		Highlights information gaps_35		
		Notes the need for data detail_42		
Social	Fishers	Talks about recreational fishing_15	fishers	46
		Discusses social media_30		
	Wider community	Highlights forgotten social values_17	Wider + community; consumer	19
		Public expects sustainable_18		
		Identifies competition_26		
		Public is disengaged until a crises_28		
		Consumer disinterested_29		
		Discusses changes in lifestyle_31		
		Consumer interested in Healthcheck_41		
		Talks about overseas fisheries_53		
		Talks about labour issues_55		
	Unmatched	Talks about webpage_21		
		Highlights app useful_22		
		Prefers hardcopy_23		
		CSIRO trusted_24		
		Risk to CSIRO_25		

safety from a consumption perspective). These additional issues were addressed by adding or revising categories (biological revised to become ecological; social expanded to social and ethical; external influences added); adding or revising sub-categories (for example, carbon and pollution added; environmental costs revised to energy costs; ethical – animal welfare and human welfare added; various climate change sub-categories added); and revising indicators (for example, in the energy cost sub-category, fossil fuel subsidies were added as an indicator, and refinement to the indicators for the carbon and pollution sub-category was done to reflect complementary indicators from a systems analysis perspective) (Fig. 1B). This process of modification was able to occur without major framework modification and allows for revision in future. This is a desirable feature as needs change and new processes and agreements come in to place, and for reporting to new initiatives, such as the Sustainable Development Goals (United Nations, 2015) or IPBES (Díaz et al., 2015). Descriptions of categories and sub-categories are provided in Online Appendix 4.

4. Discussion

Fisheries are widely recognized examples of social-ecological systems (Ostrom, 2009; Perry et al., 2011; Frusher et al., 2016), in which system sustainability requires not only a sustainably fished stock, but also economic (in the harvest, processing and distribution elements),

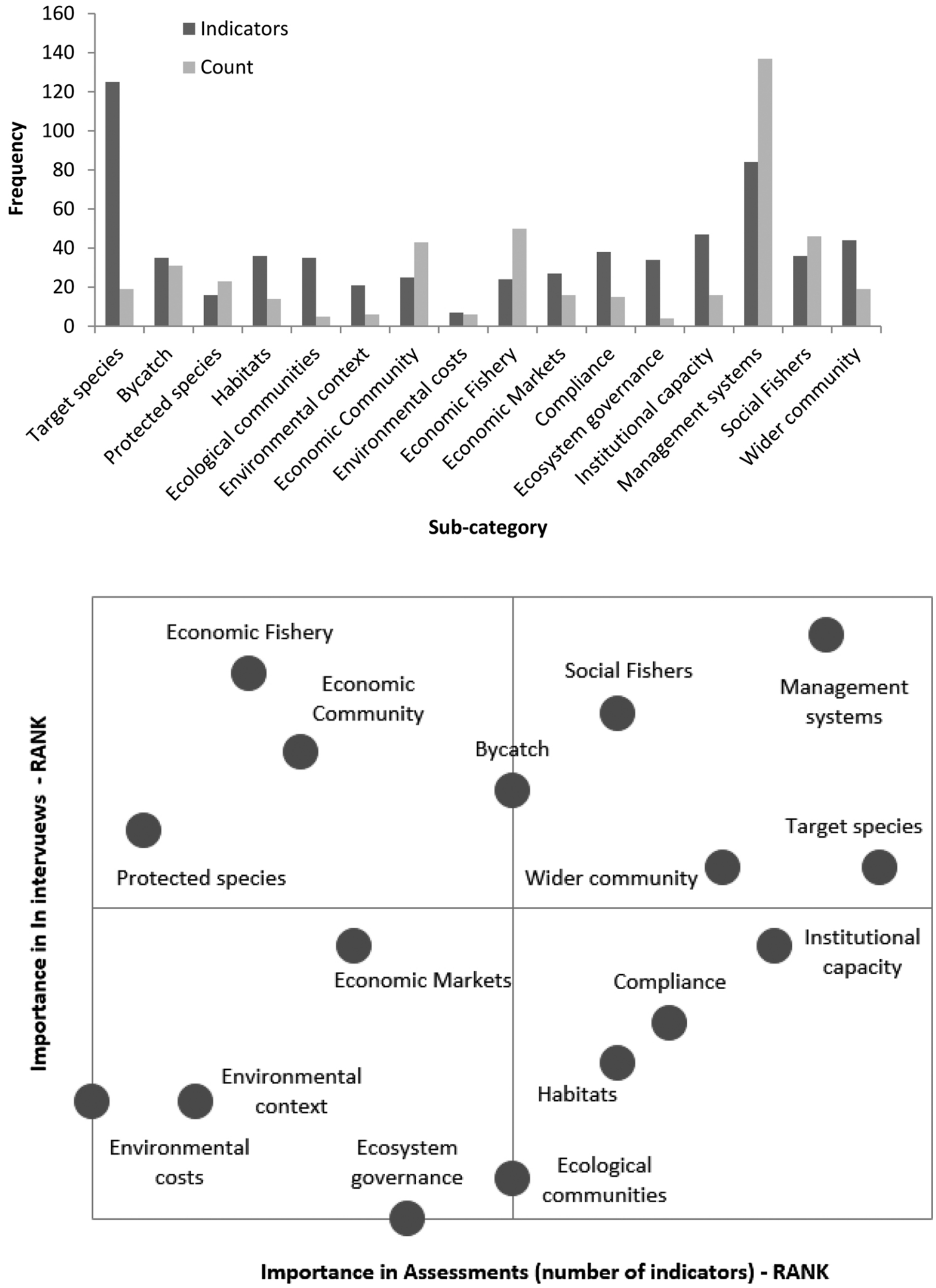

Fig. 3. A Number of indicators in existing assessments and counts (number of references) to that sub-category (times mentioned) in interviews. B: Rank plot of the 16 sub-categories in existing assessments (high rank is to the right) and in interviews (high rank is to the top).

and social sustainability – including acceptance by people and communities that work and support those industries (Anderson et al., 2015; Hilborn et al., 2015; Stephenson et al., 2017). Given fisheries contribution to food security and employment (FAO, 2016), and the fact that they are an industrial exploitation of a common resource, demonstration of sustainability is no longer an internal, private affair for such systems. Society-at-large now seeks information on the sustainability of most food production industries and the seafood sector is no exception (Roheim, 2009).

