Australia's First National Bycatch Report

Steven J Kennelly

IC Independent Consulting

ISBN: 978-0-6488217-0-0

Table of Contents

Summary

Bycatch (non-targeted organisms that are unintentionally caught when fishing) remains one of the most important issues in the world's fisheries. Discards (the component of bycatch that is thrown away, dead or alive) are considered the most important component of bycatch because they represent a perceived wastage of seafood resources, involve interactions with Threatened, Endangered and Protected species (TEPS), and attract significant interest from many stakeholders including other fisheries, conservation groups, third party certifications, stock assessment scientists and the general public. There is now growing acceptance and international, regional and national agreements and instruments that encourage and/or require governments to report on the status of bycatches. And there have been several efforts to do so including FAO's three decadal global reports (www.fao.org/3/t4890e/T4890E00.htm; www.fao.org/3/y5936e/y5936e00.htm; www.fao.org/3/CA2905EN/ca2905en.pdf) and the United States' National Bycatch Reporting process (www.fisheries.noaa.gov/resource/document/national-bycatch-report).

This report constitutes Australia's first national attempt to report on bycatch from its commercial fisheries. It is the result of the application of the following 5-step methodology:

1. Identify all individual fisheries (and the fishing methods used in them) for each jurisdiction and the annual landings for each. Express these data as averages with associated standard errors (SEs).
2. Gather all available papers, reports and datasets on fisheries discards and TEPS interactions in each jurisdiction. From these, derive retained:discard ratios for each fishery/method and express these as averages (if multiple ratios exist) with associated SEs.
3. For those fisheries/methods that lack ratios in Step 2, identify and include any substitute ratios from similar fisheries/methods from other jurisdictions.
4. Multiply the average ratios from Steps 2 and 3 by the average landings data from Step 1 to obtain total estimated annual discards for each fishery/method and add these together to get jurisdictional totals with appropriate SEs.
5. Apply the steps in the USA's Tier Classification Scheme (www.fisheries.noaa.gov/resource/document/national-bycatch-report) for estimating the quality of the bycatch information for each fishery/method, weighted by the estimated level of discards for each.

This study required many assumptions when extrapolating the limited number of empirically derived discard ratios by total retained catches to obtain estimates for individual fisheries, methods and jurisdictions. In these circumstances, surrogate ratios from other, similar fisheries/methods from the same or other jurisdictions had to be used - an unavoidable problem for those fisheries/methods where there are no observer data or other ways to estimate discards.

Notwithstanding these shortfalls, the results delivered three new pieces of information about Australia's commercial fisheries during the decade 2010-19: (i) estimates of discards by fishery,

method, jurisdiction and nationally; (ii) a summary of information about fisheries' interactions with TEPS; and (iii) estimates of the quality of the information used to generate (i) and (ii).

The quantity and quality of discard ratios available enabled a reasonably robust estimate of the level of discards occurring throughout Australia's 8 fisheries jurisdictions. Overall, during the last decade, Australia's commercial fisheries were estimated to have annually discarded 37.6% (SE 4.3%) of what was caught or 92,368t (SE 10,661t). Whilst this rate is quite high compared to, for example, the 17% for the USA's federal fisheries, it is significantly less than the 55.3% estimated for Australia by FAO's 2nd global decadal report and similar to the 39.8% in FAO's most recent database. This suggests that, over the past 20 years, Australia's commercial fisheries have significantly reduced their discards – although, the latest estimate of 37.6% still leaves room for improvement.

The data showed that 71.2% of all discards in Australia's commercial fisheries came from just 9 fisheries/methods with the remaining 298 fisheries/methods contributing only 28.8%. Clearly, effort to reduce discards further in Australia should focus on the former 9 fisheries/methods and in particular the Queensland East Coast Prawn Trawl fishery which alone contributed 27.1% of all of Australia's discards. Of the other 8 highest discarding fisheries/methods, 5 are also trawl fisheries - the Commonwealth's Northern Prawn and Southeast Trawl fisheries, and NSW's and South Australia's Prawn Trawl fisheries – an expected result as prawn trawling is well-known as the least selective fishing method in the world. A significant amount of research has occurred (particularly in Australia) to modify these methods so that they fish more selectively but our results suggest that there remains work to be done in this area - especially in the implementation of already developed technologies.

Two other high discarding discarding fisheries were the Western Australian and Tasmanian Rock Lobster fisheries - perhaps the most surprising result from this study. Most would consider lobster trapping as a reasonably selective method yet this study estimated that 47.6% and 77.9% of catches are discarded in these 2 fisheries, respectively. But it is important to note that most of these discards are undersize (and/or berried female) lobsters – which are required by regulations to be released and are believed to have very high survival rates after discarding - so the actual impact of such discarding on populations is likely to be minimal.

In addition to the above observations, additional findings worth noting for each jurisdiction include: (i) the many discard ratios available for NSW are quite old suggesting that updated observer programmes are warranted; (ii) a lack of access to Queensland's observer database required many assumptions and surrogates to be used for this state; (iii) the Northern Territory showed the lowest levels of discarding of all of Australia's jurisdictions - just 14.6%; (iv) Victoria's information led to a significant underestimate of discarding due to confidentiality restrictions precluding the apportionment of discard ratios to a large part of the catch; (v) the majority of fisheries/methods in Western and South Australia showed few discards due to a combination of the relatively low total landings of many fisheries/methods and the use of quite benign methods (eg. hand-gathering, spears, nooses, etc.) in some; (vi) most of Western Australia's discards

(62.4%) came from just two fisheries (Western Rock Lobster – 46.4% and Shark Bay Prawn Trawl - 16%); and (vii) Australia's Commonwealth fisheries had the best discard data of all Australia's jurisdictions due to the availability of information from AFMA's long-running observer (and more recent) Electronic Monitoring (EM) programmes. The results showed the dominant contribution to discards in Commonwealth fisheries was by the Northern Prawn fishery (50.2% of the total) with estimates for most other fisheries being quite low.

The Commonwealth's data on discards also allowed a comparison that indicated that fishers' logbook information under-estimated levels of general discards (as estimated from observer data) by 89.7% - confirming the often-stated but rarely-proven assertion that self-reported information about discards do not always reflect true levels.

Whilst this study produced reasonable estimates of general discards for most fisheries and methods in Australia, the same cannot be said for interactions with TEPS. This was because: (i) such species are, by their very nature, rare, so interactions between them and commercial fisheries are also rare and sporadic; and (ii) fishers' willingness to self-report such interactions can be influenced by the controversy that such interactions may incur. As a result, we were unable to provide any sort of annual estimates of these interactions for almost all jurisdictions.

The exception to this was the very good information available from Australia's Commonwealth observer programmes which permitted extrapolations about TEPS interactions to a fishery level. The results showed that 106 TEPS were recorded by observers over a 9 year period at an average of 37,616 interactions per year (with 61.7% animals released alive). And the largest number of these interactions occurred in trawl fisheries with the Northern Prawn fishery recording by far the most (52% of all interactions) – the majority of which involved sea snakes (with 65.3% released alive).

The Commonwealth's data on TEPS interactions also allowed a comparison that showed that fishers' logbook information under-estimated TEPS interactions (as estimated by observer data) by 60.4% - much better than the under-reporting rate for general discards seen above. Further, this situation has improved in some Commonwealth fisheries in recent years due to the implementation of an EM programme.

Whilst the poor information about TEPS interactions in Australia's 7 states and territories precluded the calculation of annual estimates, it is important to note that these jurisdictions are far from being alone in this regard. This is a common problem throughout the world, even for jurisdictions that run observer programmes for the express purpose of providing information about TEPS interactions. One solution is to increase sample sizes to such levels that variances are reduced to acceptable levels. But such programmes are very expensive and possibly unnecessary in Australia, given the relative number of TEPS interactions that, intuitively, our fisheries may have. However, Electronic Monitoring (EM) of fisheries using cameras is offering solutions to this

issue by auditing (and so improving) self-reported data about such interactions in fishers' logbooks (shown here for 2 of Australia's Commonwealth fisheries).

The application of the USA's Tier Classification system for scoring the quality of bycatch information to Australia's data yielded quite reasonable quality scores for general discards across most jurisdictions, with an average weighted national score of 57.6%. The best performing jurisdiction was the Commonwealth (69.9%) – due to its long-running and quite comprehensive observer and (more recent) EM programmes. Jurisdictions with at least some observer data (especially those that cover high discarding fisheries/methods) also scored well (NSW, Northern Territory, Tasmania and Queensland) whilst Victoria, South Australia and Western Australia scored the lowest due to their scarcity of observer data and the need to substitute many surrogate rates from other fisheries/methods/jurisdictions. For TEPS interactions, quality scores were far worse - a national average score of just 10.8%. The exception was for Commonwealth fisheries with a score of 49% – again due to the observer and recent EM programmes. An important use of these quality metrics is in providing a baseline measure against which future metrics can be compared to allow one to gauge improvements (or diminishments) in information about bycatch. And they also allow one to identify priorities for future bycatch monitoring programmes - which would ideally focus on the higher discarding fisheries identified in this study.

In providing the above information, this report has yielded: (i) a baseline to be used by Australia's jurisdictions in the future to track performance in managing discards, TEPS interactions and the quality of bycatch information; (ii) the identification of key gaps in information where future work to monitor and reduce discards should focus; and (iii) a methodology that may be used by other countries and jurisdictions to estimate and report on bycatch to various entities and processes including stock assessments, Ecosystem-based Fisheries Management initiatives, FAO's Code of Conduct for Responsible Fisheries, assessments by eco-labelling organisations, the EU's Common Fisheries Policy and its Landing Obligation, as well as the most important stakeholders of all – the perpetual owners of all fisheries discards and TEPS – the general public.

Introduction

Bycatch was once said to be the fisheries issue of the 1990's. Yet it still dominates fisheries management, policy and science, being a major component of Ecosystem-based Fisheries Management, the United Nations Food and Agriculture Organization's (FAO) Ecosystem Approach to Fisheries Management and Code of Conduct, stock assessments, fisheries assessments by eco-labelling organisations, the European Union's (EU) Common Fisheries Policy, its Landing Obligation, and a host of state, national, regional and global instruments.

Justinian the Great (Emperor of Rome) in 533 CE defines public resources as "*Et quiden naturali jure communia sunt omnia haec, aer, aqua profundus, et mare et per hoc litorra maris*" or "By natural law they are goods common to all these things: the air, running waters, the sea, and, consequently, the marine shores" (Justinian, 533). So the general public own fisheries resources – at least up to the point where they are retained for sale or consumption by fishers. And for millennia (as far back as the Chin Dynasty 249-207 BCE, Justinian the Great, 533, and the Magna Carta, 1215), the basic form of the "Public Trust Doctrine ……. obliges governments to manage common natural resources in the best interests of their citizens, the beneficiaries of the trust". Whilst fisheries jurisdictions have long recognised the need to report to its public and other stakeholders regarding the status of exploited stocks, there is growing acceptance that governments also need to report on the status of bycatches and, in particular, discards. This is because, for discarded fish, public ownership is perpetual, ie. the public own all discarded fish, all the time. So governments (who are given the task of managing this property on behalf of that public) are expected to undertake those activities expected of anyone who is responsible for someone else's property: its stewardship, management, monitoring and reporting (FAO, 2015).

In recent years, the importance of bycatch monitoring and reporting has been recognised in a variety of international agreements, guidelines and policies, such as FAO's International Guidelines on Bycatch Management and Reduction of Discards and the EU's Common Fisheries Policy. But reporting on bycatches, and consolidating such reporting into jurisdictional summaries, is very different from reporting on landed catches because: (i) it is far more difficult to obtain bycatch data (usually by using quite expensive observer programmes and/or, in recent times, EM camera technology); and (ii) because of its scarcity, reporting on such data requires significant assumptions and extrapolations.

There have been, however, several efforts to consolidate reporting on bycatch including FAO's decadal global reports in 1994, 2005 and 2019 (Alverson et al, 1994; Kelleher, 2005; Pérez Roda, et al., 2019). And UN member countries have agreed via their endorsement of the FAO Guidelines on Bycatch Management and Reduction of Discards (FAO, 2011) to also report on bycatches and discards for their own jurisdiction(s). The United States was the first nation to do so via their very comprehensive National Bycatch Reporting process (NMFS, 2011).

The only nationally consolidated estimates of bycatch for Australia are those contained in FAO's two most recent decadal reports. Kelleher (2005) estimated that Australia's commercial fisheries discard more than they retain (i.e. 55.3%) whilst Pérez Roda, et al.'s (2019) database provided an

estimate of 39.8%. Such figures may surprise many (including fishing industries, environmental groups and those concerned with seafood security) and has the potential to adversely affect Australia's well-earned brand as a responsible fisheries management nation. But these estimates are problematic as they incorporated very few empirical estimates of discards from Australia's fisheries.

This document constitutes the first attempt to exhaustively obtain, estimate and report bycatches for all Australia's commercial fisheries and also estimate the quality of the data used to make such estimates. In so doing, this report provides a means to allow comparisons among Australia's jurisdictions regarding their bycatch management and estimation as well as against estimates from other countries and global averages. It also provides a first benchmark that can be compared to future estimates which will allow the public and other stakeholders to track improvements (or declines) in Australia's bycatch management and estimation.

Scope and Definitions

It is important in any study about bycatch to establish (quite early) its scope and definitions - to set the boundaries around what is being described. In terms of scope, this study examines the marine commercial marine fisheries across all 8 of Australia's fisheries' jurisdictions (New South Wales, Tasmania, Northern Territory, Queensland, Victoria, South Australia, Western Australia and the Commonwealth). It is anticipated that, in time, recreational, traditional and freshwater fisheries will be examined and their bycatches reported but, for the time-being, we concentrate on the commercial fisheries of Australia because, like elsewhere in the world, these have the most information available. In addition, because bycatch issues are always related to the particular fishing method(s) used in a fishery, this study reports on each fishing method used in each commercial fishery in each jurisdiction.

Regarding definitions about bycatch, it is important to identify the meaning of particular terms like "bycatch", "discards" and "by-product". There has been significant difficulty throughout the world in settling on a robust and standard definition of "bycatch" which may, depending on one's jurisdiction, include: discards, threatened, endangered or protected species (TEPS), retained and/or sold "by-product" species, juveniles, trash fish, pre-catch losses, slipped fish, fish released due to high-grading, mortalities due to ghost fishing, offal, discarded fish heads and frames, parts of sharks, and even broader ecosystem and habitat impacts of fishing (FAO, 2015). Notwithstanding this variety of definitions, the most commonly used definitions tend to settle on **"bycatch" being the non-targeted organisms that are unintentionally caught when fishing for particular species (or sizes of species)**. This bycatch is then most commonly divided into those non-target organisms that are kept and eaten/sold ("landed bycatch" or "by-product") and "discards" which are those organisms thrown back into the sea. The latter may be dead or alive.

It is this latter subset of bycatch (discards) which is the usual focus of projects such as this one, because it is this subset that represents a perceived wastage of resources, includes TEPS, attracts significant controversy, and is of interest to many stakeholders including stock assessment

scientists, interacting fisheries, eco-labelling organisations, conservation groups and the general public. Consequently, most studies that report on bycatch tend to report on discards (as is the case for FAO's decadal reports and the US National Bycatch Report). This present project, therefore, focuses on discards as the key component of bycatch to report on, meaning that this document does not report on items like the landings of byproduct, pre-catch losses, offal, fish frames/heads/etc, ghost fishing, ecosystem or habitat effects of fishing, and other aspects of fishing that sometimes find their way into jurisdictions' definitions of bycatch.

In terms of reporting by weights or numbers of organisms, again there is an international norm that is becoming commonplace in the bycatch field (eg. Kelleher, 2005; NMFS, 2011, Pérez Roda, et al., 2019) – where bycatches are usually expressed as weights for most organisms (i.e. general discards), but for TEPS, it is usual to report on interactions in terms of numbers of individuals. In this project, we adhere to this practice.

Methods

Ways to Estimate Bycatch

The key variables used when quantifying bycatch are fishery/method-specific ratios that are derived from data that may be collected using a variety of methods. These methods are described in Kennelly (2015) and are summarised here:

- Research vessels have been used to quantify bycatch (particularly early in the history of bycatch monitoring) but this relies on them being able to mimic normal commercial fishing operations.
- Compliance or control inspections have been used - where vessels are boarded, and catches examined whilst at sea.
- Post-trip interviews of captains and crews are also used and, whilst such techniques can be inexpensive, the data collected on problematic (or controversial) discards (including TEPS) are considered to be less reliable than other methods. It is worth noting, however, that the accuracy of such information has been improved in recent times when used in conjunction with Electronic Monitoring using cameras (EM) as an audit tool.
- Monitoring landed catches is considered an accurate way to quantify landed bycatch (byproduct) at low cost but does not quantify discards.
- Fishers' self-reporting data on bycatch and discards is used in many fisheries. This involves fishers completing logbooks and, more recently, recording information on laptops, phone and tablet apps which can be sent to scientists and managers in close-to real-time. However, like post-trip interviews, such data are considered less than accurate, particularly for the bycatch of problematic or controversial species, although, as mentioned above, EM auditing is improving this accuracy.
- Study fleets are also used – where particular, "trusted" captains and crews record data which are taken to be representative of the whole fleet.