Participants in the Australian commercial fishing sector already recognise the need for transparent reporting on the sustainability of target stocks (Flood et al., 2014). There is also increasing awareness of societal demand for information on other aspects of biological, governance, social and economic sustainability, as is occurring elsewhere in fisheries (Link et al., 2018; Stephenson et al., 2017, 2018b), other environmental management systems (e.g., IPBES, Díaz et al., 2015, CBD Dunn et al., 2014) and observing networks (e.g., Muller-Karger et al., 2014). Analysis of existing assessments showed that some sustainability areas were likely under-reported (e.g., social, governance areas), compared to their importance as indicated in stakeholder interviews. It can be difficult to judge when and what information will be needed by society, as particular crises in fisheries show (e.g., Tracey et al., 2013; Kittinger et al., 2017), and so a comprehensive and forward-looking sustainability assessment framework is desirable (Anderson et al., 2015; Hilborn et al., 2015; Stephenson et al., 2017).

Broad sustainability assessments provide fisheries managers and other stakeholders with a clear view of successes, strengths, and challenges for particular fisheries. They can also form the basis for performance reporting on fisheries for use in other efforts, such as Australia's State of Environment Reports (e.g., SoE, 2016), integrated regional assessments (e.g., Boughton et al., 1999), the UN Sustainable Development Goals (UN, 2017- http://www.un.org/sustainabledevelopment/sustainable-development-goals/) or implementing Ecosystem-Based Fisheries Management (Pitcher et al., 2009). The work described here can potentially guide the development of new regional fishery sustainability assessments, or new data streams for existing assessments, that better reflect societal demands for information. With development of broad sustainability reporting guidelines and indicators, public access to information on fisheries may improve which could lead to better understanding and acknowledgement of the status of Australian fisheries. It will also highlight areas for improvement in fisheries that are yet to meet societally determined standards and further data collection. While our sample size was limited, fishers, managers, and eNGO interviewees all felt that comprehensive sustainability assessments have an important function in showcasing successful fisheries, and providing an incentive for improvement across the commercial fishing sector.

Qualitative analysis of the interview data we collected revealed four important sustainability themes related to (i) decision-making processes, (ii) existing assessments, (iii) the proposed assessment, and (iv) the environmental state of ecosystems or species. A major criticism of current decision-making processes concerning sustainability of fisheries that emerged in our analysis indicated that transparency was a core concern for many stakeholders, particularly the eNGO community. Comprehensive assessments may be limited by data gaps, but this was not seen as a barrier by participants in this study (see also Stephenson et al., 2017), but rather as a driver for collection of relevant information. Given that fisheries agencies are often resource-limited, particularly when managing small fisheries, attention must be given to the cost-effective collection and sharing of information. Overall, most stakeholders did not want the assessment project team to develop a single "performance metric," but there was agreements that use of favoured or reliable indicators selected from the comprehensive sustainability assessment could be used to promote fisheries or management practices.

The issues raised in our engagement with potential users of a broad fisheries sustainability assessment identified similar concerns to those identified in existing seafood assessments. However, the relative importance of issues differed to what is provided in existing assessments. A cautious interpretation of the relationship between the importance of issues discussed in interviews (word count) and the number of indicators in existing assessments is warranted given the limited interviewee sample sizes and alternative explanations for the patterns. However, in principle, this type of analysis can inform planning for future sustainability assessments, particularly when resources to collect, collate and analyse sustainability data are limited. For example, issues that are not well covered in existing assessments but are a priority to stakeholders (Fig. 3B, upper left quadrant) deserve more attention in assessments, while issues in the lower left quadrant might see a reduced focus in assessments if they are seen as less important by end users, or have been managed such that they are no longer a problem. Issues that are seemingly less important in both existing assessments and to our group of interviewees are more problematic. They may be less important in reality, or less important due to a lack of awareness, or an emerging issue that is not yet a priority. These alternative explanations can only be resolved with additional discussion with end users of sustainability assessments. Obviously, in an examination based on ranking of issues, some will always be of lesser importance, and so the design goal might be to develop an assessment where there is agreement between need for and provision of information. In Fig. 3B, this would be indicated by a 1:1 correspondence between need and provision, however, this approach could also be flexible over time as issues and priorities change.

Our analysis revealed that fishery managers, eNGOs, and fishery participants are aware of the importance of timely reporting, easy availability, and broad coverage of fishery sustainability information. They emphasized the importance of the "trustworthiness" of information through transparency of data management. Inclusion of additional categories and sub-categories following the 18 months of additional stakeholder engagement resulted in even broader coverage, and a total of 24 sub-categories. Notably, stakeholders suggested the inclusion of issues such as human and animal welfare, climate change, and pollution. Issues outside the direct control of fisheries, but which impact on fishery sustainability were also identified and included in the revised framework. These external influences were seen as important to include, as they helped stakeholders understand the socio-ecological system in which fisheries operate.

Development of broader sustainability frameworks is of world-wide interest, however, there are many existing global assessment schemes (Roheim, 2009; Hilborn et al., 2015; Hobday et al., 2016). According to study participants, a reporting framework that supports these many existing assessments, rather than adds more competition, represents the best option. Thus, rather than developing another competitor scheme for Australia, in future the Healthcheck process will gather, verify and provide existing data across the sub-categories identified here for use in any existing assessment (Hobday et al., 2016). A challenge in selection of indicators or information-types in each of the sub-categories that can be used in other assessments is the diversity of options. Many existing assessments attempt to provide a substantial number of indicators (e.g., Pitcher and Preikshot, 2001; Anderson et al., 2015), but many of them are based on expert-assessment and qualitative scoring, which may not provide the detailed information required by seafood consumers and other interested stakeholders when making their own judgements about sustainability (Stephenson et al., 2017). There may also be considerable variation across fisheries in terms of data availability and ability to collect data. While comparison between fisheries is easiest when the indicators used are common across fisheries, there might need to be a trade-off between generality and specificity, and qualitative and quantitative indicators. Finally, the scale of the indicator-data process can be problematic. For example, selection of just two indicators for each of our 24 sub-categories (Fig. 3B) results in 48 indicator requirements per fishery, three indicators requires 72, and so on.