- It is well-accepted that by far the most reliable and accurate way to collect bycatch information is through the use of onboard observer programmes. These involve scientifically trained staff going out on normal fishing operations and recording all relevant data. Many such programmes exist throughout the world and, in the past few decades, they have become a major, mainstream source of fisheries information for many uses – particularly for estimating bycatch. However, such programmes are relatively expensive – especially in smaller scale fisheries.
- In more recent years, significant developments have occurred in the use of onboard camera technology to replace human observers for the collection of certain types of bycatch data and (as mentioned above), as a means to audit industry-reported data. Many trials of EM technology have been completed throughout the world with several fisheries now adopting it as the main way such data are collected.

Bycatch Ratios for Extrapolations

Once estimates of bycatch have been obtained using one or more of the above method(s), estimates of bycatches by whole fisheries are then usually made using one of two extrapolation methods (see also Andrew and Pepperell, 1992; Kennelly, 1993; Kennelly et al, 1998; Kelleher, 2005; Pérez Roda, et al., 2019):

- The "retained:bycatch ratio" method uses the known total landings from a fishery to extrapolate observed mean bycatch ratios up to annual estimates for whole fleets. This is the most commonly used method because data on total retained catches by fisheries are usually available.
- Alternatively, the "fishing effort:bycatch ratio" method uses the known total effort in a fishery to extrapolate mean bycatches observed over some unit of effort (like a day's fishing, a trip, a tow, a trap's soak time, etc.) to estimates for whole fleets. This method is not as commonly used as the retained:bycatch ratio because fishing effort is not as commonly reported as landings data and, where it is, the units involved vary by gear type (eg. tows for trawls, soak hours/days for traps, numbers of sets for longlines, etc.), making the calculation of total bycatches complex and method-specific. In addition, it is also known that reports of landed catches are more accurate than fishing effort because fishers (and compliance officers) are able to check and verify landings records against sales receipts, weigh-ins, etc., whereas records of the various units associated with fishing effort have fewer opportunities for verification.

However, it is important to note that incidences of bycatches in catches are often not correlated to the levels of retained (or targeted) catch, but are more likely to be correlated with fishing effort. Because of this, it is generally accepted that extrapolating estimates of bycatches is more accurately done using fishing effort multipliers (when they are, albeit rarely, available) than by using total catches (see FAO, 2015; Kennelly, 2015). Notwithstanding this, it is also well accepted, and indeed, has become the norm, to report bycatches as a percentage of total retained catch. This is because, in addition to the above-mentioned problems with effort-based reporting,

stakeholders (that include fisheries managers, conservation bodies, interacting fisheries and the public) usually wish to know about the quantities of bycatch relative to landings when assessing the impacts of a fishery compared to its provision of seafood. In this study, some fishing effort data was available for a few of the jurisdictions examined (NSW, Queensland and the Commonwealth). But because of the reasons outlined above, and to maintain consistency with other jurisdictions and international norms, we use the retained:bycatch ratio method and the total known landings from fisheries/methods to extrapolate discard ratios to fisheries and jurisdictions.

Measurements of Error

When calculating extrapolations, it is desirable to try to include some estimate of the variances (or confidence limits) around one's estimates. However, whilst multiplying up average bycatch rates by average landings is relatively straightforward, deriving accurate estimates of variances around such extrapolations is more difficult. This is because of several factors:

(i) Variances around bycatch estimates are often not provided.
(ii) Where variances are provided, significant assumptions are required to apply them throughout the whole spatial or temporal scale(s) of one's extrapolation(s) for the particular fishery or fishing method under consideration.
(iii) Significant assumptions are also required when one is forced to substitute bycatch ratios (and their variances) from particular fisheries/methods to others that lack estimates (eg. due to there being no direct estimates from an observer program).
(iv) Finally, in virtually all cases where bycatch estimates have been provided with confidence limits, such limits are mostly ignored by end-users, who tend to only focus on the average estimates provided.

However, in situations where several bycatch estimation studies have been done, it is possible to consider one's collection of bycatch estimates as replicate samples of the possible population of bycatch estimates throughout a fishery, method or jurisdiction, allowing one to calculate variances for the averages derived. This technique was used by Kelleher (2005) in his FAO global discard report and is the technique used in the present study where such "replicate" ratios are available. Thus, any variances shown in this study derive from the population of bycatch ratios collected from replicate individual studies - they do not reflect the internal variance of individual records within those studies.

Quality/Performance Metrics

In providing a national bycatch report for Australia, it is important to try to include some way of identifying the quality of the estimates and extrapolations used, against which future reports may measure whether such things are improving (or declining) over time. In doing so, it would be remiss not to consider the quite sophisticated quality/performance measures and tracking tools developed in the USA's National Bycatch Report process (NMFS, 2011). Of particular interest here is the Tier Classification System which assists the US's National Marine Fisheries Service to track how they are improving the effectiveness and accuracy of their bycatch monitoring programmes,

and the success (or otherwise) of their bycatch reduction programmes. This system provides a measure of the relative quality of bycatch estimates via a detailed and prescriptive allocation of point scores (maximum score of 73) against set criteria using a series of guidelines (see Table 3.1 in NMFS, 2011). The criteria assess many aspects of the data collected including programme design, longevity, coverages, availability of "expansion factors" (used to extrapolate estimates to whole fisheries/jurisdictions), data collection biases, dataset management systems, analyses etc. The sophistication of the system reflects the large number and diversity of observer programmes in the US and the corresponding resources provided by the US government to run them. One interesting point in this system is the very heavy weighting assigned to observer data (a maximum of 33 points) compared to industry-gathered data (a maximum of 2 points), illustrating the relative value that NMFS places on the accuracy of these two sources.

Once scored using the system, each region, bycatch category, stock and fishery is then placed into 5 tiers based on the scores as follows (Table 1):

Table 1 - Tier Descriptions used in the US system

Tier	Score	Description
4	66-73	Bycatch estimates were available and were based on the highest-quality data and analytical methods.
3	49-65	Bycatch estimates were also generally available but higher quality data (i.e., data that are more reliable, accurate, and/or precise than those used in lower tiers) were utilised to compute these estimates.
2	32-48	Bycatch estimates were generally available. However, these estimates would have benefited from improvements in data quality and/or analytical methods (such as improved sampling designs, increased coverage levels, and peer review of methods). Where by-catch estimates were not available, methods are being developed.
1	1-31	Bycatch data were available but were generally unreliable (e.g., from unverified or potentially biased sources). In some cases, higher quality data were available but analytical methods had not been implemented.
0	0	Bycatch data-collection programmes or estimation methods did not exist and, therefore, bycatch estimates were not available.

This current study adopted the above US Tier Classification System and scored the quality of information used to derive estimates of general discards and TEPS interactions for all commercial fisheries/methods in Australia. In addition to providing a means to compare these quality metrics with those of the US, this application also provides a benchmark against which future reports may track improvements (or declines) in such metrics over time.

Methodology to Estimate Discards

Taking account of the above issues, a former study (Kennelly, 2018) developed a methodology by which jurisdictions can estimate and report on the quantities of discards from their commercial fisheries. This involves a series of 5 quite simple steps which are applied throughout the rest of this report:

1. Identify all individual fisheries (and the fishing methods used in them) for each jurisdiction and the annual landings for each. Express these data as averages with associated standard errors (SEs).
2. Gather all available papers, reports and datasets on fisheries discards and TEPS interactions in each jurisdiction. From these, derive retained:discard ratios for each fishery/method and express these as averages (if multiple ratios exist) with associated SEs.
3. For those fisheries/methods that lack ratios in Step 2, identify and include any substitute ratios from similar fisheries/methods from other jurisdictions.
4. Multiply the average ratios from Steps 2 and 3 by the average landings data from Step 1 to obtain total estimated annual discards for each fishery/method and add these together to get jurisdictional totals. Use Goodman's (1960) formula for calculating the product of variances to derive the appropriate SEs.
5. Apply the steps in the USA's Tier Classification Scheme for estimating the quality of the discard information for each fishery/method, weighted by the estimated level of discards for each.

Identification of Fisheries, Fishing Methods and Landings

The first step in estimating discards for a jurisdiction and its component fisheries is to identify the individual fisheries and fishing methods operating in each. This is because, as in all bycatch estimation projects (eg. Kelleher, 2005; NMFS, 2011; Kennelly, 2018; Pérez Roda et al., 2019), it is important to partition discard rates and total catches according to fishing method: the former (discard rates by method) is needed because different methods have intrinsically different levels of discards; and the latter (catches by method) is needed as the way to extrapolate discard rates to the whole fishery and, eventually, the jurisdiction. Taking each of Australia's fisheries jurisdictions in turn:

For **NSW** and **Tasmania**, the NSW Department of Primary Industries and University of Tasmania provided annual records of reported landings for each fishing method in each of their commercial fisheries from 2009-14 and 2010-15, respectively.

NT Fisheries provided all landings data for the commercial fisheries of the **Northern Territory** from 2012-2016. Two minor adjustments were required to the NT data - 2012 landings from the Finfish Trawl fishery were combined into the Demersal fishery due to the merging of these fisheries and data for the Restricted Bait fishery includes data from the bait net fishery in 2012 and 2015.

The Department of Agriculture and Fisheries in Queensland has a publicly available, easy-to-use, web-based system for reporting on the catch and effort in its fisheries. Average annual retained catches in **Queensland**'s commercial fisheries were obtained from 2010/11 to 2014/15. These data were adjusted in the following ways: (i) we assumed an average weight of 500g per oyster in the East Coast Pearl fishery and 250g per fish for the marine Aquarium Fish fishery; (ii) we combined data for adult and juvenile eels in the Eel fishery; and (iii) the East Coast Otter Trawl fishery includes data for the much smaller Fin Fish (Stout Whiting) Trawl sector.

The landings data for **Victoria**'s commercial fisheries (obtained from the Victorian Fisheries Authority for the years 2012-18) were very incomplete due to confidentiality restrictions precluding the provision of data in strata with less than 5 operators (a particular issue in Victoria's relatively small commercial fisheries). This meant that information regarding 41.5% of total landings were not able to be provided. Catches from individual methods were not provided for several fisheries which required 4 adjustments to the data that was provided: (i) catches from unidentified methods in a fishery were apportioned to the identified methods in that fishery proportionately, assuming that unidentified catches were mostly due to fishers not assigning catches to existing methods and no different methods were used; (ii) because discard rates were only available for the categories of "haul seines" and "mesh nets", data for the individual types of these gears were combined into these categories; (iii) unspecified Trawl (inshore) catches were assumed to be Prawn Trawl catches and combined into that category; and (iv) fisheries classifications for which there were virtually no landings data were removed (ie. Fish Trawl, Gippsland Lakes (Bait) Crab Trap/Pot and Shrimp Dredge, Westernport/Port Phillip Bay Octopus Trap/Pot, General (Eels), Banded Morwong, General (Commercial), Purse Seine (Ocean), Purse Seine (Port Phillip Bay), Noxious Aquatic Species, Snowy River (Bait), Sydenham Inlet (Bait), Scallop (Ocean), Fish Receivers' (Scallop), Mallacoota Lower Lake (Bait), Scallop Dive (PPB) and General (Research)).

Western Australia has the largest number of individual marine commercial fisheries of any jurisdiction in Australia. Annual landings data for most fisheries and fishing methods were provided by WA Fisheries for the years 2010 to 2018. However, some fisheries/methods recorded no landings during that period or their data were unavailable due to confidentiality reasons (ie. for fisheries/methods with 3 or fewer operators). Removing these fisheries/methods meant that 94% of total landings were included in this study.

Primary Industries and Regions South Australia (PIRSA) provided annual landings data for most commercial fisheries in **South Australia** from 2010/11 to 2016/17. Data for one fishery/method with 5 or fewer operators was not included (ie the West Coast Prawn sector) which represented an unknown, but probably small amount of catch.

Annual landings data for all **Commonwealth** fisheries were provided for all years between 2010-18 by the Australian Fisheries Management Authority (AFMA). Three relatively minor adjustments were made to these data so as to match discard estimates available from AFMA's observer database. These were: (i) combining data listed as coming from the Commonwealth Trawl fishery with those from the South East Trawl fishery (due to a name change); (ii) combining data across the various prawn trawl methods listed for the North West Slope and Torres Strait Prawn fisheries (again due to naming differences); and (iii) due to the differential targeting and discard rates associated with Banana Prawn (*Penaeus merguiensis*) trawling and Tiger Prawn (*Penaeus esculentus*) trawling in the Northern Prawn fishery, we partitioned catches for this fishery accordingly.

The landings information shown in Table 2 identified the 136 marine commercial fisheries and 307 fishing methods occurring throughout Australia during the past decade, with their annual average landings (and SE's) - as provided by each jurisdiction. These data were used as the basis for subsequent extrapolations of discard ratios done later in this report.

Table 2 - Mean (and SE) of annual retained landings from each method used in each of Australia's marine commercial fisheries, during the decade 2010-2019. If only 1 record was available, no SE is given.

	Fishery	**Method**	**Mean Landings (t)**	**SE**
New South Wales	Estuary General	Meshing net	2024.02	48.43
		Hauling net (general purpose)	948.35	132.90
		Prawn net (set pocket)	157.84	24.84
		Crab trap	111.28	11.10
		Fish trap (bottom/demersal)	105.24	18.55
		Flathead net	91.35	10.31
		Eel trap	76.16	5.38
		Prawn net (hauling)	73.75	6.09
		Handgathering for pipis and beachworms	73.60	14.41
		Prawn running net	53.01	4.81
		Seine net (prawns)	44.52	5.14
		Bait net	19.03	4.87
		Garfish net (bullringing)	18.45	4.56
		Handline	13.69	1.81
		Pilchard, anchovy and bait net - beach based	6.59	1.08
		Setline	3.58	0.63
		Dip or scoop net (prawns)	0.50	
		Hoop or lift net	0.29	0.10
	Estuary Prawn Trawl	Otter trawl net (prawns)	387.14	36.88
	Ocean Trawl	Otter trawl net (prawns)	1728.41	98.32
		Otter trawl net (fish)	1253.93	90.15
	Ocean Hauling	Hauling net (general purpose)	2382.16	162.68
		Purse seine net	1780.64	291.51
		Pilchard, anchovy and bait net - beach based	56.87	11.34
		Garfish net (hauling) - boat based	34.10	7.59
		Garfish net (hauling) - beach based	7.40	3.15
	Ocean Trap and Line	Fish trap (bottom/demersal)	594.51	37.68
		Handline	410.78	29.22
		Trolling	173.17	31.39
		Setline (demersal)	135.75	6.23

		Spanner crab net	111.00	12.08
		Jigging	87.09	9.73
		Dropline	72.46	13.67
		Setline	52.15	8.50
		Poling	45.28	15.57
		Trotline (bottom set)	28.06	9.43
		Driftline	16.61	7.81
	Abalone	Diving	105.77	9.78
	Lobster	Trapping	150.38	3.87
	Others	Danish seine trawl net (fish)	182.60	33.23
		Pilchard, anchovy and bait net - boat based	3.50	1.54
		Skindiving	1.63	0.94
	Special Permits	Purse seine net	93.50	19.44
		Scallop Dredge	13.48	1.28
		Submersible Lift Net	11.02	3.69
		Eel trap	5.98	0.95
Tasmania	Abalone	Dive	2139.8	124.5
	Southern Rock Lobster	Pots	1126.7	52.6
	Scallop	Dredge	677.9	185.7
	Octopus	Pots (unbaited)	79.5	14.3
	Giant Crab	Pots	29.4	2.8
	Scalefish	Automatic squid jig	251	183.6
		Beach seine	243.7	62.2
		Purse seine	239.6	198.6
		Graball net	105.9	5.8
		Hand line	81	2.8
		Danish seine	70.5	8.7
		Squid-jig	51.4	3.9
		Dip-net	19.3	1.5
		Small mesh net	11	1.7
		Troll	8.8	1.5
		Fish trap	8.5	0.4
		Drop-line	5.2	1
		Spear	4.2	0.3
		Hand collection	2.7	0.8
	Commercial Dive and Shellfish	Hand Collection	42.9	4.6
Northern Territory	Demersal	Trap, handline, dropline, demersal trawl	2453.17	197.26
	Timor Reef	Trap, handline, dropline, demersal trawl, longline	722.93	35.60
	Barramundi	Gillnet	718.01	123.15
	Offshore Net and Line	Gillnet, longline	613.58	158.81
	Spanish Mackerel	Troll, baited line	255.23	34.11
	Mud Crab	Pot and baited gillnet	224.16	50.39
	Coastal line	Hook and line	111.88	8.36

	Trepang	Hand gathering	51.56	13.11
	Restricted Bait	Bait net	31.44	7.03
	Aquarium Display	Hand gathering	10.21	2.16
	Coastal net	Gillnet	6.53	1.54
Queensland	Coral	Hand harvest	88.40	6.39
	Crayfish and Rocklobster	Hand harvest	153.40	11.93
	East Coast Pearl	Hand harvest	0.05	0.04
	Marine Aquarium Fish	Hand harvest	32.10	2.73
	Eel Fishery	Fyke and other nets	19.00	3.74
	Sea Cucumber Fishery (East Coast)	Hand harvest	346.20	12.83
	Trochus	Hand harvest	7.40	4.15
	Coral Reef Finfish	Hook and line	1388.80	33.05
	Deep Water Finfish	Hook and line	3.00	1.48
	East Coast Spanish Mackerel	Hook and line	300.20	15.47
	Gulf of Carpentaria Line	Hook and line	194.80	16.16
	Rocky Reef Finfish	Hook and line	142.40	8.81
	East Coast Inshore Finfish Fishery	Nets	4598.60	84.09
	Gulf of Carpentaria Inshore Finfish	Nets	1952.60	219.92
	Blue Swimmer Crab	Crab traps	361.60	12.27
	Mud Crabs	Crab traps	1357.20	50.02
	Spanner Crabs	Spanner crab net	1086.80	66.35
	East Coast Otter Trawl	Trawl	7482.00	259.20
	Gulf of Carpentaria Developmental Fin Fish Trawl	Trawl	187.60	115.93
	River and Inshore Beam Trawl	Trawl	223.80	25.89
Victoria	Abalone	Dive	739.1	13.4
	Rock Lobster	Pots	319.4	5.1
	Ocean (General)	Drop Line	3.1	1.7
		Hand Line	87.0	7.8
		Shark Long Line	10.1	3.0
		Snapper Long Line	4.3	1.2
		Octopus Trap/Pot	7.6	7.6
	Westernport/Port Phillip Bay	Haul Seine	226.4	28.4
		Multifilament Mesh	71.6	19.2
		Snapper Long Line	100.9	15.7
		Purse Seine	107.9	52.0
		Garfish Seine	12.6	6.8
	Corner Inlet	Ringing Seine	176.7	8.2
		Multifilament Mesh	91.2	10.2
		Haul Seine	42.8	20.5
	Bait (General)	Bait Pump	2.6	1.3