Sustainability is a broad and complex concept, and consideration of the diverse suite of factors involved in social, economic, ecological and governance arrangements is needed to create truly sustainable food production industries (Stephenson et al., 2017). A new assessment for Australian fisheries that incorporates biological, economic, governance and social components is clearly supported by the stakeholders involved in this research, consistent with international trends (e.g., Link et al., 2018; Stephenson et al., 2018b). For this vision to be fully achieved, participatory processes that involve interested stakeholders in development of fishery assessment frameworks, prioritization of useful indicators and testing the systems for accessing and delivering the information, are needed.

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Appendix A. Supplementary data

Supplementary material related to this article can be found, in the online version, at doi:https://doi.org/10.1016/j.fishres.2018.08.006.

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Stakeholder trust and holistic fishery sustainability assessments

Aysha Fleming [a,d,*], Emily Ogier [b,d], Alistair J. Hobday [c,d], Linda Thomas [c], Jason R. Hartog [c], Bianca Haas [a,b,d]

[a] CSIRO Land and Water, Hobart, Tasmania, 7000, Australia
[b] University of Tasmania, Institute of Marine and Antarctic Studies, Australia
[c] CSIRO Oceans and Atmosphere, Hobart, Tasmania, 7000, Australia
[d] Centre for Marine Socioecology, Hobart, Tasmania, 7000, Australia

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ABSTRACT

Australia is considered world-leading in sustainable fisheries management. Despite this, public perceptions and trust in how fisheries are managed vary widely. Existing models of trust and community acceptance in extractive industries suggest transparently reporting on a wider range of sustainability issues than resource use and condition levels, or the status of target stocks in the case of fisheries, as a potential way to build public awareness and trust. Public perceptions of sustainability can be narrow or broad and related to different world views and perspectives about what is important. Here we investigate whether approaches such as Australia's conceptual 'Healthcheck' framework for fisheries sustainability reporting, could contribute to increasing public trust in fishery management. Interviews with 21 people who currently use (or would use) fisheries information in their professional work revealed interest in a wide range of sustainability issues and a desire for more easily accessible and trusted information. The interviews also revealed four common themes: Trust and distrust; Sustainability concerns and interpretations; Conflicts and values; and Fisheries information sources and knowledge gaps. These themes emphasise the need to take a broad view of sustainability and communication in fishery management, across the range of actors involved, to collaborate widely and build more engagement and relationships with the public in different forms. We use these findings to propose how the established model of trust and community acceptance of natural resource-based sectors could be applied to commercial fisheries and relate to other initiatives, such as the Sustainable Development Goals.

1. Introduction

Social license to undertake extractive activities is now recognised as a powerful force [1,2]. Social license can mean the difference between an activity going ahead, or not [3]. Social license has been most commonly explored in terrestrial contexts including mining, wind farms and forestry, and is also emerging as a strong issue for marine resource sectors, including energy production, fishing and aquaculture and even non-extractive recreational uses [1,4,5]. In both terrestrial and marine studies, trust and relationships are identified as key aspects of social license [4,6,7]. Trust is dynamic, relational and difficult to define – there are many definitions, each highlighting different aspects depending on the context. Most definitions convey something about accepting vulnerability, as well as making a 'choice' and weighing risks rationally and/or emotionally and making judgments about character and potential risks and benefits from granting trust (e.g. Ref. [8]. According to Meijboom et al. [9] "one trusts someone if one has adequate reason to believe it will be in that person's interest to be trustworthy" and further, trust "enables us to act in cases of uncertainty and lack of personal control" [9]; p429-430). Trust is especially important for extractive industries that use publicly owned natural resources [2,6,7], including fisheries.

Our use of the term 'fisheries' is deliberately broad in this paper, to allow the diverse range of actors involved in commercial fisheries to be considered when thinking about sustainability performance, assessment and perceptions. These actors include fishers and fishery managers, but also supply chain partners, business, community, government and researchers, indigenous representatives and non-government organisations and potentially others depending on the context (e.g. media). Similarly, our use of the term 'sustainability' is broad and not prescriptive, to enable a range of perspectives to be included [10]. In general, sustainability is about the possibility for an activity, such as

* Corresponding author. CSIRO Land and Water, Hobart, Tasmania, 7000, Australia.
E-mail address: Aysha.Fleming@csiro.au (A. Fleming).

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fishing, to be continued in perpetuity, to occur in a healthy environment, and requires a socio-ecological perspective (e.g. Ref. [11]). There is currently a recognised gap in addressing social sustainability in Australian fisheries [12,13].

In fisheries, obtaining sufficient levels of trust in the sustainability of operations and their management is complicated by generally low public awareness regarding the activities associated with commercial fisheries and difficulty in accessing information [14]. Fishing activities are not readily observable to 'passers-by' as they might be for forestry or mining activities. Seafood regulations and supply chains can span many countries and as a result, the consumer relationship to seafood and its production systems can be diverse and complex [15,16]. Social media and the internet have resulted in an increase in the amount of information people can access, but it has also made some aspects of trust more complicated as consumers can now access multiple, and potentially conflicting or misleading, information about how natural resources are used for production [2]. The proliferation of information appears to make the importance of personal connections increasingly influential, to interpret or filter messages [17]. Fisheries sustainability assessments often rely on technical experts to report on both biological and ecological sustainability and the diversity of fisheries makes achieving an overarching platform to communicate with the public hard. For all these reasons, trust is particularly important to be established and maintained in commercial fisheries [14,18–20].

One way to understand the factors contributing to trust pertinent to extractive industries has been proposed by Moffat et al. [7] (Fig. 1). This model, developed in relation to community interaction with mining industries, postulates that the four components that contribute to trust are perceptions that the industry or business entity are: 1) the industry impacts on social well-being of affected communities, 2) the level of contact between industries and affected and interested communities, 3) the quality of the contact and 4) the fairness of procedures in place to govern the activities and actions of industry in relation to community interests. Transparency and engagement are required to demonstrate the four components. Yet transparency alone is not sufficient to establish trust [9]. Formal processes such as whether rules are followed and how business infrastructure (such as social networks or buildings and equipment) contribute and relate to local communities [7] are also potential pathways for businesses to demonstrate trustworthiness and build relationships.

Credible monitoring and reporting are essential components of demonstrating an activity, such as fishing, is sustainably managed [21]. Yet this monitoring and reporting is typically limited to performance areas directly within the scope of management structures and what they can control [22,23], and can risk falling short of consumer expectations of information on a wider range of sustainability considerations [22], such as social well-being [12,13,24,25]. Global moves towards broader

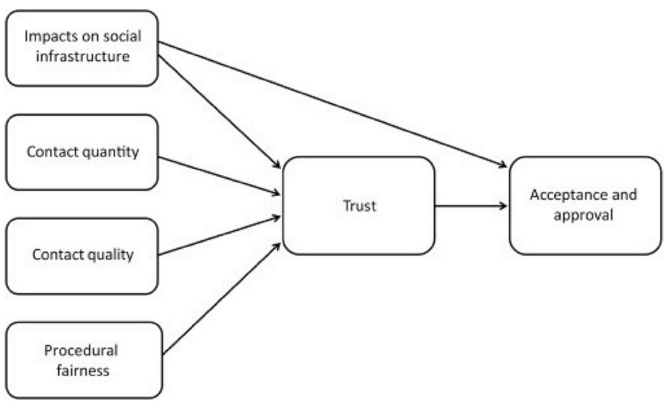

Fig. 1. Components of trust relative to community acceptance of extractive industries, from Moffat et al. [32].

scope of sustainability assessments, including for example human welfare [26], fuel consumption [27] and transparency of the supply chain [15], attempt to address the trend toward a need for fairer trade and improved social responsibility [24]. Broad, holistic scope of fishery performance reporting has the potential to provide information to assess all four components described above (Fig. 1).

In Australia, a conceptual framework for holistic fishery performance assessment and reporting, termed the 'Healthcheck', has been developed to increase transparency and access to information across a broad range of indicators [28]. The focus of this framework is on the sustainability of marine fisheries and is thus broader than existing reporting on status of fish stocks (e.g. Refs. [29,30]). The Healthcheck comprises a framework, guidance document, and data compilation to transparently, independently and comprehensively support reporting on a broad range of sustainability issues relevant to Australian commercial fisheries. These data can be used by a range of stakeholders to understand sustainability issues and reuse in other formats. The Healthcheck framework spans four categories relatively common to sustainability assessments: biological, economic, governance and social and ethical. A fifth category recognises that a range of external issues can also affect fisheries sustainability (positively and negatively). In the Healthcheck, each of the five categories contain between 4 and 6 sub-categories (see Fig. 2) and include indicators within each sub-category (see Appendix 2). Not all components of the Healthcheck are able to be influenced by fishery managers (e.g. labour welfare protections) but they capture what the public might want to know about fisheries and demonstrate that fishery sustainability is influenced by many different actors.

In this paper, we examine the Healthcheck through interviews with Australian marine stakeholders and potential holistic fishery assessment users to understand trust, information needs and gaps, and consider implications for broader public perceptions of fishery sustainability and public trust in fisheries and fishery management. We review the adequacy of Moffat et al.'s [7] model of components of trust relative to community acceptance of extractive industries in light of these findings and adapt the model to reflect components applicable to Australian commercial fisheries. We then discuss our findings in relation to current approaches to reporting, including the Sustainable Development Goals, which are currently informed by Status of Australian Fish Stock assessments in Australia to include the biological, catch and effort information of Australia's key wild catch fish stocks ([29]; see fish.gov.au), but not yet by the broader categories outlined by the Healthcheck.

2. Methods

To explore whether holistic fishery assessments such as the Healthcheck can contribute to improving public trust in fishery sustainability or fishery management, our research adopted a broadly interpretivist, qualitative approach, following social constructivism and utilising grounded theory [31] to capture perceptions and experiences and understand values and concerns, such as foundations for trust [2]. This allowed us to identify and understand different stakeholders' perceptions of fisheries sustainability, and experiences with information about fisheries and their management. Semi-structured interviews aimed to elicit:

(i) Information needs and gaps about Australian fisheries for a general or mixed audience.
(ii) How information might be used and would be best presented.
(iii) Perceptions and values of Australian fisheries.
(iv) Levels of trust in how fisheries are managed and how this might be improved.

We focused our questions on commercial marine fisheries, however, comments about other aspects of marine users and uses (such as recreational fishing) were also made by participants and used to inform the analysis.

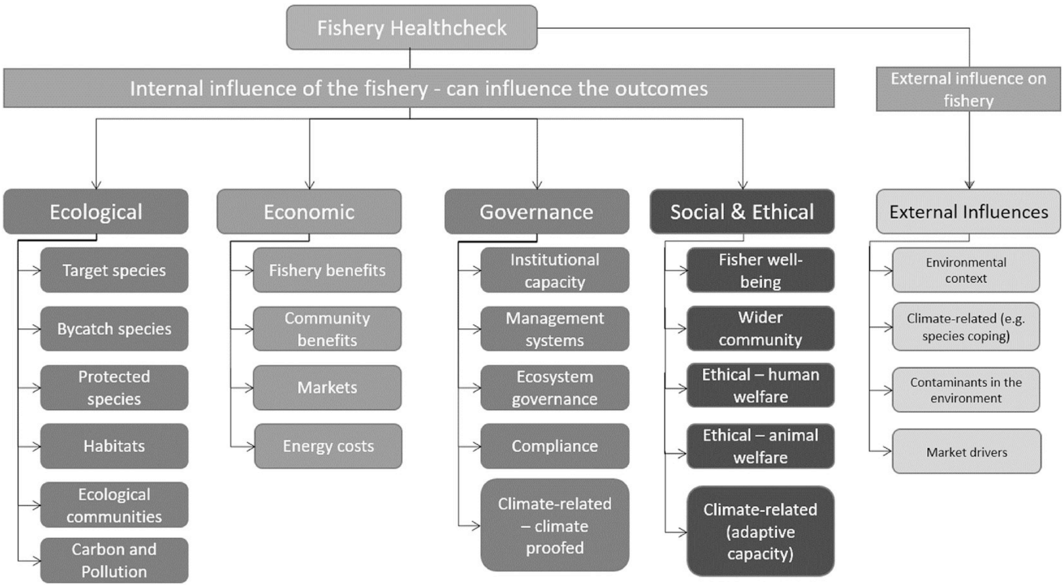

Fig. 2. The Healthcheck categories and subcategories. Source Hobday et al. [28].