		Yabbie Pot	3.5	1.1
	Eel	Fyke net	74.0	6.3
	Gippsland Lakes	Multifilament Mesh	149.2	13.4
		Prawn Stake Net	13.9	7.5
	Trawl (Inshore)	Prawn Trawl	178.5	24.4
	Gippsland Lakes (Bait)	Bait Pump	34.0	8.8
	General (Sea Urchin)	Dive	32.5	5.6
	Wrasse (Ocean)	Handline	25.2	2.3
	Giant Crab	Pots	7.5	2.7
Western Australia	West Coast Rock Lobster Managed Fishery	Potting	5804.33	177.54
	South Coast Purse-Seine Managed Fishery	Purse Seine	1997.78	106.28
	Shark Bay Prawn Managed Fishery	Trawling	1893.11	101.66
	Northern Demersal Scalefish Fishery	Fish Trap	1159.67	33.95
	Joint Authority Southern Demersal Gillnet and Demersal Longline Managed Fishery	Gillnet	1013.44	26.00
		Longline	9.00	6.15
	Pilbara Fish Trawl (Interim) Managed Fishery	Trawling	868.56	235.39
	Exmouth Gulf Prawn Managed Fishery	Trawling	764.22	86.17
	Shark Bay Scallop Managed Fishery	Trawling	946.17	289.11
	FBL condition 93 Purse Seine Development Zone	Purse Seine	487.78	142.32
	Abrolhos Islands and Mid West Trawl Managed Fishery	Trawling	953.75	438.95
	Pilbara Trap Managed Fishery	Fish Trap	269.11	86.04
	Kimberley Prawn Managed Fishery	Trawling	236.44	24.77
	Abalone Managed Fishery	Diving	224.11	22.01
	Shark Bay Crab Managed Fishery	Crab Trap	222.78	53.91
		Trawling	182.67	36.65
	Pearl Oyster Managed Fishery	Diving	217.22	21.57
	West Coast Purse Seine Fishery	Purse Seine	206.44	52.00
	FBL condition 73 South Coast Trawl Fishery	Trawling	176.75	53.86
	Nickol Bay Prawn Managed Fishery	Trawling	120.56	24.34
	South Coast Salmon Managed Fishery	Beach Seine	120.56	30.49
	Shark Bay Beach Seine and Mesh Net Managed Fishery	Beach Seine	102.78	4.96
		Haul Net / Ring Net	52.11	22.58

	Kimberley Gillnet and Barramundi Managed Fishery	Gillnet	97.22	8.79
	West Coast Demersal Gillnet and Demersal Longline (Interim) Managed Fishery	Gillnet	88.89	16.98
		Longline	8.00	8.00
	South West Coast Beach Net Fishery (Order)	Beach Seine	80.56	8.70
	West Coast Estuarine Managed Fishery	Crab Trap	79.00	6.86
		Gillnet	35.78	5.97
		Haul Net / Ring Net	103.11	11.11
	FBL condition 42 herring	Trap Net	112.80	37.20
	South West Coast Salmon Managed Fishery	Beach Seine	53.00	16.02
	South West Trawl Fishery	Trawling	51.14	35.60
	West Coast Demersal Scalefish (Interim) Managed Fishery	Dropline	36.67	5.30
		Dropline and Hydraulic Gunwhale Mounted Reel	2.67	1.30
		Handheld Reel and Dropline	5.78	1.05
		Gunwhale Mounted Hand Operated Reel	22.00	7.45
		Electric Gunwhale Mounted Reel	58.11	4.03
		Hydraulic Gunwhale Mounted Reel	141.44	7.63
		Handheld Reel	33.44	4.09
	West Coast Deep Sea Crustacean Managed Fishery	Crab Trap	84.33	42.19
		Potting	112.78	20.36
	Cockburn Sound (Crab) Managed Fishery	Crab Trap	40.60	10.56
	West Australian Sea Cucumber Fishery	Diving	16.88	16.88
	Open Access in the North Coast, Gascoyne Coast and West Coast Bioregions	Beach Seine	10.78	4.03
		Potting	0.20	0.20
		Squid Jigging	4.11	0.72
		Gillnet	4.33	1.78
		Hydraulic Gunwhale Mounted Reel	30.00	30.00
		Haul Net / Ring Net	18.56	3.62
	Open Access in the South Coast Bioregion	Beach Seine	9.78	1.98
		Haul Net / Ring Net	0.17	0.17
		Handline	2.67	1.00
		Trolling	7.22	2.60
		Gillnet	13.00	0.93
		Squid Jigging	13.89	1.16
		Electric Gunwhale Mounted Reel	14.22	4.55
		Gunwhale Mounted Hand Operated Reel	16.67	2.74
		Handheld Reel	19.22	2.54
		Hydraulic Gunwhale Mounted Reel	32.56	4.16
		Dropline	32.67	4.62

	South Coast Estuarine Managed Fishery	Crab Trap	9.67	2.05
		Fish Trap	1.44	0.80
		Haul Net / Ring Net	13.00	1.51
		Gillnet	204.56	8.79
	Gascoyne Demersal Scalefish Managed Fishery	Electric Gunwhale Mounted Reel	4.89	2.58
		Gunwhale Mounted Hand Operated Reel	5.00	5.00
		Handheld Reel	13.44	4.95
		Hydraulic Gunwhale Mounted Reel	238.44	24.81
	Pilbara Line Fishery (Condition)	Electric Gunwhale Mounted Reel	4.89	4.89
		Handheld Reel	2.22	1.57
		Hydraulic Gunwhale Mounted Reel	72.89	12.33
	Octopus Interim Managed Fishery	Shelter Pot	4.00	1.28
		Trigger Pot	174.11	14.24
	Trochus Fishery	Intertidal Hand Collection	5.50	2.60
	Mackerel Managed Fishery	Trolling	258.22	6.74
		Trolling and Jigging	13.89	3.64
		Jigging	14.67	4.55
		Handheld Reel	2.43	2.27
	Mandurah to Bunbury Developing Crab Fishery	Crab Trap	1.22	1.22
	South Coast Crustacean Managed Fishery	Crab Trap	5.00	5.00
		Potting	90.44	7.61
	Warnbro Sound Crab Managed Fishery	Crab Trap	0.56	0.38
	Cockburn Sound (Line and Pot) Managed Fishery	Handheld Reel	0.38	0.38
		Squid Jigging	1.22	0.15
		Shelter Pot	35.50	6.13
		Octopus Pot	26.67	6.16
		Handline	0.29	0.29
	FBL condition 74 Fish Trapping	Fish Trap	0.22	0.15
South Australia	Marine Scalefish and Miscellaneous	Lines	1467.71	122.59
		Nets	861.54	37.47
		Traps	239.96	31.35
		Other	114.07	3.77
	Prawn	Trawling	1986.48	108.45
	Lakes and Coorong - Other	Mostly Nets	1190.67	31.25
	Lakes and Coorong - Pipis	Rakes etc.	433.79	29.23
	Rock Lobster (South)	Pots	1241.93	1.64
	Rock Lobster (North)	Pots	324.54	4.87
	Abalone	Diving	755.37	33.86
	Blue Crab	Pots	635.22	13.44
	Sardine	Purse Seine	34365.41	1043.06
	Giant Crab	Pots	17.88	0.87
Commonwealth	Coral Sea	Bottom otter trawl	0.97	

		Dropline	4.52	2.14
		Fish trap	36.02	0.31
		General diving	4.25	1.44
		Hand collection (miscellaneous)	0.45	
		Handline (mechanised)	7.61	4.48
		Hookah diving	3.81	0.25
		Hooks	0.60	
		Rod and reel	2.60	1.54
		Set autolongline (demersal longline)	27.20	5.10
		Set longline (demersal longline)	0.28	0.15
		Trotline	0.17	
	East Coast Deep Water	Bottom otter trawl	40.20	23.83
		Midwater otter trawl	83.03	29.40
	Eastern Tuna and Billfish	Drifting longline (pelagic longline)	4550.02	175.02
		Handline (mechanised)	13.01	4.55
		Pole and line	0.61	0.54
		Rod and reel	0.80	0.18
		Set gillnet (demersal gillnet)	0.26	0.07
		Set longline (demersal longline)	0.95	
		Trolling	0.55	0.20
		Trotline	0.01	
	Gillnet, Hook and Trap	Dropline	54.13	9.86
		Fish trap	6.03	2.04
		Handline (mechanised)	19.74	3.70
		Hooks	1.65	
		Rod and reel	20.87	10.45
		Set autolongline (demersal longline)	655.93	32.91
		Set gillnet (demersal gillnet)	1439.44	54.67
		Set longline (demersal longline)	293.52	45.54
		Trolling	0.24	
		Trotline	5.92	
	Great Australian Bight	Bottom otter trawl	1697.14	85.59
		Bottom otter twin trawl	9.24	2.53
		Bottom pair trawl	34.17	33.38
		Danish seine (trawl fishery)	106.45	4.81
		Midwater otter trawl	3.02	2.13
		Trawl	20.96	
	High Seas Non-trawl	Drifting longline (pelagic longline)	3.89	
		Dropline	2.05	0.58
		Handline (mechanised)	3.98	
		Set autolongline (demersal longline)	132.43	11.03
		Set longline (demersal longline)	5.68	
	High Seas Trawl	Bottom otter trawl	295.44	134.51
		Midwater otter trawl	280.51	86.81

	Informally Managed	Purse seine	107.58	30.48
	Kimberley Prawn Fishery	Bottom shrimp trawl (prawn trawl)	70.85	
	North West Slope	Bottom trawl (nephrops trawl)	53.11	6.07
	Northern Prawn	Targeting banana prawns	5011.59	481.10
		Targeting tiger prawns	2256.50	260.34
	Scallop	Scallop dredge	1736.60	405.26
	Small Pelagic	Bottom otter trawl	49.09	34.09
		Midwater otter trawl	5916.85	2791.88
		Purse seine	325.83	159.70
		Squid jigs (mechanised)	0.01	
	South East Trawl	Bottom otter trawl	7873.29	495.59
		Bottom pair trawl	2.01	
		Danish seine (trawl fishery)	1943.34	96.52
		Midwater otter trawl	1217.44	517.22
		Set gillnet (demersal gillnet)	0.59	
	Southern Bluefin Tuna	Dropline	0.02	
		Handline (mechanised)	0.24	0.15
		Pole and line	1.90	1.15
		Purse seine	4367.52	213.58
		Rod and reel	0.82	0.77
		Trolling	0.43	0.18
	Squid Jig	Squid jigs (mechanised)	381.05	103.77
	Torres Strait	Dropline	0.44	
		Free diving	8.81	1.70
		General diving	287.87	43.69
		Hand collection (miscellaneous)	8.74	
		Handline (hand operated)	31.66	2.32
		Hooks	0.47	0.22
		Trolling	80.76	4.35
	Torres Strait Prawn	Bottom shrimp trawl (prawn trawl)	454.44	57.57
	Western Deep Water	Bottom otter trawl	18.12	7.57
		Bottom pair trawl	90.85	
		Danish seine (trawl fishery)	0.22	
	Western Tuna and Billfish	Drifting longline (pelagic longline)	346.83	23.77
		Handline (mechanised)	9.62	1.65
		Hooks	4.02	
		Pole and line	7.50	
		Trolling	0.89	0.44
Total			**153492.68**	**7887.19**

Estimates of General Discards

The next step to estimate discards for the above fisheries/methods is to identify retained:discard ratios that are available for each or, if unavailable, identify substitute ratios from similar fisheries/methods in the same or another jurisdiction.

All available papers, reports and datasets on fisheries bycatches, discards and TEPS interactions in Australia's 8 fisheries jurisdictions were gathered and examined to derive ratios. Sometimes this involved obtaining estimates directly from many papers and reports (see References), sometimes it required making additional calculations from the data or graphs in various documents, sometimes it involved obtaining data directly from observer databases (as for the Commonwealth and the Northern Territory) and sometimes it required interviewing individual authors or scientists. This resulted in a large and diverse number of estimates for many commercial fishing methods used in Australia.

All discard ratios are expressed as retained weight:discarded weight. Where more than one estimate is available, the average ratio is provided with the associated standard error for the discarded part. In a few instances, where discard ratios are expressed as numbers of individuals, the appropriate conversion to weights is described and applied. All estimates are provided in Table 3. Taking each jurisdiction in turn:

New South Wales

NSW has a long and diverse history in bycatch quantification, beginning with Dannevig's (1904) pioneering work in Port Jackson – which was, in fact, one of the first observer studies done in the world. But it wasn't until the late 1990's that regular observer programmes got underway in NSW with a large number of studies being done from that time. However, unlike the use of continuous observer programmes to monitor bycatch (as is the case in the US, Canada, regional tuna fisheries and Australia's Commonwealth fisheries – see below), the limited resources available meant that NSW's observer programmes were strategic, short-term projects - where a particular fishery/method is examined for a year or so before resources are moved onto another. The intention was to do periodic repeats of these targeted studies every decade or so, but unfortunately this has rarely occurred. The result from these many studies is a large number of quite good, focussed projects being completed in NSW (and often published in international peer-reviewed journals), but few current programmes, leaving us with discard estimates that are quite old. Notwithstanding this, the NSW studies provide a diverse assemblage of discard ratios, across many fishing methods and locations, on which one can derive state-wide estimates and also use as surrogates for those fisheries/methods in other jurisdictions that lack ratios. Taking each fishery in turn:

NSW's **Estuary General** fishery uses many methods to target a wide diversity of species. As mentioned above, the first document that records bycatch levels in Australia (and one of the first in the world) is Dannevig's (1904) work in Sydney Harbour. Whilst this pioneering work quantified bycatches in a Port Jackson prawn fishery, it did not include records of retained catches or fishing effort, precluding the use of the study to derive bycatch estimates for the method. But more

recently, many of the fishing methods in the Estuary General fishery have had at least some observer programmes and/or experimental studies quantify discards. For mesh netting, Gray (2002) and Gray et al. (2005) describe observer work done in 1999 and 2001 in many estuaries through the state. The mean retained:discard ratio from these was 1:0.145 (SE = 0.044). For the general purpose haul net, Gray et al. (2001) and Gray and Kennelly (2003) describe observer work done in 1998-99 in 3 estuaries to provide an average ratio of 1:1.109 (SE = 0.301). For the set pocket prawn net, Andrew et al. (1995), Gray (2004) and Gray et al. (2006) describe observer work done in 1991-93 and 1999-2000 in 2 estuaries which gave an average ratio of 1:0.235 (SE = 0.106). For crab traps, we have observer work and control data from experimental studies by Butcher et al. (2012), Leland et al. (2013) and Broadhurst et al. (2015a) done in 2010 and 2012 in 3 estuaries which provided an average ratio of 1: 0.142 (SE = 0.015). For bottom-set fish traps, Stewart and Ferrell (2001, 2003) describe results from experimental studies whose control data provided a ratio of 1:0.14. For the flathead net, Gray et al. (2004)'s observer programme in 2001 in 3 estuaries provided an average ratio of 1: 0.897 (SE = 0.269). For eel trapping, NSW has no direct estimates of discard rates so instead we use the information from the Victorian eel fishery where McKinnon and Milner's (2009) experimental study contained control data showing a ratio of 1:0.74. For the prawn hauling net, Gray et al. (2003) and MacBeth and Gray (2008) describe observer work done in 1998-99 in 4 estuaries whose average ratio was 1: 0.252 (SE = 0.097). For the hand gathering of Pipis (*Donax deltoides*) and beachworms (F: Onuphidae), Gray (2016) did an observer programme at 4 beaches in 2013 to provide an average ratio of 1:0.125 (SE = 0.015). For the prawn running net, Gray (2004), Gray et al. (2006) and Gray (unpub. data) describe observer work done from 1999 to 2001 in 2 estuaries which provide an average ratio of 1: 0.138 (SE = 0.018). For the prawn seine net, Gray (2001, 2004), Gray et al. (2006) and MacBeth and Gray (2008) describe observer work done from 1998 to 2001 in 3 estuaries which provided an average ratio of 1: 0.490 (SE = 0.206). For the bullringing garfish net, we have no direct discard estimates so instead we assume the ratio for the similar beach-based garfish hauling net from the NSW Ocean Haul fishery of 1:0.04 obtained during an observer programme by Stewart (2007, 2008). For handlining, once again, in the absence of any direct estimates, we assume the ratio for a similar method obtained using an observer programme in the NSW Ocean Trap and Line fishery by MacBeth and Gray (2016) of 1:0.14. For setlining, and again the absence of any direct estimates, we assume the ratio for a similar method obtained using an observer programme in the NSW Ocean Trap and Line fishery by MacBeth et al. (2009) of 1:0.132. For the hoop (lift net), we use estimates from observer work and control data from experiments done by Broadhurst et al. (2015b) and Leland et al. (2013) from 2010 to 2012 in 2 estuaries that provided an average ratio of 1:0.071 (SE = 0.037). Finally, for the bait net, beach-based pilchard, anchovy and bait net and the prawn dip or scoop net (prawns), we assume negligible discards due to the highly selective nature of these methods (Gray and Stewart, pers. comm.).

For the **Estuary Prawn Trawl** fishery, we use the observer work of Kennelly et al. (1992), Kennelly (1993), Kennelly and Liggins (1992) and Liggins et al. (1996) done in 5 estuaries between 1989 and 1992 which provided an average ratio of 1: 0.24 (SE = 0.143).

For the **Ocean Prawn Trawl** fishery, we have the observer work of Kennelly (1993) and Kennelly et al. (1998) done out of 4 ports between 1990 and 1992 which provided an average ratio of 1: 2.001 (SE = 0.534).

For the **Ocean Fish Trawl** fishery, Liggins' (1996) observer programme done out of 3 ports from 1993-95 provided an average ratio of 1:0.8443 (SE = 0.204).

NSW's **Ocean Haul** fishery uses several net-based methods to target Mullet (*Mugil cephalus*), Pilchards (*Sardinops sagax*), Garfish (*Hyporhamphus australis*) and other species. For the general purpose haul net, MRAG did an observer programme throughout the state in 2005 and provided a ratio of 1:0.002. For purse-seines, in the absence of any direct estimates, we assume the ratio derived from AFMA's observer programme in the Commonwealth's Small Pelagic fishery (which uses a similar method) of 1:0.13 (SE = 0.07). For the beach-based garfish haul net we have the observer work done by Stewart (2007, 2008) in 2005-06 in Port Stephens which provided a ratio of 1:0.04. And in the absence of a direct estimate for the boat-based garfish haul net, we use the same ratio. Finally, for the beach-based pilchard, anchovy and bait net we assume negligible discards due to the highly selective nature of the method (Stewart, pers. comm.).

NSW's **Ocean Trap and Line** fishery uses a variety of line and trap methods to target several species. For bottom/demersal fish trapping, control data from experimental work done by Stewart and Ferrell (2001), Stewart and Ferrell (2003) and Stewart and Hughes (2008) provide a ratio of 1:0.019. For handlining, we have the observer data from MacBeth and Gray (2016) collected in 2007 to 2009 which estimated a ratio of 1:0.14 which we also assume for trolling, jigging, poling and driftlining in the fishery. For demersal setlines, we use the ratio of 1:0.15 from MacBeth and Gray's (2016) observer work– which we also assume for bottom-set trotlines. For other setlines, we use the estimate from MacBeth and Gray's (2016) observer work of 1:0.132. For droplines, we have the observer data from MacBeth and Gray (2016)'s work done in 2007 to 2009 which estimated a ratio of 1:0.07. Finally, for Spanner Crab nets, in the absence of any direct estimate from NSW, we use the Queensland ratio derived by DEEDI (2011f) using survey data of 1:0.314 (SE = 0.023).

NSW's **Abalone** (*Haliotis* spp.) fishery, which uses hand-gathering, can be expected to have very little discarding - although there may be occasional discarding of undersize/undesirable/over-quota individuals, which may vary with the experience of divers. Such discarding has been estimated by Gibson et al. (2002) to be around 8.3% of landings (or a retained: discard ratio of 1:0.09).

NSW's **Lobster** fishery uses lobster traps to target the Eastern Rock Lobster (*Sagmariasus verreauxi*). NSW DPI (2004) estimates discards from this fishery to be at a ratio of 1:0.84 based on observer work done in 1999 to 2002.

There are several other relatively **Minor fisheries** and **Special Permits** provided to fishers in NSW that use a variety of methods to catch several species. None have direct discard ratios available so

we have assumed ratios derived in other fisheries for similar methods. For Danish Seine, we assume the ratio from the Commonwealth's Southeast Trawl Danish Seine sector obtained from AFMA's observer data of 1:0.962 (SE = 0.087). For the purse seine special permit, we use the ratio from the Commonwealth's Small Pelagic fishery obtained from AFMA's observer data of 1:0.13 (SE = 0.07). For the scallop dredge special permit, we use the ratio from observer and survey work reported by Haddon et al. (2006) and AFMA (2015) for the Bass Strait Scallop fishery of 1:0.11. For the submersible lift net special permit, we use the ratio for the NSW Estuary General Hoop or Lift net of 1:0.071 (SE = 0.037) (Broadhurst et al., 2015b; Leland et al., 2013). For the eel trap special permit we again use the information from the Victorian eel fishery where McKinnon and Milner (2009)'s experimental study had control data showing a ratio of 1:0.74. Finally, for skindiving and the boat-based pilchard, anchovy and bait net, we assume negligible discards due to the highly selective nature of these methods.

Tasmania

Of the commercial wild harvest fisheries in Tasmania, some can be expected to have little (or no) discarding, as the principal method used is hand-gathering. For such fisheries, discard rates can be assumed to be negligible But for the other commercial fisheries in Tasmania, which involve methods like pots, traps, nets, etc., discards are unlikely to be negligible and are probably similar in scale to fisheries elsewhere that employ such methods. But the problem is that there exists virtually no data that directly quantifies these discards. In fact, despite a close examination of the available reports, papers and datasets, the only ongoing, systematic estimates of bycatches in any of these fisheries come from the Southern Rock Lobster (*Jasus edwardsii*) fishery. Taking each fishery in turn:

The Tasmanian **Abalone** fishery, which uses hand-gathering, can be expected to have very little discarding - although there may be occasional discarding of undersize/undesirable/over-quota individuals, which may vary with the experience of divers. Whilst this has not been estimated for the Tasmanian fishery, we saw above that, in NSW, such discarding may be around 8.3% of landings (or a retained: discard ratio of 1:0.09 - Gibson et al., 2002).

For the **Rock Lobster** fishery, we are fortunate to have available the results of the recently completed FRDC funded project "Ensuring monitoring and management of bycatch in Southern Rock Lobster Fisheries is best practice" (FRDC 2017/082 – Leon et al., 2019). In this exhaustive study, quite accurate estimates of discards from the Tasmanian, Victorian and South Australian Rock Lobster fisheries were provided based on observer programmes augmented with survey data. For the Tasmanian fishery, the estimate is a retained:discard ratio of 1:3.52 where most discards are undersize lobsters that are released (usually alive) due to regulation.

For the Tasmanian **Scallop** fishery, despite there being a significant number of published reports about the fishery and even one tantalizingly titled "Juvenile Scallop Discard Rates and Bed Dynamics: Testing the Management Rules for Scallops in Bass Strait" (Haddon et al., 2006), very few actual rates of discarding are available. For example, while Haddon et al. (2006) examines the efficacy of the 20% "trashing rule" for discards of juvenile Scallops (*Pecten fumatus*), the authors

do not provide estimates of the actual level of discards, basically assuming it to be 20% or less - because if it were more than 20%, the fishery would not operate. This logic is also confirmed by DEH (2005), and AFMA (2015) also note that the Harvest Strategy for the Commonwealth portion of the fishery directs the industry co-management committee to voluntarily close scallop beds that do not meet the discard rate of less than 20 per cent of scallops smaller than 85mm in length. And it is also reported that fishers tend to voluntarily avoid areas found to contain undersized scallops because it is not in their commercial interests to continue fishing there. In the absence of any direct estimates, if one assumes that the scallop fishery operates at half the 20% scallop discard level (by weight) and there is negligible discarding of any other species, then one could estimate that the retained:discard ratio for the fishery is 1: 0.11.

For the **Octopus** fishery, whilst Emery and Hartmann (2016) give a recreational discard rate of the number of cephalopods discarded as 61.8% of the total catch, no data are provided on discards from the commercial fishery. Gardner (pers. comm.) advises that there are three components in the commercial octopus fishery: (i) byproduct of *Octopus maorum* from the lobster fishery; (ii) hand collection of *O. maorum* from knee-deep water; and (iii) trapping of *O. palidus* and *O. tetricus*. It was noted that there were negligible discards for all three components as there is no size limit and the pots used in the main targeted fishery (iii above) are designed to catch larger animals - so we assume a zero discard rate for this fishery.

For the **Giant Crab** fishery, Emery et al. (2015b) and Hartmann and Gardner (2011) note that observer work, industry logbooks and discards recorded in photographs taken by fishers reveal negligible discards of undersize crabs on the east coast but approx. 0.4 crabs/standardised potlift soak days on the west coast. With an average weight of undersize crabs at approx. 2.5 kg, and approx. 15,000 potlifts per annum, this leads to a state-wide estimate of approx. 15 tonnes of undersize Giant Crabs (*Pseudocarcinus gigas*) discarded per year - a discard rate of 33.78% or a retained:discard ratio of 1:0.51.

For the multi-method **Scalefish** fishery, most methods have no discard rates available (Emery et al., 2015a). But for the two squid jig methods, dip-nets, spears and hand collection, one could assume negligible discards. Some discard data exists for the graball gillnet and small mesh net methods (Lyle et al., 2014) which indicated discard rates (by numbers of individuals) of 51.9% and 66.5%, respectively. Assuming the average weight of discarded individuals is one-third that of retained individuals (ie. due to most discards being undersize), this provided retained:discarded ratios of 1:0.36 for the graball net and 1:0.66 for the fine mesh net. For other methods in this fishery, and in the absence of Tasmanian discard ratios, we use the NSW ratios for beach seine (1:0.002 – MRAG, 2005), handline and troll (1:0.14 – MacBeth and Gray, 2016), fish trap (1:0.019 – Stewart and Ferrell, 2001, 2003 and Stewart and Hughes, 2008) and dropline (1:0.07 - MacBeth and Gray, 2016). For purse seine and Danish seine, we use AFMA's estimates from their observer programmes in the Commonwealth's Small Pelagic fishery (1:0.13, SE = 0.70) and Southeast Trawl Danish seine fishery (1:0.96, SE = 0.09).

Northern Territory

Due to their exclusively tropical location, most of the Northern Territory's fisheries differ significantly from those in the more southern jurisdictions of Australia. Of particular relevance to this study is the Northern Territory's observer programmes where regular monitoring of catches and bycatches (including discards) occur in several fisheries – among the few extant observer programmes running in Australia's non-Commonwealth jurisdictions. All data collected from these programmes since 2011 were provided to this project by NT Fisheries and mainly concerned the largest (and more non-selective) fisheries in the jurisdiction. Taking each fishery in turn:

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). Turtle Exclusion Devices are required in the trawl gear and operators use square mesh codends to reduce unwanted bycatches and improve catch quality. Discards reported from the observer programme across the variety of methods used were provided from 2011 to 2017 and yielded an estimated annual average retained:discard ratio of 1:0.16 (SE 0.007).

The **Timor Reef** fishery also targets Tropical Snappers using baited traps, hand lines, droplines and demersal longlines. Trawl gear is also being trialled in the fishery. Like the Demersal fishery above, Turtle Exclusion Devices are required in the trawl gear and operators use square mesh codends to reduce unwanted bycatches and improve catch quality. Reported discards from the observer programme from 2011 to 2017 yielded an annual average ratio of 1:0.10 (SE 0.03).

The **Barramundi** fishery targets Barramundi (*Lates calcarifer*) and King Threadfin (*Polydactylus macrochir*) using gillnets. Discards as estimated by observers in 2005 and from 2007 to 2011 yielded an average annual ratio of 1:0.32 (SE 0.2).

The **Offshore Net and Line** fishery targets Australian Blacktip Sharks (*Carcharhinus tilstoni*), Common Blacktip Sharks (*C. limbatus*), Spottail Sharks (*C. sorrah*) and Grey Mackerel (*Scomberomorus semifasciatus*) using pelagic gillnet and longline gear. Discards, as estimated by these observers in 2003, 2007 to 2014 and 2016 to 2017, yielded an average annual ratio of 1:0.18 (SE 0.04).

The **Spanish Mackerel** fishery targets Spanish Mackerel (*Scomberomorus commerson*) using trolled lures or baited lines from a mother ship and/or dories. Observers have opportunistically conducted monitoring on these vessels and, while bycatch was not explicitly measured, it was estimated to be <1% of the total catch and consisted of trevallies (F: *Carangidae*) and other smaller mackerels (F: *Scombridae*). In 2013, discards were estimated to be approximately 0.1% of the total harvest based on logbook catches, and consisted exclusively of trevallies (NTG, 2015). There were no recorded discards during 2014, and a small number of Trevallies were recorded as discards during 2015 (NTG, 2017). As was the situation for the Queensland Spanish Mackerel fishery, we lack any definitive information regarding discards in this fishery so we assume the ratio from the similar fishery in NSW of 1:0.14 (MacBeth and Gray, 2016).

The **Mud Crab** fishery targets Mud Crabs (*Scylla serrata*) using baited pots. Fishers may also use gillnets to catch fish for use as crab bait. There has been no observer programme in this fishery so no NT-based discard estimates are available. Instead, as we did for Queensland below where, similarly, no discard data were available, we apply the average NSW retained:discard ratio for its mud crab fishery of 1:0.14 (SE = 0.01)(Butcher et al., 2012; Broadhurst et al., 2015a; Leland et al., 2013).

The **Coastal Line** fishery mainly targets Black Jewfish (*Protonibea diacanthus*) using hook and line, but several other gears are also permitted: cast nets (for bait only), scoop nets, gaffs and fish traps. No bycatch was reported by commercial operators in this fishery during 2013, 2014 and 2015. Observers have opportunistically monitored these vessels and, while bycatch was not explicitly measured, it was estimated to be <1% of the total catch and consisted mainly of sharks (F: *Carcharhinus*) and Catfish (*Neoarius* spp.). The Queensland Gulf of Carpentaria Line and Coral Reef Finfish fisheries are similar fisheries to this one and these have a retained:discard ratio of 1:0.095 which we assume here.

The **Trepang** fishery targets Sandfish (*Holothuria scabra*; a Sea Cucumber), using hand-gathering while hookah diving. Selective harvesting by the fishery avoids bycatch so discards are assumed to be negligible. The very small **Restricted Bait** fishery uses a variety of bait nets and is also assumed to have negligible discards. The **Aquarium Fish/Display** fishery supplies a range of aquarium fishes, plants and invertebrates (including corals) to pet retailers and wholesalers. Fishers can use several types of nets, hand pumps, freshwater pots and hand-held instruments to collect specimens. All methods are considered highly selective with negligible discards.

The **Coastal Net** fishery harvests a range of species including Mullets (F: *Mugilidae*), Blue Threadfin (*Eleutheronema tetradactylum*), sharks and Queenfish (*Scomberoides* spp.). The main fishing method used are gillnets, with cast nets also occasionally used. Nets must be cleared in water not less than 30 cm deep to facilitate the release of any bycatch or prohibited species. There was no reported bycatch in this fishery by licensees during 2013, 2014 and 2015 and there are no observer data available. However, it is unlikely that such a fishery would have no discards so we assume discard levels from the similar Queensland Gulf of Carpentaria Inshore Finfish fishery – a ratio of 1:0.051.

Queensland

In terms of reporting on bycatch and discards, Queensland's system is not as good as its comprehensive system for reporting landings and effort from its fisheries - not because of a scarcity of observer-gathered discard information, but difficulties concerning access to those data due to problems of accuracy and confidentiality. Queensland has done regular and relatively recent observer-based monitoring of bycatches in many of its fisheries including a formal observer programme (part of the "Long Term Monitoring Program") that lasted from 2007 until 2012. The problem is that the observer dataset could not be provided to this project because much of it had not been checked, is known to contain errors and concerns regarding its confidentiality (Engstrom,

pers. comm.). An exception is the very good discard information based on the recent observer programme provided by Wang et al. (2019) for Queensland's East Coast Otter Trawl fishery.

Despite the above problem, we have been able to obtain discard information for several Queensland fisheries using a less direct approach - by examining various reports and papers by Queensland researchers over the past 20 years or so. Of particular assistance were the annual status reports for most fisheries provided on Queensland's web portal – which sometimes included references to discard rates. Whilst these data were not as recent, nor probably as thorough as the data from the recently completed observer programme, when augmented by discard rates for similar fisheries/methods in other jurisdictions this information permitted us to derive at least some discard estimates for most of Queensland's commercial fisheries. Taking each fishery in turn:

Queensland's **Harvest fisheries** mostly employ hand-gathering as the principle method. The **Coral** Fishery involves the hand-collection of live anemones, soft and hard corals, ornamental corals, live rock, coral rubble and coral sand (DEEDI, 2011a). The **Crayfish and Rocklobster** Fishery targets Tropical Rock Lobster (*Panulirus* spp) using hookah to collect animals by hand, nooses or spears (DEEDI, 2011b). The **East Coast Pearl** Fishery gathers Silverlip and Blacklip Pearl Oysters (*Pinctada maxima* and *P. margaritifera*) by hand, the **Marine Aquarium Fish** Fishery collects Damselfish, Anemone fish, Angelfish (F: *Pomacentridae*), Butterflyfish, Bannerfish (F: *Chaetodontidae*), Wrasses (F: *Labridae*) and Gobies (F: *Gobiidae*) – again by hand. And the **East Coast Trochus** Fishery uses hand-held non-mechanical implements to harvest Topshells (or Topsnails; F: *Colloniidae*) (DEEDI, 2010a). The **Sea Cucumber** Fishery (East Coast) targets all species of Sea Cucumber including the White Teatfish (*Holothuria (Microthele) fuscogilva*), Burrowing Blackfish (*Actinopyga spinea*) and Curryfish (*Stichopus* spp.) by hand, using free-diving methods, hookah or SCUBA (DAFF, 2012a). For all these methods we assume that there are no discards.