We identified Australian stakeholders with a professional interest in, or as an active user of, fisheries information. As the Healthcheck model had been previously explored with fishers and fishery managers [28], this round of interviews focused on potential stakeholders whose views had not been captured, namely researchers, public servants and indigenous and media representatives and industry advisors. This is not intended to be a representative sample but to explore the potential utility of a Healthcheck type of approach to a range of stakeholders. We selected interviewees using a combination of purposive sampling and snowballing. We first identified key stakeholders through professional networks or through internet searches, seeking a wide range of participants (see Table 1). Interviewees were asked to recommend others who they thought might be relevant (snowball technique). Participants were invited via email and a follow-up phone-call. We conducted semi-structured interviews with 21 participants (11 men and 10 women). Seven participants were from or spoke particularly about Victoria, three from Tasmania, two from Queensland, one each from Northern Territory, South Australia and New South Wales. Six preferred to speak about fisheries nationally.

Interviews were generally 30 min in duration. All were conducted face to face or by telephone between July and October 2018. The interviews started with a brief introduction and then sought information on the individual's current role and interest in Australian commercial fisheries. This was followed by questions about their information needs, their perceptions of gaps in the information available, how they might like to access information (e.g. on the internet) and what level of detail they would like. We also asked about trusted sources of information, networks of information (who they might ask questions of) and how they might judge accuracy of information. We asked if they could recollect any media stories about fisheries and why they thought that story was reported. We asked about the concept of the Healthcheck and holistic fishery assessments generally. Finally, participants were asked to reflect on what they valued about Australian fisheries, who was responsible for ensuring sustainability of Australian fisheries and how they felt about Australian fisheries sustainability.

The interviews were audio recorded and transcribed. The qualitative data analysis software QSR NVivo® (QSR International, version 11) was used to aid the coding, analysis and management of the data. Interview transcripts were analysed using 'bottom up' and iterative coding followed by thematic analysis. This means that the transcripts were coded according to the ideas and meanings that were in the data. The result was a hierarchical structure of themes and sub-themes through multiple rounds of coding (Appendix 1 shows the final structure).

We then examined key themes that emerged in the interviews regarding stakeholder perspectives about Australian fisheries and perceptions of (and trust in) sustainability looking for key issues and opportunities brought to light by the themes. We then compare these with the model components proposed by Moffat et al. [7] and discuss how our findings link to the model and how the model can be interpreted for Australian commercial fisheries. We highlight what these findings mean regarding current reporting and global initiatives assessing fishing sustainability.

Table 1
Interview participants by stakeholder category (note there is overlap in some participants, e.g. public servant and indigenous representative, in that case the main affiliation as portrayed by the participant is used).

Stakeholder category	Number of participants
Fishery manager	2
Industry advisor (consultant, industry group, policy)	7
ENGO	1
Researcher	2
Public servant (council, government, MPA)	5
Indigenous representative	2
Media representative	2
Total	21

3. Results

3.1. Result 1: responses to the Healthcheck

The interview results suggest that more holistic sustainability assessment and reporting, as represented here by the Healthcheck, is likely to be desirable. All interviewees were generally positive about the potential of holistic fishery assessment and reporting to improve public access to information about fisheries, with about half (10) saying that a Healthcheck-style framework would be directly useful to the public. The remaining interviewees thought that a Healthcheck would be more useful for fishery managers or were not sure about the audience. There was general caution about whether a Healthcheck-style system would be trusted, depending on how it was funded and branded, and whether the data was able to be verified, especially through personal contacts and conversations with members of trusted networks. The ability to co-produce components of a sustainability reporting framework was also nominated as an important aspect of whether the assessment would be accepted (and used) by the fishing industry. Most interviewees thought they would personally use a Healthcheck, with only five saying that they were not sure, or they 'might'. Similarly, interviewees proposed different uses of the Healthcheck, such as to identify areas needing improvement, to demonstrate good performance, to compare specific fisheries, or just to 'browse' out of interest. The Environmental Non-Government Organisational representative was particularly interested in reports of bycatch and interactions with protected species, as well as environmental monitoring, whereas fisheries managers were interested in a range of information, from biological to social, and were most positive about having all the information in one place. Journalists and researchers were seeking an easy source of credible general information on fisheries.

While a central repository of data is the approach proposed with the Healthcheck system, the finding that the data could be used in different ways suggests that it could be organised in different ways and hosted on different platforms (e.g. each industry website) not necessarily all together (e.g. on a government website), thus potentially making it easier to update information and reducing the risk of the Healthcheck having to be centrally and independently funded and maintained. The potential consequence of a single database for the Healthcheck data is that it might be trusted and used by some groups and not by others, depending on perceptions of the brand or website host. The process of developing the Healthcheck categories and how to make it accessible to the public can be considered as more of the start of a dynamic process for larger industry wide or even cross industry approaches to produce, gather and collate data (including new data) and make it more freely available and understandable in a range of ways.

3.2. Result 2: Trust

Through the analysis of interview data, trust emerged as a key issue related to data collection and interpretation and reporting. *Trust (and distrust)* was a prominent theme in the data, along with *Sustainability concerns and interpretations*; and broader issues of *Conflicts and values*; and *Fisheries information sources and knowledge gaps* (see Appendix 1). While *Fisheries information sources and knowledge gaps* is the 'largest' theme in terms of number of references (227), followed by *Conflicts and values* (208), it has a broader range of codes to make up the total (see Appendix 1) which means that *Trust and distrust* (132) and *Sustainability concerns and interpretations* (158) are seen to be quite important issues.