The Queensland **Eel** Fishery targets Longfin and Southern Shortfin Eels (*Anguilla reinhardtii* and *A. australis*) in rivers and freshwater impoundments at two stages in their lifecycles, as adults (> 30 cm) and as elvers (glass eels) (< 30 cm). The methods involve baited eel or round traps, fyke nets, dip nets and flow traps. Discards have not been measured in this fishery so we assume the retained:discarded ratio determined for the similar Victorian eel fishery of 1:0.74 (McKinnon and Milner, 2009).

Queensland's **Line fisheries** mainly use hook-and-line methods to catch a variety of finfish species. The **Coral Reef Fin Fish** Fishery is predominantly a line-only fishery that targets a range of bottom-dwelling reef fish focussing on Coral Trout (*Plectropomus* spp.) and mainly operating in the Great Barrier Reef Marine Park. Despite the volume caught in this fishery (Queensland's 4th largest), limited information on bycatches are available. 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 programme (Mapstone et al., 2001) where approximately 225 dory days of fishing were observed. The data revealed that discards were dominated by undesired target species (ie usually under legal size), especially Coral Trout, which

was responsible for greater than 50 percent of the bycatch. Other species discarded were Red-Throat Emperor (*Lethrinus miniatus*), Grassy Sweetlip (*Lethrinus laticaudis*), Stripey Seaperch (*Lutjanus carponotatus*), Hussar (*Lutjanus adetii*), trevallies and Blacktip Rockcod (*Epinephelus fasciatus*). The results indicated a total discard rate (by number of individuals) of 33.0%. Assuming that, on average, discarded individuals in this fishery weighed one third that of average retained individuals, this provided a weight-based retained:discard ratio for the fishery of 1:0.16.

Queensland's **Deep Water Finfish** Fishery targets Blue Eye Trevalla (*Hyperoglyphe antarctica*) and Bar Cod (*Epinephelus ergastularius*) using trotlines or droplines. Bycatch information has been collected by observers in Queensland's Long Term Monitoring Programme (DEEDI, 2010b) but, as discussed earlier, the data are not available. We therefore assumed that this fishery has similar discard rates as those for fisheries using similar methods in NSW - an average retained:discard ratio of 1:0.123 (SE 0.018 - Macbeth et al., 2009; MacBeth and Gray 2016).

The **East Coast Spanish Mackerel** Fishery is a line-only fishery in which Spanish Mackerel are generally caught trolling. As above, there has been an observer programme completed in the fishery but no data are currently available from it. Instead, we use the NSW ratio for a similar method of 1:0.14 (MacBeth and Gray 2016).

The **Gulf of Carpentaria Line** Fishery is a multispecies fishery which harvests a range of pelagic (open water) and demersal (bottom-dwelling) fish with Spanish Mackerel accounting for the majority of the catch. Other species taken include Trevally (*Pseudocaranx georgianus*), small mackerels, snappers, cods (F: *Serranidae*) and emperors. The methods include surface trolls and hand lines. Whilst little work has been done on bycatch in this fishery, Roelofs (2004a) notes that, although bycatch is considered negligible (G. McPherson, pers. comm. 2003; SOQ, 2013), Barracuda (*Sphyraena barracuda*), sharks, tunas (F: *Scombridae*), Swordfish (*Xiphias gladius*) and rays (F: *Dasyatidae*) are sometimes caught and discarded. Roelofs (2004) also notes that bycatch in the demersal hand line component of this fishery should be similar to that in the east coast Coral Reef Fin Fish Fishery, given the similar methods and species caught (ie. a retained:discard ratio of 1:095).

The **Rocky Reef Finfish** Fishery targets Snapper (*Chrysophrys auratus*), Pearl Perch (*Glaucosoma scapulare*), Teraglin (*Atractoscion aequidens*) and Cobia (*Rachycentron canadum*) using hook and line. There is said to be limited bycatch in this fishery as recorded by observers and this consists mostly of undersized target species or other pelagic species that are retained as by-product (DEEDI, 2011d). But, in the absence of any data on bycatch levels, we use the retained:discard ratio of 1:0.10 (SE 0.03) from the similar Northern Territory Timor Reef fishery (see above).

Queensland's **Net fisheries** mainly use various types of nets to catch a variety of finfish species. The **East Coast Inshore Finfish** Fishery targets Sea Mullet (*Mugil cephalus*), sharks, Sand Whiting (*Sillago ciliata*), Yellowfin Bream (*Acanthopagrus australis*), Sand Flathead (*Platycephalus arenarius*), Tailor (*Pomatomus saltatrix*), small mackerels, threadfins (F: *Polynemidae*) and Barramundi. The gear permitted includes mesh, haul (seine), tunnel and cast nets and hook and

line. Most fishers prefer to use net sizes that selectively catch fish of a certain size to meet market demand. The number, mesh size and length of nets depends on the species targeted and whether the fisher is operating in near-shore or offshore waters. DEEDI (2010c) notes that bycatch levels in the fishery are low compared to the retained component of the catch, indicating the gear and methods used are quite selective. Observers reported 27% total bycatch in net operations targeting sharks although these were preliminary results. An observer programme was implemented in 2009 but, as noted above, the data from that programme are unavailable.

Halliday et al. (2001) reported on bycatch in this fishery (as estimated by observers), concluding that levels were similar across the various components of the fishery (7 – 28% by number) even though the size ranges of species targeted differed considerably. The discard rates (by numbers of individuals) provided were: for the East coast "mixed estuary" fishery 15.3%; for the East coast Barramundi fishery 13%; for the Small Mackerel fishery 16.3%; for the Whiting fishery 27.5%; and for the Sea Mullet fishery 5.7%. If we take the average of these estimates as indicative of the whole fishery, we get a discard rate of 15.5% (SE 3.51). And to convert this to a weight-based estimate using the assumption that discarded individuals weigh one-third that of retained individuals, we get a retained-discard ratio of 1:0.061 (SE 0.012).

Like the above fishery, the **Gulf of Carpentaria Inshore Finfish** Fishery employs fishing gears and methods that are thought to be quite selective at harvesting the nominated target species (Halliday et al. 2001). Bycatch is generally comprised of fish and elasmobranchs. Early, observer programmes provided reliable data on bycatch in various parts of the fishery as reported by Halliday et al. (2001) and Roelofs (2004b). In summary, these indicated that the Gulf of Carpentaria Mixed Estuary Fishery had a discard rate of 13.4% by number and the Gulf of Carpentaria Barramundi fishery, 13.1% by number (an average of 13.25%). And to convert this to a weight-based estimate using the above assumption that discarded individuals weigh one-third that of retained individuals, we get a retained-discard ratio of 1:0.051.

Queensland's **Pot fisheries** mainly use pots and traps to catch crabs. 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 that quantified these discards. In their absence, 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).

Commercial crab pots (with rigid or collapsible frames) are used in the Queensland **Mud Crab** Fishery. DEEDI (2011e) notes that, in an observer programme, of 1452 trap lifts observed (on 801 unique pots) the bycatch was predominately comprised of soft male, undersized male and female Mud Crabs (98% of the bycatch by number), with the remaining 2% of the bycatch by number being teleosts. Unfortunately, however, there are no data available relating this bycatch to retained catches. In its absence, we can apply the average NSW retained:discard ratio for its Mud Crab fishery (Butcher et al., 2012; Broadhurst et al., 2015; Leland et al., 2013) but doubled to try to

account for the fact that all female Mud Crabs are required to be discarded (usually alive) in Queensland. This gives a ratio of 1:0.298 (SE 0.036).

The Queensland **Spanner Crab** (*Ranina ranina*) fishery uses prescribed dillies as the fishing method and DEEDI (2011f) reported minimal discards of non-Spanner Crabs in the fishery. Brown et al (2001) noted that animals other than Spanner Crabs that are occasionally taken include Blue Swimmer Crabs (*Portunus pelagicus*), juvenile Flathead and Flounders (F: *Rhombosoleidae*), as well as small gastropod and bivalve molluscs, solitary corals, sipunculids, Brittle-Stars (F: *Amphiuridae*) and Sea Urchins (F: *Strongylocentrotidae*). But the incidence of non-Spanner Crab bycatch is noted to be very rare and was reported as just 4 grams per dilly lift from data obtained in a 2001 survey – around 4 tonnes per year for the fishery. However, many undersize Spanner Crabs are discarded in this fishery. The data indicated that, over a 10 year period from 2001 to 2010, the average discard rate of undersize crabs was 41.3% (SE 1.52) by number. To convert this number-based estimate to a weight-based estimate, we again assumed that discarded crabs weighed one-third that of retained crabs to derive a retained:discard ratio of 1:0.23 (SE 0.005).

The **East Coast Otter Trawl** Fishery targets a variety of prawns, scallops, bugs, squid, and several other by-product species. It uses demersal otter board trawling as the principal method. The Fin Fish (Stout Whiting) Trawl Fishery is a small fishery with just 5 operators who use otter trawls and Danish seines to target Stout Whiting. As for any tropical demersal trawl fishery, bycatch and discards can be expected to be significantly greater in these fisheries than in all of the other Queensland fisheries discussed so far.

These two fisheries had the best bycatch information available to this project due to the recent work of Wang et al. (2019) which used data from various research projects and specific use of Queensland's recent observer dataset. That paper provides an exhaustive assessment of various ways to estimate discards in these fisheries (using weight-based, effort-based and swept area-based extrapolation methods). The paper provides estimates of total discards for these fisheries which, averaged over the most recent 5 years (2010-2014) was 24,926 tonnes per annum (SE 2,704). Comparing this with the landings data available for those years, we get a retained:discard ratio of 1:3.35 (SE 0.14).

Operators in the **Gulf of Carpentaria Developmental FinFish Trawl** Fishery use a semi-demersal otter trawl to fish certain shoals. DEEDI (2011g) states that the percentage of reported bycatch in the fishery increased from 36% (272 t) in 2009 to 39% (237 t) in 2010 giving a retained:discarded ratio of 1:0.64.

The **River and Inshore Beam Trawl** Fishery targets Bay Prawns (*Metapenaeus bennettae* and *M. insolitus*), Banana Prawns, School Prawns (*Metapenaeus macleayi*) and Squids (F: *Ommastrephidae*) in certain rivers and creeks, towing a single 5 m head-rope trawl. The only exception is Laguna Bay, where a small otter trawl net may be used. An early study by Robins and Courtney (1998) gave a catch:bycatch ratio for the fishery of 1:3.5 but DEEDI (2009) reports that preliminary analysis of more recent observer data indicated an average ratio of 1:0.25.

Victoria

For the size of Victoria's fisheries jurisdiction, there are a relatively large number (26) of commercial fisheries/methods. Some are categorised according to target species (eg. the Abalone and Rock Lobster fisheries), some by location (eg. the Westernport Bay/Port Phillip Bay, Corner Inlet and Gippsland Lakes fisheries), some by method (eg. the Trawl and Purse Seine fisheries) and some by a combination of the above. Some fisheries use one method, others use many.

Some of these fisheries can be expected to have little (or no) discarding, as the principal method used is hand-gathering. But for other fisheries, which involve methods like trawls, pots, traps, seines, mesh nets, haul nets, fyke nets, etc., discards are not likely to be negligible and are probably similar in scale to fisheries elsewhere that employ such methods. But the problem associated with reporting on discards from these fisheries is the fact that there exists virtually no data that directly quantifies discards. In fact, despite an examination of the available reports, papers and datasets, the only systematic estimates of bycatches in any of these fisheries come from the Rock Lobster fishery which provides bycatch estimates derived from research surveys and observer data. Taking each fishery in turn:

The **Abalone** fishery, which uses hand-gathering, can be expected to have very little discarding - although there may be occasional discarding of undersize/undesirable/over-quota individuals, and this may vary with the experience of divers. Whilst this has not been estimated for the Victorian fishery, we assume the NSW estimate of a retained: discard ratio of 1:0.09 - Gibson et al., 2002).

For the **Rock Lobster** fishery, as discussed earlier for Tasmania, we are fortunate to have available the results of the recently completed FRDC funded project "Ensuring monitoring and management of bycatch in Southern Rock Lobster Fisheries is best practice" (FRDC 2017/082 – Leon et al., 2019). For Victoria, the estimates are retained:discard ratios of 1:0.81 for the eastern zone and 1:1.41 for the western zone for an average of 1:1.11 (SE = 0.3).

The **Ocean (General)** fishery uses several methods, none of which have direct discard estimates available. So for these we have assumed discard rates for similar methods used in NSW. These are drop line (retained:discard ratio of 1:0.07 - MacBeth and Gray, 2016), handline (1:0.14 - MacBeth and Gray, 2016), shark longline (1:0.132 - MacBeth et al., 2009) and snapper longline (1:0.15 - MacBeth and Gray, 2016). For the octopus fishery we use information for a similar fishery in Tasmania where there was noted to be negligible discards as there is no size limit and the pots are designed to catch larger animals (Garner, pers. comm.).

For the **Westernport/Port Phillip Bay** fishery, 5 methods are used and, for discard ratios, in the absence of any for the fishery we again use those obtained in NSW for similar methods. For haul seine, we have ratios in NSW of 1:0.51 (Botany Bay – Gray et al., 2001), 1:1.353 (Lake Macquarie – Gray and Kennelly, 2003) and 1:1.464 (St. Georges Basin - Gray et al., 2003). These give an average haul seine discard ratio for large bays in south eastern Australia of 1:109. For mesh netting, we use the 12 discard rates provided by Gray (2002) and Gray et al. (2005) for various estuaries in NSW. The average of these is 1:0.145 (SE = 0.04). For snapper longlining, we use NSW's 1:0.15 (MacBeth

and Gray, 2016). For garfish seines, we use Stewart's (2007 and 2008) estimates for NSW of 1:0.04. For purse seine, we use the estimate from the Commonwealth's Small Pelagic fishery of 1:0.123 (SE = 0.07).

For the **Corner Inlet** ringing seine, haul seine and mesh net fisheries, we use the same NSW estimates as those used above for the Westernport/Port Phillip Bay fishery (ie. 1:1.109 for ringing and haul seines and 1:0.145 for mesh nets).

For the **Bait (General**) fisheries using bait pumps and yabbie pots, we assume negligible discards. Similarly, for the **Gippsland Lakes (Bait)** fishery and the **General Sea Urchin** fishery, we can assume negligible discards due to the simple tools and hand-gathering methods used.

For the **Eel** fishery that uses fyke nets, we have little discard information although fyke nets are known to catch a variety of bycatch species including Sea Mullet, Australian Salmon (*Arripis trutta* and *A. truttaceus*), Black Bream (*Acanthopagrus butcheri*), Gudgeons (F: *Cyprinidae*), Trout (*Oncorynchus mykiss*), Whiting, Blackfish (*Gadopsis marmoratus*), Crabs (F: *Portunidae*), Trevally, Gobies, Leatherjackets (F: *Monacanthidae*), Carp (*Cyprinus carpio*), Goldfish (*Carassius auratus*), Redfin (*Perca fluviatilis*), Tortoises (F: *Chelidae*) and Platypus (*Ornithorhynchus anatinus*). In a study done to examine ways to reduce bycatch in this fishery, McKinnon and Milner (2009) obtained estimates of bycatches from a series of trials done in 2008. Combining data from the standard commercial fyke net used in those trials, we found that, in catching a total of 302 eels, 224 individuals of other species were caught (which are required to be discarded by the commercial fishery). If we assume individuals of these bycatch species weighed similar to individuals of the retained eels, this equates to a retained:discard ratio of 1:0.74.

For the **Gippsland Lakes** Mesh net fishery, we can use the same NSW estimates as we did above for the Westernport/Port Phillip Bay and Corner Inlet fisheries of 1:0.145. For the **Gippsland Lakes Prawn** stake net fishery, we use the discard rate for the similar set pocket (stow) net fishery in NSW which has an average ratio of 1:0.235 (SE = 0.15) (Andrew et al., 1995; Gray, 2004; Gray et al., 2006).

For the **Inshore Trawl** fishery, we can use the average discard ratio for the similar NSW Ocean Prawn Trawl fishery of 1:2.001 (SE = 0.534) (Kennelly, 1993; Kennelly et al., 1998).

For the **Wrasse (Ocean)** fishery, which uses handlining, the ratio from NSW of 1:0.14 is used (MacBeth and Gray, 2016). And finally, for the **Giant Crab** fishery, without discard estimates from Victoria, we use information from the similar Tasmanian Giant Crab fishery (Emery et al., 2015b) which led to an estimated ratio of 1:0.51.

Western Australia

Western Australia (WA) has the largest number of individual marine commercial fisheries/methods of any jurisdiction in Australia. And one may expect that each of the methods used in these fisheries will have different bycatch and discarding issues. Some can be expected to have little (or no) discarding, such as when the method is hand-gathering. But for others, which use trawls, pots, traps, seines, mesh nets, haul nets, hooks-and-lines, etc., discards are not likely to be negligible and are probably similar in scale to fisheries elsewhere that employ such methods.