Another key overarching finding from the interviews is that the term 'sustainability' was considered by some interviewees to have lost meaning, to be a just a "buzzword" or to miss key elements, such as indigenous conceptualisations, (n = 7), and by others to have a much wider scope than only biological and ecological factors and be more about balancing everything involved (n = 16). Some of the factors that needed to be balanced alongside environmental status or fish stocks, are relevant to all the four key themes mentioned above. These 'cross-cutting' issues are:

- transparency and availability of information
- trust in data and accountability (who takes responsibility for decisions)
- occupational health and safety including fisher well-being and mental health
- livelihood security and ethical distribution of resources and benefits, especially in terms of public/private and regional communities (including Indigenous)
- public participation and negotiation of decision making e.g. public say in proposed developments, rules and restrictions applicable to different sectors (e.g. recreational fishing, indigenous communities) and social license

Another cross-cutting issue was engagement and co-production, which were nominated as ways to build trust, reduce conflict, better capture sustainable outcomes and provide information:

> "How do you get people engaged in a decision so that they actually accept it and appreciate it? And I think the most outstanding response I got was that engagement is providing people with the facts and allowing them to make up their own minds. As opposed to having the facts and saying, that's why this is sustainable. There'll always be other elements to a discussion" (Interview 3, Industry advisor).

> "The hard part is that engagement takes an awful lot of effort and resource to actually make a difference […] engagement is a process of building long-term relationships and that's a very tricky business to attend to that there's not the immediate economic impact, […] We see the economic environmental social outcomes through the collaboration once communities have had that time to reflect and gauge and then uptake for their own community development and for their country management, so it's an extended process that may not necessarily look like it's having helped, but it informs good governance in the long-term" (Interview 12, Indigenous representative).

Trust was recognised as being hard to obtain, but nevertheless an essential, and unavoidable process for the range of actors involved in fisheries management and fisheries communication to start to develop further. It was also related to comments about social license. In response to a question about any media stories that came to mind about fisheries, 13 participants mentioned the 'supertrawler' debate as an issue which related to social license, the erosion of public trust and the conflict between big business and small local users. The case referred to by participants was the considerable public backlash in 2012–13 against a supertrawler, the *FV Margiris*, which came to catch jack mackerel along the southern shores of Australia [32,33]. The issue attracted extensive mainstream media attention and was the focus of public protest and opposition relating to concerns around sustainability and local community benefit [5,19,34,35]. As a result, the supertrawler ultimately did not begin operations.

3.3. Result 3: Sustainability now includes "everything"

Sustainability, as a concept that encompasses the effects of an activity on more than fish stocks or habitat, was a prevalent theme in the interviews. In particular, the importance of communities and people's needs and behaviour were seen to be integrally related to sustainability:

> "It is sustainability but it's finding the right balance point across the triple bottom line, so balancing the economic, social and environmental elements of a fishery, and that's on different scales as well. So, of relevance to us at the moment is how well fisheries work with our regional communities and things like this, that as well as statewide, perhaps economics and sustainability ratings" (Interview 16, Industry advisor).

> "For us, stuff like biomass isn't so much of an issue, were not so much interested in the sustainability of the stock, its more understanding that general pressure that fishing has on the marine environment, so that we can overlay that with any natural social economic values that we might have, and make some assessment about when we are trying to interpret trends, whether it's in natural values or social values" (Interview 21, Public servant).

Related to broader views of what sustainability encompasses, livelihoods and mental health were reported as key issues for the fishing industry to address:

> "We have to address mental health so that they are actually still there and that they have the capacity to adapt and take on new ideas. So

that's why I would be putting mental health right up there because you can do all the technical stuff in the world but, if people are completely and utterly depressed [there is no point]" (Interview 11, Researcher).

These factors point to an urgent need for the commercial fishing industry (and other related sectors, including aquaculture and recreational fishing) to look at ways to support fishers and communities and to decide how they want their industry to look in 10–20 years, whether they are on track to achieve that vision and who they might need to partner with in order to get there. Cultural changes may be required, e.g. "doing things differently" – fishing in different places, catching different stock at different times, sharing the marine space with more users, committing to talking about health and well-being:

"I think it is going to be really important to assist people in the industry in redefining their identity in new ways that give them more flexibility to adapt and change to things like ocean aquaculture and other activities that are coming up on the horizon, that are very different" (Interview 11, Researcher).

"I think small fishing villages are really battling. I mean, if you went through – there might have been – don't quote me on the figures but there might have been 50 or 60 or 70 co-ops in Australia, fishing co-ops in Australia, 40 years ago, there would be half a dozen now and I think there's some things ought be looked at that, how they can make it easier for these co-ops or what have you to be able to survive because it's the heart and soul of these towns" (Interview 20, Industry advisor).

"We've got people in the industry now that are getting old. And we don't have that - the new group coming through, it's very rare. And then when you get the new group coming through, they mainly want to run businesses. They don't want to get out on boats. It's very hard. Well, it's not particularly appealing to be out on a boat for a month" (Interview 17, Indigenous representative).

As one interviewee stated, the issues that the industry needs to face seem broader and more complex than ever:

"Once it was about sustainability now it's moved on – ethics, resource sharing, well-being, values. There are lots of contentious issues now" (Interview 14, eNGO).

The themes we have identified from the interview data have some implications for how the Moffat et al. [7] model can be used for the fishing industry. Overall, we found the importance of level of contact and contact quality as well as procedural fairness, were supported by our interview findings under the *Trust (and distrust)* theme. The impact of social infrastructure was not a substantive thematic component of our interviews, but this is perhaps not surprising given the marine domain we are exploring. Finally, the procedural fairness component most overlaps with our interview findings under the *Sustainability concerns and interpretations* theme concerning the need for more widely implemented ecosystem-based management, alongside new monitoring and data collection for ecological and social impacts.

4. Discussion

This investigation of the need for broad sustainability reporting, such as proposed in Australia's Healthcheck framework, revealed that trust is a key issue for the acceptance of assessment and reporting of fisheries performance, alongside values and conflict, information needs and gaps and interpretations of sustainability. Some issues of specific interest in different countries are not well captured here, such as slavery or child labour [24]. However, the four themes we identified through interviews are still likely to be relevant to fisheries sustainability assessment and reporting outside of Australia. These themes were *Trust (and distrust)*, *Sustainability concerns and interpretations*, *Conflicts and values* and *Fisheries information sources and knowledge gaps*.