Some years ago, Western Australia attempted to get as many of its fisheries as possible certified by the Marine Stewardship Council (MSC). This involved MSC pre-assessments for most fisheries followed by full evaluations for a subset. This substantial amount of work required an examination of, among other things, bycatch issues such as levels of discards and interactions with TEPS because these fall under principle 2 of MSC's standard. So, when searching for rates of general discarding and TEPS interactions in WA, the first places to look were these MSC pre- and full assessments. However, the MSC pre-assessments were confidential and therefore unavailable but, in any case, we have been advised that these mainly provided general descriptions of likely bycatch compositions in each fishery rather than actual rates of discarding. There is, however, discard information available from some previous observer programmes and EM work. These programmes, rather than being large, ongoing programmes as done by, for example, AFMA for Australia's Commonwealth fisheries (see below), have instead been similar to those run in NSW: ie. more strategically focussed, short-term programmes done in fisheries/methods with a greater potential to have bycatch issues. For other fisheries/methods, however, there are no direct, empirical measures of discarding so, as we have done elsewhere, we use discard rates from similar fisheries/methods in other jurisdictions and fisheries. Taking each fishery in turn:

The **West Coast Rock Lobster** fishery is Western Australia's most valuable fishery and has historically been Australia's most valuable single species wild capture fishery. Bellchambers et al. (2012) provides some information on bycatch in this fishery where the rates of fish and invertebrate bycatch (but not discards) were recorded during normal rock lobster fishing operations in 2006/7 and again in 2009/10. Approximately 17,084 fish and invertebrates other than Western Rock Lobster (*Panulirus cygnus*) and Octopus (*Octopus* spp.) were captured during the latter survey. If we adopt their assumption that each of these individuals weighed 1kg, and given that 5,899 tonnes of targeted catch were landed that year, the catch:bycatch ratio obtained is 1: 0.003. However, this estimate takes no account of retained byproduct because the numbers of discards were not provided and nor does it include any discards of undersize lobsters and octopus.

Another study (de Lestang et al., 2019) mentions logbook reports of bycatches of certain species in the Rock Lobster Fishery in 2018 (2354.6kg of Baldchin Groper (*Choerodon rubescens*) was said to form 58% of all bycatch whilst 622.7kg of Pink Snapper (*Chrysophrys auratus*) formed 15.3%). This information allows one to determine that the total reported bycatch in 2018 was 4,060 kg (out of a total landings weight of 6046 tonnes – providing a ratio of 1:0.0007 or 0.07%). But, as above, this

estimate does not account for bycatches that were retained (byproduct) versus discarded, nor any discards of undersize Rock Lobsters. The latter is particularly important as we have seen in other jurisdictions (in South Australia, Victoria and Tasmania – Leon et al., 2019, and in NSW – NSW DPI, 2004) where the discard of targeted conspecifics in lobster fisheries can be very significant.

As for Tasmania's and Victoria's lobster fisheries, we are fortunate to have available the results of Leon et al. (2019). In that study, the estimated discards for South Australia's lobster fishery (the closest to WA's lobster fishery), including discarded lobsters, was 49.6% in the northern zone and 40.0% in the southern zone for an average retained:discard ratio of 1:0.91 (SE = 0.16). In the absence of any discard rate available directly for the WA lobster fishery, we assume this average ratio.

The **South Coast Purse Seine** Fishery involves the taking of small pelagic fish (mainly targeting Pilchards, also called Australian Sardine) by purse seines in all waters between Cape Leeuwin and the South Australian Border. Although no discard rates are provided, Nardi et al. (2007) state that "incidental bycatch is insignificant, but may occasionally include fish predators of the target species or other fish species accidentally captured…". Since no direct general discard data are available, we assume the retained:discard ratio derived from an observer programme in the similar purse seine sector in the Commonwealth's Small Pelagic Fishery of 1: 0.13 (SE = 0.07).

The **Shark Bay Trawl** Fishery is a multi-species fishery mainly targeting Western King and Brown Tiger Prawns (*Melicertus latisulcatus* and *Penaeus esculentus*). The vessels in this fishery also catch about 20-30% of the annual Saucer Scallop (*Amusium pleuronectes*) catch in Shark Bay. Kangas and Thomson (2004) and Kangas et al., (2007) describe an observer programme done after the implementation of bycatch reduction devices in these fisheries and provided ratios between 1:2 and 1:8 for the prawn sector and 1:0.5 for the scallop sector. However, a more recent study by DPIRD (2019a) used fishery-independent trawl biodiversity surveys to provide a ratio for the prawn sector of 1:0.96.

The **Northern Demersal Scalefish** fishery mainly targets high value species including Goldband Snapper (*Pristipomoides multidens*), Red Emperor (*Lutjanus sebae*) and various cod species using fish traps. Newman et al. (2008) described the annual discards in the fishery in 2001 and 2002 from surveys on industry vessels as equivalent to approximately 1.3% (by number) of the total retained catch. They assumed that the proportion of non-retained catch by numbers was similar to that by weight and estimated that the total weight of discards in the fishery was approximately 6.4 t in 2001 and 5.6 t in 2002. The landings recorded in those two years in the fishery were 509t and 434t, respectively, providing an average discard ratio of 1:0.013 (SE = 0.0002).

The **Joint Authority Southern Demersal Gillnet and Demersal Longline** and **West Coast Demersal Gillnet and Demersal Longline** fisheries operate in continental shelf waters along the south and lower west coasts of Western Australia mainly targeting sharks (Gummy, Dusky, Whiskery and Sandbar - *Mustelus antarcticus, Carcharhinus obscurus, Furgaleus macki* and *C. plumbeus)* using demersal gillnets. A smaller proportion of the catch comes from demersal longlines. McAuley and

Simpfendorfer (2003) summarise research done between 1994 and 1999 on commercial gillnet vessels during regular fishing activities as part of a voluntary observer programme. The results provided estimates of the discarded elasmobranch portion of the catch as 13.7% by weight. For teleosts, 32.1% of the observed catch was discarded. These give a total estimated discard ratio of 1:0.85. For the longline component of these fisheries, we have no direct estimates of discarding but can use the ratio from AFMA's observer data for the Commonwealth Gillnet, Hook and Trap fishery's Set longline (demersal longline) method of 1:0.47 (SE = 0.09).

The **Pilbara Fish Trawl (Interim)** Fishery uses otter trawling to target a variety of Emperors (F: *Lethrinidae*), snappers, Bream and Trevally. Sharks, Bugs (F: *Scyllaridae*), Cuttlefish (*Sepia apama*) and Squid are also landed. Stephenson and Chidlow (2003) provide the results from a 100 day observer programme done in the fishery in 2002 that examined bycatches. The estimated discard rate from that study was 34% or a retained:discard ratio of 1:0.52.

The **Exmouth Gulf Prawn** Fishery takes Western King Prawns, Brown Tiger Prawns, Endeavour Prawns (*Metapenaeus endeavouri* and *M. ensis*) and Banana Prawns. DPIRD (2019b) describes recent fishery-independent trawl biodiversity surveys that provide a discard ratio for this fishery of 1:0.675.

The **FBL condition 93 Purse Seine Development Zone** fishery targets schools of Pilchards and Sardinella (*Sardinella* spp.) using purse seines. Whilst Gaughan and Leary (2004) note that unwanted bycatch is insignificant, no actual discard rates are available so we assume the retained:discard ratio for the similar purse seine sector in the Commonwealth's Small Pelagic fishery of 1: 0.13 (SE = 0.07).

The **Abrolhos Islands and Mid West Trawl** fishery uses otter trawls to target Saucer Scallops (*Amusium balloti*) and Western King Prawns. In the last decade, this fishery has mainly focused on scallops using larger mesh (mostly the same vessels that fish for scallops in Shark Bay). We therefore apply the Shark Bay Scallop ratio of 1:0.5 for this fishery (see above).

The **Pilbara Trap** fishery uses fish traps of 50 mm x 70 mm rectangular mesh to target a variety of emperors, snappers and cods. DEH (2004a) note that bycatch in the fishery is unquantified, but considered low, consisting mostly of small quantities of many scalefish (including undersized fish of target species), sharks, crustaceans, molluscs and other invertebrates. Gaughan and Santoro (2018) note that there is a limited quantity of non-retained bycatch in this fishery with the most common species being the Starry Triggerfish (*Abalistes stellatus*). In the absence of any direct discard estimate, we use the ratio from the above-mentioned Northern Demersal Scalefish fishery (which also uses fish traps) of 1:0.013 (SE = 0.0002) (Newman et al. (2008).

The **Kimberley Prawn** fishery uses twin otter trawls to target Banana and Brown Tiger Prawns. Other byproduct species are Endeavour Prawns, Squid, Coral Prawns (F: *Penaeidae*), Black Tiger Prawns (*Penaeus monodon*), Western King Prawns, Bugs, fish, and other invertebrates (scallops, cuttlefish). DEH (2004b) notes that there has not been any survey of bycatch in this fishery. In the

absence of any direct discard estimates, we instead use the above DPIRD (2019b) estimate for the similar Exmouth Gulf prawn fishery (based on fishery-independent trawl biodiversity surveys) of 1:0.675

Hart et al. (2017) note that the fishing method used in the Western Australia **Abalone** fishery is hand-gathering with animals measured *in situ* prior to harvest. They say that, whilst unusual, undersize Abalone are occasionally collected but are usually replaced on the home scar after measurement. There may also be occasional discarding of undersize/undesirable/over-quota individuals, and this may vary with the experience of divers. Whilst the rate of such discarding has not been estimated for the Western Australian fishery, we have seen that, in NSW, such discarding is around 8.3% of landings (or a retained: discard ratio of 1:0.09 - Gibson et al., (2002). Hart et al. (2017) notes that abalone shells are also often encrusted with commensal species such as coralline algae, sponges and small invertebrates (also known as 'piggy-back' species). These organisms are harvested with the abalone and, if returned to the water (some shells are kept for sale), are unlikely to survive. There is no available information on the quantity of discarding that these 'piggy-back' species represent.

Gaughan and Santoro (2018) note that the hourglass traps used in the **Shark Bay Crab** fishery are designed to minimise the capture of undersized Blue Swimmer Crabs and non-target species, the majority of which are able to escape through the entrance gaps when the pot is soaking or being hauled. The number of bycatch species recorded in the fishery (mainly finfish and other invertebrates) is said to be low. But a discard rate was not provided for this method so we assume the ratio available for the similar Blue Crab fishery in South Australia of 1: 0.05. For the trawl sector of this fishery, we assume the ratio derived above for the Shark Bay Prawn fishery (which uses the same gear) of 1:0.96.

The **Pearl Oyster** fishery of Western Australia is a dive-based fishery using hand collection. We assume no bycatch or discarding from this fishery.

Gaughan and Santoro (2018) note that the **West Coast Purse Seine** fishery targets Australian Sardine (*Sardinops sagax*), Australian Anchovy (*Engraulis australis*), Yellowtail Scad (*Trachurus novaezelandiae*) and Maray (*Etrumeus teres*) using purse seine gear in waters between Geraldton and Cape Leeuwin. They state that small quantities of finfish species are sometimes taken as bycatch but no direct discard estimates are available. As was the case above for the South Coast Purse seine fishery, we assume the ratio for the similar purse seine sector in the Commonwealth's Small Pelagic fishery of 1: 0.13 (SE = 0.07).

The **FBL condition 73 South Coast Trawl** fishery is a low activity fishery in which effort is related to the abundance of Ballot's Saucer Scallop (*Ylistrum balloti*) in any given year, which can be highly variable due to sporadic recruitment. With no direct discard data available, we use the discard ratio for Zone C trawlers examined in Laurenson et al. (1993) of 1:1.56 (see also the South West Trawl Fishery below, which also uses otter trawls to target Saucer Scallops).

The **Nickol Bay Prawn** fishery uses otter trawls to target Western King, Brown Tiger, Endeavour and Banana Prawns as well as byproduct that includes Black Tiger and Coral Prawns, Bugs, Blue Swimmer Crabs, finfish and Scallops. DEH (2004c) notes that no discard information is available for the fishery, so we use the ratio for the similar Exmouth Gulf Prawn fishery (see above) of 1:0.675.

The **South Coast Salmon** fishery is one of the oldest commercial fisheries in WA. Fishers use a beach seine net to target Western Australian Salmon (*Arripis truttaceus*) but may also use a rod and line from the beach. It is a very targeted fishery and is assumed to have negligible discards but no specific discard rates are available. Instead we assume the retained:discard ratio obtained via an observer programme from the similar beach seine fishery of NSW of 1:0.002 (MRAG, 2005).

The **Shark Bay Beach Seine and Mesh Net** fishery uses a combination of beach seine, mesh net and haul net gears in the waters of inner Shark Bay. Four main species/groups are taken: Whiting, Sea Mullet, Tailor and Yellowfin Bream and smaller quantities of other species (e.g. Garfish and trevallies) are also caught. No direct discard data are available so we use ratios for the beach seine sector from the similar beach seine fishery of NSW of 1:0.002 (MRAG, 2005). For the haul net sector, we assume the ratio derived for a similar method in the West Coast Estuarine fishery (see below) of 1:0.01.

The **Kimberley Gillnet and Barramundi** fishery targets Barramundi and Threadfin using gillnets from the Northern Territory border to the top end of Eighty Mile Beach, south of Broome. As there are no direct estimates of discards from this fishery, we use data from an observer programme done in the Northern Territory in 2005 and from 2007 to 2011 in the similar NT Barramundi fishery which yielded an average ratio of 1:0.32 (SE 0.2).

Like the above-mentioned South Coast Salmon fishery, the **South West Coast Beach Net and South West Coast Salmon** fisheries use beach seines to target Salmon and other species off the south west coast of WA. With no direct discard rates available, we use the discard ratio from the similar beach seine fishery of NSW of 1:0.002 (MRAG, 2005).

The **West Coast Estuarine** fishery uses haul and gillnets to target various temperate estuarine finfish. Blue Swimmer Crabs and some Octopus are also caught using crab traps. Johnston et al. (2015) and the addendum WAF (2018) note that the haul nets used are deployed in a targeted manner, so that few non-target species are captured. Observer projects were done on haul net vessels in March 2015 and on both haul and gillnet vessels in 2017 and 2018. These confirmed negligible discards using these gears (<1% or a ratio of 1:0.01). A discard rate was not provided for the crab pot sector so we use the rate available for the similar NSW Estuary General Blue Swimmer Crab pot fishery of 1:0.122 (Leland et al., 2013).

Most of the commercial catch of Australian Herring (*Arripis georgianus*) in Western Australia is taken on beaches in the South Coast Bioregion using herring trap nets (also known as ‘G’ trap nets) which are set from the shore in the **FBL condition 42 herring** fishery. These nets are set in a configuration that resembles a '6' or 'G' and rely on the target species' natural circling behaviour

to remain in the net. They are set during the migration period of the target species and are assumed to catch negligible bycatch.

The **South West Trawl** Fishery uses otter trawls to target Saucer Scallops. As for the FBL condition 73 South Coast Trawl Fishery mentioned above, with no direct discard data available, we use the discard ratio for Zone C trawlers given in Laurenson et al. (1993) of 1:1.56.

The **West Coast Demersal Scalefish** fishery occurs in waters 20-250m deep and is comprised of approximately 100 different species – the most important being West Australian Dhufish (*Glaucosoma hebraicum*) and Pink Snapper. Less important species include Redthroat Emperor, Bight Redfish (*Centroberyx gerrardi*) and Baldchin Groper. Fishers are not allowed to take sharks and rays. The fishery uses a variety of hook-and-line methods including dropline, dropline and hydraulic gunwhale mounted reel, handheld reel and dropline, gunwhale mounted hand operated reel, electric gunwhale mounted reel, hydraulic gunwhale mounted reel and handheld reel. In the absence of any discard estimates direct from the fishery, we assume the average retained:discard ratio for similar methods used in NSW of 1:0.11 (SE = 0.04) (MacBeth and Gray, 2016).

The **West Coast Deep Sea Crustacean** fishery uses baited traps to target Crystal Crabs (*Chaceon albus*) on the seaward side of the 150 m isobath out to the extent of the Australian EEZ (200 nm) and from the Northern Territory border to Cape Leeuwin. How et al. (2015) and the addendum WAF (2017) report on a project that validated logbook reports of zero bycatch in the fishery. On-board cameras examined thousands of potlifts over 2 seasons (2014 and 2015) and all confirmed no bycatch in the fishery.

The **Cockburn Sound (Crab)** fishery uses baited pots to target Blue Swimmer Crabs. Like the Shark Bay Crab fishery, a discard rate was not available for this fishery so we use the rate available for the similar South Australian Blue Crab fishery of 1: 0.05 (PIRSA, 2009a; Svane and Hooper, 2004). The Western Australian **Sea Cucumber** fishery is a hand-harvest fishery, with animals caught principally by diving, and a smaller amount (< 5%) by wading. On occasion undersize Sea Cucumbers (F: *Holothuroidea*) or unwanted species may be collected by mistake and returned to the water but these discards are considered negligible (Webster and Hart, 2018).

The **Open Access in the North Coast, Gascoyne Coast and West Coast Bioregions** suite of fisheries uses a variety of methods to catch quite modest quantities of a variety of species. The methods include beach seine, potting, squid jigging, gillnet, hydraulic gunwhale mounted reel and haul net/ring net. No direct estimates of discards from these methods in these regions are available so we use rates from similar methods in other fisheries described earlier. For beach seine, we use the discard ratio from the similar beach seine fishery of NSW of 1:0.002 (MRAG, 2005). For potting, we assume the rate available for the similar NSW Estuary General blue swimmer crab pot fishery of 1:0.122 (Leland et al., 2013). For gillnets and haul nets, we use the Johnston et al. (2015) and WAF (2018) estimated ratio of 1:0.01 from the similar West Coast Estuarine fishery. For the hydraulic gunwhale mounted reel, we use the ratio for a similar method used in NSW (1:0.11, SE = 0.04) (MacBeth and Gray, 2016). For squid jigging, as done for similar methods in other jurisdictions, we assume negligible discards.