Integration of a wider range of considerations in the form of more holistic performance areas and processes supporting trustworthiness of assessments into fishery management means that new tools will need be developed and new data collected.

Central to all discussions, was the need for trust built through transparency or relationships. This is highly aligned to Moffat et al.'s [7] component of 'contact quality', where quality contact needs to be two-way and involve the development of a relationship. In addition, engagement needs to be responsive and timely, so that trust can be created. As the participants noted, this is by no means an easy process but can have far reaching implications for building recognition of values commonly-held (collective values) and perceived transparency. In many cases it will require new ways of coordinating and sharing information within fisheries (i.e. between management agencies and commercial operators) and across fisheries and other partners (e.g. supply chain).

Sustainability concerns regarding social issues demonstrated that for many fisheries, it is now about more than "just the fish". Interviewees raised concerns about social issues within the remit of fishery management in relation to Indigenous access and participation, recreational and commercial interactions, livelihood security, new developments (such as the blue economy and off-shore energy) and social license. Participants noted that the industry was facing significant change, from all angles – environmental changes, social changes and governance. This high rate of change was combined with an ageing demographic of fishers, dwindling rural fishing communities and shifts toward new industries: oil, gas, tourism, energy. These issues are addressed in the substantive components of the Moffat et al. [7] trust model – effects on well-being of affected communities, and procedures for ecologically sustainable management, as components both affecting levels of trust but also directly levels of community acceptance of commercial fisheries. Our findings highlight that 'social infrastructure' may need re-interpreting for specific natural-resourced based sectors – in the case of actors involved in fisheries this may refer to impacts on the contributions they make to community wellbeing in coastal areas, for example (see Refs. [36–38]). These issues all emphasise the need for definitions of sustainability which more explicitly incorporate social well-being dimensions, ways to monitor sustainability so defined, and to work collaboratively across multiple fisheries, potentially even across multiple food sectors, and with researchers. This will improve access to information, transparency of values, objectives and decision making and ultimately transform public awareness and engagement with, and thus trust in, Australian commercial fisheries and fisheries management.

Sustainability assessment and reporting of a broader range of dimensions or performance areas comes at a time when digital technology is fast evolving and many new developments offer unprecedented access to information and potential for transparency in food production systems and fisheries. Digital tagging and tracking 'ledgers' such as bitcoin, QR codes and social media are just some of the examples of digital technology allowing possibilities for new engagement with consumers and producers [39]. However, the extent to which this new information and assessment, and the platforms through which it is shared and builds trust is still unclear. Given the challenge of measuring the fluid, contingent and dynamic nature of trust [8], assessing whether these technologies increase public trust remains challenging, especially in industries as complex and diverse as fisheries. Additional investigation is required, but based on our interview results, the demand for more trustworthy information sharing is getting stronger.

Sustainability assessment and reporting of fisheries that is more holistic in its scope also comes at a time when other international initiatives such as certification schemes and the Sustainable Development Goals (SDGs) are broadening thinking about – and responsibility for – sustainability across all sectors and countries. The SDGs are a framework established by the United Nations for improving sustainability by 2030 [40]. The goals and targets were co-produced with a range of different stakeholders and can be considered as a broadly representative and value-based synthesis of issues that are important for society. However, the goals are high level and general and many industries contribute across multiple goals, making the process of identifying specific actions and outcomes for fisheries quite difficult [41]. Nevertheless, many countries including Australia have committed to reporting on progress and to implementing the goals [42], and actors involved in fisheries will likely be expected to report more on the goals in the future (e.g. in terms of climate change). The voluntary nature of engagement with the SDGs is an opportunity for all industries to set baselines and to aim for continual improvement in data collection, transparency about implementation of actions and evaluation and learning [43]. Furthermore, some businesses may see the potential for marketing their alignment with the SDGs to demonstrate to the public their own values and commitments and as an aid to building their reputation [44]. The Healthcheck can align with the SDGs [45] but as with certification schemes and any voluntary approach, monitoring and checking individual company claims are legitimate remains a gap. The fishing industry plays an important role in achieving all of the SDGs [46] and there are many opportunities for those involved in fisheries to act towards achieving the SDGs from litter reduction to management approaches [41].

The implications of our findings are that fisheries sustainability assessment and reporting, and subsequent communication, needs to be more holistic in scope and develop strategies for information sharing that address the need for greater levels of trust in the assessment and reporting process. Reporting on broad concerns, such as safety and resource sharing, as well as being transparent about values, objectives and commitments, were all seen as important ways to build trust. As Mazur and Curtis [20] found, judgements about the social acceptability of the fishing industry are more likely to be positive if there is trust that the industry is committed to improving sustainability. Attempts by some fishing industries to improve public awareness and connection to underlying values and objectives to build this foundational awareness or relationship are demonstrated by Seafood Industry Australia's 'Our Pledge' [47], or storytelling videos raising awareness of how actors involved in fisheries are trying to improve [48]. It will, however, be difficult for any business or fishery manager to speak for all fishing activities, or for any platform to cover all ocean uses and users. This complexity and diversity are barriers to developing public trust. Increasing access to information might not be possible for some fisheries, either because the information is not available, or it is not able to be accessed. If the fishery is small, costs can prevent information being collected, or it may not be publicly released due to privacy considerations (e.g. South Australia's [49]). In the case of social data, the methods and metrics for gathering data may not yet exist or may be too costly [50]. Therefore, information is not always the answer, but it is likely to be an important part of the solution.

5. Conclusion

Interviews with 21 stakeholders showed that fishery sustainability assessment and reporting that is limited to biological and ecological elements such as stock status and environmental condition are insufficient in satisfying expectations of sustainability. Consideration of other social and cultural issues, including fisher and community livelihood and well-being, are relevant to public perceptions of fishery sustainability and important for building trust. Results of our study showed that approaches such as the Healthcheck might assist with building awareness and broaden reporting and facilitate trust. Emerging issues of transparency of ethical practices (along the supply chain), as well as the increasing need for digital data management in the future to allow for fuller reporting and accountability were identified as important for wider fishery actors to address. Holistic fishery assessment and reporting is a potential pathway for the fishing sector to foster proactive, rather than reactive, responses to sustainability issues and to make a wider range of information available to interested publics. It will also allow the industry to broaden the scope of issues they monitor and consider, building a potential foundation for future reporting and benchmarking on issues important to the public and markets (local or international), or requiring national reporting, such as the SDGs.

If Australian commercial fisheries are to be sustainable across the full suite of categories increasingly being incorporated within the concept of 'sustainability' and achieve majority levels of public trust and social acceptability more generally, new approaches to sustainability and assessment and reporting on progress to address these need to be developed. Our findings showed that trust in sustainability assessment and reporting could be increased if the scope of what is assessed was increased and if the level of transparency was increased. These insights offer one pathway for the range of actors involved in commercial fisheries to think about practical responses to increase public trust.

Declaration of competing interest

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Appendix 1. Coding hierarchy

The coding hierarchy shows how the themes are made up from the individual codes with the number of references (=the number of times coded).

Theme (number of references)	Codes (number of references)
Trust and distrust (132)	Government not trusted (2)
	Media trusted (5)
	FRDC knowledge broker (4)
	Certification is good (6)
	Certification doesn't work (4)
	Certifications are good but can be misused (8)
	Certifications are good but expensive (11)
	Labelling (9)
	Trust based on relationships (4)
	Mixed media portrayal of fisheries (14)
	Trust is hard (4)

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(*continued*)

Theme (number of references)	Codes (number of references)
	Communication issues for industry (12)
	Trust comes from impartial experts (21)
	Social media pros and cons (6)
	Difficult to get information about government decisions (3)
	Trust through transparency (19)
Sustainability concerns and interpretations (158)	Increasing demand (2)
	Gear type and use (3)
	Sustainability lost meaning (7)
	Fisheries more uncertain because out of sight (1)
	IUU fishing (2)
	Fisher viability (1)
	Changing staff a barrier (1)
	Focus on recruitment (1)
	Threatened species interaction (1)
	Balancing all aspects of sustainability (16)
	Aquaculture rising importance (4)
	Slow to embrace technology but inevitable (6)
	Health and safety and well-being (14)
	Ageing fishers – succession issue (1)
	Difference in perceptions of land and sea (1)
	People and capability focus (2)
	Community don't care about fishery management (7)
	Animal welfare (1)
	Biosecurity and disease outbreaks (8)
	Perceptions of fisheries (1)
	Lack knowledge about fisheries sustainability (3)
	Species sustainability (2)
	Consumer important (8)
	Responsibility for sustainability (34)
	Biological sustainability (7)
	Climate change (24)
Conflicts and values	Co-management (1)
	More focus on managing recruitment (2)
	Fishers need new identity (7)
	Hard to know the facts (1)
	Financing cultural change (1)
	Research caveats (1)
	A lot of research goes nowhere (7)
	Oil and gas (6)
	Recreational satisfaction surveys (1)
	Smaller fisheries need help (2)
	Describes own values (21)
	New labour sources - immigrants (2)
	Need clear objectives (6)
	Co-production and involvement important (17)
	Conflict with conservation groups (14)
	Marine parks (5)
	Indigenous issues and perspectives (22)
	Implementation and adoption hardest (3)
	Risks of Healthcheck (27)
	Consistency across fisheries difficult (5)
	Collaboration across sectors needed (4)
	Crisis examples and learnings (16)
	Resource allocation and recreational sector (32)
	Value world's best seafood (5)
Fisheries information sources and knowledge gaps	Spatial scale important (2)
	Reports still useful (2)
	International context useful (1)
	Graphics and visuals help (3)
	Gap in decision support and enterprises mapping (6)
	Have to cater to all tastes in information delivery (7)
	Get own data direct from industry (12)
	Cost of data (4)
	New industries like seaweed emerging (2)
	People want to know what seafood to eat (9)
	Clarity of audience important (13)
	App good if people use it (4)
	Examples of good information (7)
	Supports Healthcheck (12)
	Fact checking by talking to people (9)
	Internet information proliferation (good and bad) (3)
	Promote fisheries better (4)
	Areas doing well (3)
	Online best (15)
	Healthcheck is useful for managers (4)
	Healthcheck is useful for public (7)

(*continued on next page*)

(*continued*)

Theme (number of references)	Codes (number of references)
	Simplicity and clarity important (8) Link to existing assessments (1) Would use a Healthcheck (22) Biological information prominent (9) Information for social and economic (5) Uses literature (1) Gap in social and economic information (19) Rating of own fisheries knowledge (18) Doesn't look for information (1) Can't simplify the complexity (1) Hard for public to access information (13)

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.marpol.2019.103719.

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FRDC FINAL REPORT CHECKLIST

Project Title:	Healthcheck Phase 2		
Principal Investigators:	Alistair Hobday		
Project Number:	2016/060		
Description:	The Healthcheck comprises a framework, guidance document, and data compilation providing summary data to transparently, independently and comprehensively support reporting on a broad range of sustainability issues relevant to Australian fisheries. These data can be used by a wide range of stakeholders to understand sustainability issues and reuse in other formats.		
Published Date:	09/APR/2019	**Year:**	2019
ISBN:	978-1-4863-1241-2 online	**ISSN:**	
Key Words:	assessment, sustainability, Australian seafood, indicators, Eco-certification		

Please use this checklist to self-assess your report before submitting to FRDC. Checklist should accompany the report.

	Is it included (Y/N)	**Comments**
Foreword (optional)	N	
Acknowledgments	Y	
Abbreviations	N	
Executive Summary		
- **What the report is about**	Y	
- **Background – why project was undertaken**	Y	
- **Aims/objectives – what you wanted to achieve at the beginning**	Y	
- **Methodology – outline how you did the project**	Y	
- **Results/key findings – this should outline what you found or key results**	Y	
- **Implications for relevant stakeholders**	Y	
- **Recommendations**	Y	
Introduction	Y	
Objectives	Y	
Methods	Y	
Results	Y	
Discussion	Y	
Conclusion	Y	
Implications	Y	
Recommendations	Y	
Further development	Y	
Extension and Adoption	Y	
Project coverage	N	
Glossary	N	

Project materials developed	Y	
Appendices	Y	