As for the suite of fisheries listed above, the **Open Access in the South Coast Bioregion** suite also uses a variety of methods to catch quite modest quantities of a variety of species. The methods include beach seine, haul net / ring net, handline, trolling, gillnet, squid jigging, electric gunwhale mounted reel, gunwhale mounted hand operated reel, handheld reel, hydraulic gunwhale mounted reel and dropline. And again, because no direct estimates of discards from these methods in this suite of fisheries are available, we use others from similar methods in other fisheries described earlier. For beach seine, we use the discard ratio from the similar beach seine fishery of NSW of 1:0.002 (MRAG, 2005). For gillnets and haul nets, we use the Johnston et al. (2015) and WAF (2018) estimated ratio of 1:0.01 for the West Coast Estuarine fishery. For the handline, electric gunwhale mounted reel, gunwhale mounted hand operated reel, handheld reel, hydraulic gunwhale mounted reel, trolling and dropline methods, we use the average ratio for similar methods used in NSW (1:0.11, SE = 0.04) (MacBeth and Gray, 2016). For squid jigging, as done for similar methods in other jurisdictions, we assume negligible discards.

Thirteen estuaries in WA's South Coast Bioregion are conditionally open to commercial fishing in the multispecies **South Coast Estuarine** fishery targeting many estuarine finfish species, with the main fishing methods being gill net and haul net. The main target species are Cobbler (*Cnidoglanis macrocephalus*), Black Bream, Sea Mullet and Australian Herring. Gaughan and Santoro (2018) note that few non-target species are taken in this fishery and minimal discarding occurs because virtually all caught fish can be retained and marketed. However, no discard rates are provided so we assume ratios derived above for the West Coast Estuarine fishery of 1:0.01 for the haul and gill net sectors, and the NSW ratio of 1:0.122 for the crab trap sector (Leland et al., 2013). For the estuarine fish trap sector we assume the NSW estimate for a similar method of 1:0.14 (Stewart and Ferrell, 2001; Stewart and Ferrell, 2003)

The **Gascoyne Demersal Scalefish** fishery operates throughout the year and uses various hook and line methods (electric gunwhale mounted reel, gunwhale mounted hand operated reel and handheld reel) to catch Pink Snapper and a range of other demersal snappers, emperors, cods and trevallies. In the absence of any discard estimates direct from the fishery, as above, we assume the average retained:discard ratio for similar methods used in NSW of 1:0.11 (SE = 0.04) (MacBeth and Gray, 2016).

As for the fishery above, the **Pilbara Line** fishery uses similar hook-and-line methods (electric gunwhale mounted reel, handheld reel and hydraulic gunwhale mounted reel) to catch a variety of fish species. In the absence of any discard estimates direct from the fishery, as above, we assume the average retained:discard ratio for similar methods used in NSW of 1:0.11 (SE = 0.04) (MacBeth and Gray, 2016).

The **Octopus** fishery mainly targets Octopus off the West and South coasts of Western Australia using trigger pots and shelter pots. Hart et al. (2018) provide some information about bycatch in the fishery citing a 3 month fishery-independent monitoring programme using trigger pots done in 2013. While not an observer programme, this study provides the best discard estimate available

for the fishery of 5% (a ratio of 1:0.05). We assume this same ratio for the less-often-used shelter pots.

The **Trochus** fishery uses hand collection methods in the intertidal so we assume zero discards.

The WA **Mackerel** Fishery targets mackerel species (predominantly Narrow-Barred Spanish Mackerel *Scomberomorus commerson*) between Geraldton and the Northern Territory border. The main fishing method used is trolling. Baits or lures are also drifted or cast from anchored or drifting boats and jigging is used to catch Grey Mackerel in the Gascoyne and West Coast sectors. DEH (2004d) noted that no formal information is available on the level or nature of bycatch in this fishery but Mackie et al. (2010) state that some finfish species including Queenfish, Pike (*Sphyraena* spp.), tunas and sharks are occasionally caught and discarded because they are unmarketable or of relatively low value. Further, these authors noted that a small number of finfish species are caught by the troll sector and discarded because fishers do not possess a license to retain them. In the absence of any discard estimates direct from the fishery, as for other hook-and-line fisheries, we assume the average retained:discard ratio for hook-and-line methods used in NSW of 1:0.11 (SE = 0.04) (MacBeth and Gray, 2016) for trolling, jigging and handheld reel methods in this fishery.

Like some of the other crab fisheries in Western Australia, the **Mandurah to Bunbury Developing Crab and Warnbro Sound Crab** fisheries use crab pots to target Blue Swimmer Crabs. And as for these other fisheries, because of the absence of any discard data for the method, we assume the ratio available for the similar South Australian Blue Crab fishery of 1:0.05 (PIRSA, 2009a; Svane and Hooper, 2004).

The **South Coast Crustacean** fishery uses pots to target Southern Rock Lobsters, Western Rock Lobsters and deep-sea crab species including Giant, Crystal and Champagne Crabs (*Hypothalassia acerba*) off the south coast of Western Australia. For the lobster potting sector of the fishery, in the absence of any direct discard estimates, and as above for the Western Rock Lobster fishery, we assume the retained:discard ratio for the similar South Australian lobster fishery of 1:0.91 (SE = 0.16). For the crab trap component of the fishery, and again in the absence of any direct discard estimates we use information from the West Coast Deep Sea Crustacean fishery (see above) where How et al. (2015) and the addendum WAF (2017) confirmed no bycatch.

The **Cockburn Sound (Line and Pot)** fishery is a small fishery targeting Octopus and other species using a variety of methods including shelter pots, octopus pots, squid jigging, handheld reel and handline. In the absence of any discard estimates direct from the fishery for shelter pots and octopus pots, we use the Hart et al. (2018) ratio available for the Octopus Interim Managed Fishery (above) of 1:0.05. For squid jigging, as done elsewhere, we assume negligible discards. For the handheld reel and handline sectors, as for other hook-and-line sectors, we assume the average retained:discard ratio for hook-and-line methods used in NSW of 1:0.11 (SE = 0.04) (MacBeth and Gray, 2016).

For the minor **FBL condition 74 Fish Trapping** fishery, fish traps are used to catch a variety of species. We assume the ratio from the Northern Demersal Scalefish fishery which uses fish traps (see above) of 1:0.013 (SE = 0.0002) (Newman et al., 2008).

South Australia

For some fisheries/methods in South Australia, there exists some observer data whilst for others, bycatch data are available from fishery-independent surveys and/or unvalidated industry logbooks. For the remaining fisheries/methods, however, there are no direct measures of discarding so, as we have done for other jurisdictions, we use discard rates from similar fisheries/methods in other jurisdictions and fisheries. Taking each fishery in turn:

The South Australian **Marine Scalefish Fishery** occurs in all South Australian coastal waters including gulfs, bays and estuaries (excluding the Coorong estuary – see below). It uses a diverse range of fishing methods to target many permitted species. In all there are a total of 21 different gear types with the dominant ones being hook-and-line, longline, haul nets, mesh nets, traps and jigs. Fowler et al. (2009) describes an observer study done in the fishery over 122 fishing days in 2007-08 which counted numbers (not weights) of fish retained and discarded by the gear types of handline, haul nets and longlines. Assuming individual weights of discarded organisms were a third that of retained animals, the resulting retained:discard ratios were: handlines - 1:0.065 (SE = 0.016), haul nets - 1:0.17 (SE = 0.053) and longlines - 1:0.118 (SE = 0.057).

The **Miscellaneous** fishery includes certain specialised fisheries and species that are not included in the management arrangements of other fisheries. It uses several types of fishing methods and many of the sectors are low production, low value, or both. Species taken include: Sea Urchins, Scallops, Native Oyster (*Ostrea angasi*), Western Australian Salmon, beachcast seagrass and macro-algae, Eyre Golden Perch (*Macquaria ambigua*), Welch's Grunter (*Bidyanus welchi*) and Barcoo Grunter (*Scortum barcoo*).

Landings data for the Marine Scalefish and Miscellaneous fisheries are available for only 3 of the main gear types used (lines, nets and traps) so for line-caught landings, we use the discard ratios derived from the above-mentioned study of handlining and longlines (average ratio of 1:0.078, SE = 0.018), for the net-caught landings we use the above-mentioned discard ratio from haul nets (1:0.17, SE = 0.053) and for trap-caught landings we use the discard ratio from the similar fish trap fishery in NSW (the NSW Trap and Line fishery) of 1:0.019 (Stewart and Ferrell, 2001; Stewart and Ferrell, 2003; Stewart and Hughes, 2008). For the "other" remaining landings, we assume the average discard ratio of all these ratios (1:0.102, SE = 0.023).

The **Prawn Trawl** fishery of South Australia involves using demersal otter trawls in 3 regions: Gulf St Vincent, Spencer Gulf and the West Coast. The fishery targets Western King Prawns and can retain the by-product species Balmain Bugs (*Ibacus novemdentatus*) and Southern Calamari (*Sepioteuthis australis*). Several studies have been done in Spencer Gulf that provide information about discards in this fishery. For example, Currie et al. (2009) describe a fishery-independent survey of 120 sites done over 4 nights in 2007 involving typical commercial fishing gear. This study

obtained a retained:discard ratio of 1:6 (SE = 1.0). Furthermore, the older studies of Carrick (1997) estimated an overall ratio of 1:3.5 from an observer programme whilst McShane et al. (1998) estimated a ratio of 1:2.

The above studies, however, were done quite some time ago, before the fishery underwent significant changes in management. The most representative discard estimates available come from recent experimental studies developing bycatch reduction devices for the fishery (Kennelly and Broadhurst, 2014; Noell et al., 2018). Control data from 4 experiments done in 2014, 2015 and 2016 (conducted under normal commercial fishing conditions) provided an average retained:discard ratio of 1:1.53 (SE = 0.43).

Approximately 50 species are landed in the **Lakes and Coorong** fishery, the key ones being: Pipis (or Goolwa Cockles *Donax deltoides*), Mulloway (*Argyrosomus japonicus*), Yellow-Eye Mullet (*Aldrichetta forsteri*), Black Bream, Greenback Flounder (*Rhombosolea tapirina*), Golden Perch (*Macquaria ambigua*) and European Carp. The main byproduct species are Bony Bream (*Nematalosa erebi*) and Yabbies (*Cherax destructor*). This is a multi-gear fishery which uses mesh nets, swinger nets, hauling nets, bait nets, drop/hook nets, dab nets, drum nets, cockle rakes, cockle nets, crab rakes, yabbie traps, shrimp traps, set lines, razor fish tongs, fish spears and electro-fishing gear. Ferguson (2010) describes an observer study done in 2005/06 which focussed on large and small mesh nets in the fishery (the main non-Pipi methods used). A total of 53 observer trips yielded an overall retained:discard ratio of 1: 0.171 (SE = 0.0001). Ferguson and Hooper (2017) provide some information about discarding from the Pipi sector of this fishery using logbook information from commercial fishers. The retained:discard ratio derived in that study for 2010 to 2016 was 1: 0.198 (SE = 0.047).

The South Australian **Rock Lobster** fishery uses lobster traps to catch Southern Rock Lobster. As was the case for Tasmania and Victoria, we are fortunate to have available the results of the recently completed project by Leon et al. (2019). Estimated discards for South Australia's lobster fishery were 49.6% in the northern zone (a ratio of 1:0.98) and 40.0% in the southern zone (1:0.83).

The **Abalone** fishery targets Greenlip and Blacklip Abalone (*Haliotis laevigata* and *H. rubra*) by hand collection while diving on hookah. By-catch is limited to the unavoidable removal of encrusting and boring organisms that live on abalone shells, such as limpets and algae and, as we've seen for other jurisdictions, there may also be occasional discarding of undersize/undesirable/over-quota individuals, which may vary with the experience of divers. Whilst the rate of such discarding has not been estimated for the South Australian fishery, we have seen that, in NSW, such discarding is estimated to be 8.3% of landings (or a retained: discard ratio of 1:0.09 - Gibson et al., 2002).

The South Australian **Blue Crab** fishery uses crab pots to target Blue Crabs (or Blue Swimmer Crabs). Other crab species (Rock Crabs *Ozius truncatus*, Spider Crabs F: *Majidae* and Velvet Crabs *Dumea latipes* and *Nectocarcinus tuberculosus*) may also be landed and sold as by-product or used

as personal bait. PIRSA (2009a) and Svane and Hooper (2004) describe the information available concerning the composition and quantity of bycatch in this fishery through SA's annual Fishery Independent Surveys (FIS). This work noted that bycatch in the Blue Crab Fishery is low and mainly comprises other crab species that can either be retained as by-product or returned to the water alive. During surveys done in 2002, 2003 and 2004, which used commercial and research traps (the latter made of smaller mesh), 95% of bycatch were crabs that could be landed and only 5% were non-crab species that were discarded. This provides a retained:discard ratio of 1: 0.05 which, whilst not a true observer programme assessing typical commercial fishing, is the best discard estimate available.

The large South Australian **Sardine** fishery targets the Australian Sardine with Australian Anchovy, Redbait (*Emmelichthys nitidus*) and Mackerel (*Scomber australasieus*) also landed. The fish are primarily used as feed for the aquaculture of Southern Bluefin Tuna (*Thunnus maccoyii*), with small amounts also sold for human consumption and bait. PIRSA (2009b) notes that logbook data and observations by SARDI staff suggest that bycatch in the fishery is low and occasionally includes crustaceans, mackerels, sprat (*Sprattus* spp.), molluscs and sharks. But since no direct discard data are available for this fishery, we assume the retained:discard ratio derived from AFMA's observer programme for the similar purse seine sector in the Commonwealth's Small Pelagic fishery of 1: 0.13 (SE = 0.07).

Commercial fishing for **Giant Crabs** is not formally identified as a discrete fishery in South Australia but is usually included as one of the Miscellaneous fisheries described earlier. However, because separate landings data were provided by SARDI for this sector, we also treat it separately here. Whilst no direct discard estimates are available for this fishery in South Australia, we know from PIRSA (2018) that it is likely that by-catch could include Hermit Crabs, other crabs, Leather Jackets, Bearded Rock Cod (*Pseudophycis barbata*) and Octopus. Without discard estimates from SA, we can use information from the similar Tasmanian Giant Crab fishery (Emery et al., 2015b) which led to an estimated ratio of 1:0.51.

Commonwealth fisheries

From a bycatch perspective, the major point about most of the Commonwealth's many fisheries/methods is the fact that AFMA has very good estimates of discards due to its long-running observer programmes. In addition, AFMA have very good data handling procedures so that all industry logbook data and observer data are, for the most part, complete and were made available for this project. As a result, the discard information available for Commonwealth fisheries is, by far, the best of any jurisdiction in Australia. Taking each fishery in turn:

The **Coral Sea** fishery uses trawls, traps, various hook-and-line and hand collection methods to catch a variety of species in the Coral Sea. AFMA's observer data provides discard estimates for the bottom trawl, dropline, auto-longline, set longline and fish trap sectors of the fishery (see Table 3) but not for the other methods. For diving and hand collection methods, we can assume negligible discards. For trotline, we can use the observer estimate for the similar set longline method in the fishery (a retained:discard ratio of 1:0.01). For handlines, hooks, and rod and reel

sectors, we can apply the retained:discard ratio for the dropline sector in the same fishery of 1:0.01.

The **East Coast Deepwater** fishery uses trawls in the area adjacent to (but not within 25 nautical miles of) Lord Howe Island. AFMA's observer data provides good discard estimates for both the bottom and midwater trawl sectors of the fishery (1:0.14 and 1:0.06, respectively - Table 3).

The **Eastern Tuna and Billfish** fishery targets tuna and billfish off the east coast of Australia using a variety of hook and line methods and gillnets. AFMA's observer data provides good discard estimates for the drifting longline sector of the fishery (Table 3) but the other methods do not have direct observer data available. For these we use other discard ratios from other fisheries. For handlining, pole and line, trolling and rod and reel sectors, we use the ratio from the observer data from the Gillnet, Hook and Trap dropline fishery of 1:0.15 (SE = 0.05)(see below). Similarly, for set gillnet, we use the ratio from the observer data for the set gillnet sector in the Gillnet, Hook and Trap fishery of 1: 0.77 (SE = 0.04). For the set longline and trotline sectors, we use the estimate from the set auto-longline method used in the Gillnet, Hook and Trap fishery of 1:0.47 (SE = 0.09).

The **Gillnet, Hook and Trap** fishery targets sharks and scalefish off southern and eastern Australia using gillnets, hooks and traps. AFMA's observer data provides discard estimates for the dropline, fish trap, set auto-longline and set gillnet sectors of the fishery (Table 3) but the other methods do not have observer data available. For handlining, hooks, trolling and rod and reel sectors, we use the rate for the dropline sector in the fishery (1:0.15, SE = 0.05). For the set longline and trotline sectors, we use the estimate from the set auto-longline method in the fishery of 1:0.47 (SE = 0.09).

The **Great Australian Bight** fishery uses trawls in the Great Australian Bight to catch a variety of species. AFMA's observer data provides discard estimates for the trawl, bottom otter trawl, bottom pair trawl and Danish seine sectors of the fishery (Table 3) but the other methods do not have direct observer data available. For the bottom otter twin trawl sector, we use the retained:discard ratio for the bottom otter trawl sector in the same fishery of 1:1.51 (SE = 0.13). For the midwater trawl sector, we use the ratio for the South East Trawl mid water trawl sector of 1:0.07 (SE = 0.05)(see below).

The **High Seas Non-trawl** fishery uses various hook and line methods to catch demersal fish in high-seas areas of the South Pacific and Southern Indian Oceans. AFMA's observer data provides discard estimates for the dropline and set auto-longline methods in the fishery (Table 3) but not for the other methods. For the drifting longline method we use the ratio from the same method in the Eastern Tuna and Billfish fishery of 1:0.47 (SE = 0.22)(see above). For handlining we apply the ratio for droplining (1:0.12, SE = 0.08) and for set longline, we use the ratio for set auto-longline (1:0.06, SE = 0.01), in the same fishery.

The **High Seas Trawl** fishery operates similarly as the above fishery but uses trawl gear. AFMA's observer data provides good discard estimates for both trawl methods used (Table 3).

The **Informally Managed** fishery uses small-scale purse seines to catch schooling fish in southern Australia. Since no direct observer data are available, we use the retained:discard ratio for the similar purse seine sector in the Small Pelagic fishery of 1: 0.13 (SE = 0.07)(see below).

The **Kimberley Prawn Trawl** fishery uses trawls to mainly target Banana Prawns off northern Western Australia. No direct observer data are available for this fishery so we use the ratio for trawling Banana Prawns in the Northern Prawn fishery of 1:1.36 (SE = 0.25)(see below).

The **North West Slope** fishery uses trawl gear to target deepwater prawns. AFMA's observer data provides a good discard estimate for this method (Table 3).

The **Northern Prawn** fishery uses trawls to target Banana and Tiger Prawns off Australia's northern coast from Cape York to Cape Londonderry. A special examination of the observer data was done by AFMA to provide retained:discard ratios for this project. It involved obtaining the average total bycatch recorded per trawl by observers each year between 2010-18 and multiplying this by the average total number of trawls done in the same year. Comparing this to the total catches of targeted species for each year gave annual discard ratios. This treatment provided an average retained:discard ratio when targeting tiger prawns of 1:3.92 (SE = 0.52), and when targeting Banana Prawns of 1:1.36 (SE = 0.25).

The **Scallop** fishery targets scallops using dredges in Bass Strait. No observer data are directly available to estimate discards in this fishery but we can use the ratio assumed for the similar Tasmanian fishery of 1: 0.11 (Haddon et al., 2006; AFMA, 2015).

The **Small Pelagic** fishery uses trawls and purse seines to target Jack Mackerel (*Trachurus declivis*) and other small pelagic fish off southern and eastern Australia. AFMA's observer data provides discard estimates for the bottom otter trawl, midwater otter trawl and purse seine sector (Table 3) but not for the squid jig sector. However, squid jigging is known to be a very selective method so we assume negligible discards for this sector.

The **South East Trawl** fishery is also called the Commonwealth Trawl fishery and involves trawling for mixed species off southeast Australia. AFMA's observer data provides good discard estimates for the bottom otter trawl, bottom pair trawl, Danish seine and midwater otter trawl sectors (Table 3) but not for the set gillnet sector. For this latter sector we use the discard ratio for the same method in the Gillnet, Hook and Trap fishery of 1:0.77 (SE = 0.04)(see above).

The **Southern Bluefin Tuna** fishery mainly uses purse seines to target Southern Bluefin Tuna (*Thunnus maccoyii*) around the Australian coastline out to 200 nm. AFMA's observer data provides good discard estimates for the main method used (purse seine – Table 3) but not for the other methods. For the dropline, handline, pole and line, trolling and rod and reel sectors, we use the discard rate from the Gillnet, Hook and Trap dropline method of 1:0.15 (SE = 0.05)(see above).

The **Squid Jig** fishery targets Squid off southern and eastern Australia. It is known as a very selective method that we assume has negligible discards.

The **Torres Strait** fishery (including its prawn trawl sector) uses a variety of methods to target several species in Torres Strait. AFMA's observer programme provides no information about discards in the fishery except an estimate for bottom shrimp trawling (Table 3). For the other methods, we assume that free diving, general diving and miscellaneous hand collection have negligible discards. For the dropline, handline, trolling and hooks sectors, we use the discard ratio from the Gillnet, Hook and Trap dropline fishery of 1:0.15 (SE = 0.05) (see above).

The **Western Deepwater Trawl** fishery involves trawling for mixed species in water deeper than 200 metres off the coast of Western Australia from Exmouth to Augusta. AFMA's observer data provides good discard estimates for the bottom otter trawl sector which we also apply to the bottom pair trawl and Danish seine sectors in the same fishery (Table 3).

The **Western Tuna and Billfish** fishery targets tuna and billfish off the southern and western coasts of Australia. There are no direct estimates of discards from the AFMA observer programme so for the handline, hooks, trolling and pole and line sectors, we use the ratio from the Gillnet, Hook and Trap dropline fishery of 1:0.15 (SE = 0.05) (see above), and for the drifting longline sector we use the ratio for the same method in the Eastern Tuna and Billfish fishery (1:0.47, SE = 0.22 – see above).

The retained:discarded ratios derived above for each fishery/method and discard rate (expressed as a percentage of total catch) for each jurisdiction are provided in Table 3 below.

Table 3 – Derived retained:discard ratios and percentage discard rates for Australia's various fisheries and fishing methods. Also provided are the methods used to obtain each discard estimate, their source and reference(s). Where only 1 record was available, no SE was calculated.

	Fishery	Method	Retained: Discard Ratio (1:x)	SE	Discard %	Method of discard data collection	Source of estimate	Reference(s)
New South Wales	Estuary General	Meshing net	0.14	0.04	12.65	a	This fishery	Gray, 2002; Gray et al, 2005
		Hauling net (general purpose)	1.11	0.30	52.58	a	This fishery	Gray et al., 2001; Gray and Kennelly, 2003
		Prawn net (set pocket)	0.24	0.11	19.03	a	This fishery	Andrew et al, 1995; Gray, 2004; Gray et al, 2006
		Crab trap	0.14	0.01	12.45	a, c	This fishery	Butcher et al., 2012; Leland et al., 2013; Broadhurst et al., 2015a
		Fish trap (bottom/demersal)	0.14		12.28	c	This fishery	Stewart and Ferrell, 2001, 2003
		Flathead net	0.90	0.27	47.29	a	This fishery	Gray et al., 2004
		Eel trap	0.74		42.53	c	Victorian Eel	McKinnon and Milner, 2009
		Prawn net (hauling)	0.25	0.10	20.14	a	This fishery	Gray et al., 2003; MacBeth and Gray, 2008
		Handgathering for pipis and beachworms	0.13	0.02	11.11	a	This fishery	Gray, 2016
		Prawn running net	0.14	0.02	12.09	a	This fishery	Gray, 2004; Gray et al., 2006; Gray, unpub data
		Seine net (prawns)	0.49	0.21	32.89	a	This fishery	Gray, 2001; Gray, 2004; Gray et al., 2006; MacBeth and Gray, 2008
		Bait net	0.00		0.00	d		
		Garfish net (bullringing)	0.04		3.85	a	NSW Ocean Haul Garfish net (hauling) - beach based	Stewart, 2007; 2008
		Handline	0.14		12.28	a	NSW Ocean Trap and Line Handline	MacBeth and Gray, 2016
		Pilchard, anchovy and bait net - beach based	0.00		0.00	d		
		Setline	0.13		11.66	a	NSW Ocean Trap and Line Handline	MacBeth et al., 2009
		Dip or scoop net (prawns)	0.00		0.00	d		
		Hoop or lift net	0.07	0.04	6.63	a, c	This fishery	Broadhurst et al., 2015b; Leland et al., 2013

	Estuary Prawn Trawl	Otter trawl net (prawns)	0.24	0.14	19.34	a	This fishery	Kennelly et al., 1992; Kennelly and Liggins, 1992; Kennelly, 1993; Liggins et al., 1996; Liggins and Kennelly, 1996
	Ocean Trawl	Otter trawl net (prawns)	2.00	0.53	66.68	a	This fishery	Kennelly, 1993; Kennelly et al, 1998
		Otter trawl net (fish)	0.84	0.20	45.78	a	This fishery	Liggins, 1996
	Ocean Hauling	Hauling net (general purpose)	0.00		0.20	a	This fishery	MRAG, 2005
		Purse seine net	0.13	0.07	11.33	a	Commonwealth Small Pelagic	AFMA Observer database
		Pilchard, anchovy and bait net - beach based	0.00		0.00	d		
		Garfish net (hauling) - boat based	0.04		3.85	a	NSW Ocean Haul Garfish net (hauling) - beach based	Stewart, 2007, 2008
		Garfish net (hauling) - beach based	0.04		3.85	a	This fishery	Stewart, 2007, 2008
	Ocean Trap and Line	Fish trap (bottom/demersal)	0.02		1.86	c	This fishery	Stewart and Ferrell, 2001; Stewart and Ferrell, 2003; Stewart and Hughes, 2008
		Handline	0.14		12.28	a	This fishery	MacBeth and Gray, 2016
		Trolling	0.14		12.28	a	NSW Ocean Trap and Line Handline	MacBeth and Gray, 2016
		Setline (demersal)	0.15		13.04	a	This fishery	MacBeth and Gray, 2016
		Spanner crab net	0.31	0.02	23.92	b	Qld Spanner Crab	DEEDI, 2011f
		Jigging	0.14		12.28	a	NSW Ocean Trap and Line Handline	MacBeth and Gray, 2016
		Dropline	0.07		6.54	a	This fishery	MacBeth and Gray, 2016
		Setline	0.13		11.66	a	This fishery	MacBeth et al., 2009
		Poling	0.14		12.28	a	NSW Ocean Trap and Line Handline	MacBeth and Gray, 2016
		Trotline (bottom set)	0.15		13.04	a	NSW Ocean Trap and Line Setline	MacBeth and Gray, 2016
		Driftline	0.14		12.28	a	NSW Ocean Trap and Line Handline	MacBeth and Gray, 2016
	Abalone	Diving	0.09		8.26	a	This fishery	Gibson et al., 2002
	Lobster	Trapping	0.84		45.65	a	This fishery	NSW DPI, 2004
	Others	Danish seine trawl net (fish)	0.96	0.09	49.02	a	Commonwealth Southeast Trawl Danish Seine	AFMA Observer database

		Pilchard, anchovy and bait net - boat based	0.00		0.00	d		
		Skindiving	0.00		0.00	d		
	Special Permits	Purse seine net	0.13	0.07	11.33	a	Commonwealth Small Pelagic	AFMA Observer database
		Scallop Dredge	0.11		9.91	a, b	Bass Strait Scallop	Haddon et al., 2006, AFMA, 2015
		Submersible Lift Net	0.07	0.04	6.63	a, c	NSW Estuary General Hoop or Lift net	Broadhurst et al., 2015b; Leland et al., 2013
		Eel trap	0.74		42.53	c	Victorian Eel	McKinnon and Milner, 2009
Tasmania	Abalone	Dive	0.09		8.26	a	NSW Abalone	Gibson et al., 2002
	Southern Rock Lobster	Pots	3.52		77.90	a, b	This fishery	Leon et al., 2019
	Scallop	Dredge	0.11		9.91	a, b	This fishery	Haddon et al., 2006, AFMA, 2015
	Octopus	Pots (unbaited)	0.00		0.00	d		Gardner, pers. comm.
	Giant Crab	Pots	0.51		33.78	a	This fishery	Emery et al., 2015b, Hartmann and Gardner, 2011
	Scalefish	Automatic squid jig	0.00		0.00	d		
		Beach seine	0.00		0.20	a	NSW Ocean Haul	MRAG, 2005
		Purse seine	0.13	0.07	11.33	a	Commonwealth Small Pelagic	AFMA Observer database
		Graball net	0.36		26.45	a	This fishery	Lyle et al., 2014
		Hand line	0.14		12.28	a	NSW Ocean Trap and Line Handline	MacBeth and Gray, 2016
		Danish seine	0.96	0.09	49.02	a	Commonwealth Southeast Trawl Danish Seine	AFMA Observer database
		Squid-jig	0.00		0.00	d		
		Dip-net	0.00		0.00	d		
		Small mesh net	0.66		39.82	a	This fishery	Lyle et al., 2014
		Troll	0.14		12.28	a	NSW Ocean Trap and Line Handline	MacBeth and Gray, 2016
		Fish trap	0.02		1.86	c	NSW Ocean Trap and Line Fish trap	Stewart and Ferrell, 2001; 2003; Stewart and Hughes, 2008
		Drop-line	0.07		6.54	a	NSW Ocean Trap and Line Dropline	MacBeth and Gray, 2016
		Spear	0.00		0.00	d		
		Hand collection	0.00		0.00	d		

	Commercial Dive and Shellfish	Hand Collection	0.00		0.00	d		
Northern Territory	Demersal	Trap, handline, dropline, demersal trawl	0.16	0.01	13.81	a	This fishery	NT Fisheries Observer database
	Timor Reef	Trap, handline, dropline, demersal trawl, longline	0.10	0.03	9.44	a	This fishery	NT Fisheries Observer database
	Barramundi	Gillnet	0.32	0.20	24.17	a	This fishery	NT Fisheries Observer database
	Offshore Net and Line	Gillnet, longline	0.18	0.04	15.52	a	This fishery	NT Fisheries Observer database
	Spanish Mackerel	Troll, baited line	0.14		12.28	a	NSW Ocean Trap and Line Handline	MacBeth and Gray, 2016
	Mud Crab	Pot and baited gillnet	0.14	0.01	12.45	a, c	NSW Estuary General Mud crab	Butcher et al., 2012, Leland et al., 2013, Broadhurst et al., 2015a
	Coastal line	Hook and line	0.10		8.68	a	Queensland Gulf of Carpentaria Line and Coral Reef Finfish	Roelofs, 2004a
	Trepang	Hand gathering	0.00		0.00	d		
	Restricted Bait	Bait net	0.00		0.00	d		
	Aquarium Display	Hand gathering	0.00		0.00	d		
	Coastal net	Gillnet	0.05		4.85	a	Queensland Gulf of Carpentaria Inshore Finfish	Halliday et al., 2001, Roelofs, 2004b.
Queensland	Coral	Hand harvest	0.00		0.00	d		
	Crayfish and Rocklobster	Hand harvest	0.00		0.00	d		
	East Coast Pearl	Hand harvest	0.00		0.00	d		
	Marine Aquarium Fish	Hand harvest	0.00		0.00	d		
	Eel Fishery	Fyke and other nets	0.74		42.53	c	Victorian Eel	McKinnon and Milner, 2009
	Sea Cucumber Fishery (East Coast)	Hand harvest	0.00		0.00	d		
	Trochus	Hand harvest	0.00		0.00	d		
	Coral Reef Finfish	Hook and line	0.16		13.79	a	This fishery	Andersen et. al., 2004, Mapstone et al., 2001
	Deep Water Finfish	Hook and line	0.12	0.02	10.95	a	NSW Ocean Trap and Line Handline	Macbeth et al., 2009; MacBeth and Gray 2016
	East Coast Spanish Mackerel	Hook and line	0.14		12.28	a	NSW Ocean Trap and Line Handline	MacBeth and Gray, 2016
	Gulf of Carpentaria Line	Hook and line	0.10		8.68	a	Queensland East Coast Coral Reef Fin Fish	Roelofs, 2004a
	Rocky Reef Finfish	Hook and line	0.10	0.03	9.44	a	NT Timor Reef	NT Fisheries Observer database

	East Coast Inshore Finfish Fishery	Nets	0.06	0.01	5.75	a	This fishery	Halliday et al., 2001
	Gulf of Carpentaria Inshore Finfish	Nets	0.05		4.85	a	This fishery	Halliday et al., 2001 and Roelofs, 2004b.
	Blue Swimmer Crab	Crab traps	0.12		10.87	a	NSW Estuary General blue swimmer crab	Leland et al., 2013
	Mud Crabs	Crab traps	0.30	0.04	22.96	a	Double NSW Estuary General Mud crab	Butcher et al., 2012; Broadhurst et al., 2015; Leland et al., 2013
	Spanner Crabs	Spanner crab net	0.23	0.01	18.70	b	This fishery	DEEDI, 2011f
	East Coast Otter Trawl	Trawl	3.35	0.14	77.01	a, b	This fishery	Wang et al., 2019
	Gulf of Carpentaria Developmental Fin Fish Trawl	Trawl	0.64		38.99	a	This fishery	DEEDI, 2011g
	River and Inshore Beam Trawl	Trawl	0.25		20.00	a	This fishery	DEEDI, 2009
Victoria	Abalone	Dive	0.09		8.26	a	NSW Abalone	Gibson et al., 2002
	Rock Lobster	Pots	1.11	0.30	52.61	a, b	This fishery	Leon et al., 2019
	Ocean (General)	Drop Line	0.07		6.54	a	NSW Ocean Trap and Line Dropline	MacBeth and Gray, 2016
		Hand Line	0.14		12.28	a	NSW Ocean Trap and Line Handline	MacBeth and Gray, 2016
		Shark Long Line	0.13		11.66	a	NSW Ocean Trap and Line Shark Longline	MacBeth et al., 2009
		Snapper Long Line	0.15		13.04	a	NSW Ocean Trap and Line Longline	MacBeth and Gray, 2016
		Octopus Trap/Pot	0.00		0.00	d	Tas Octopus	Gardner, pers. comm.
	Westernport/Port Phillip Bay	Haul Seine	1.11	0.30	52.58	a	NSW Estuary General Haul	Gray et al., 2001; Gray and Kennelly, 2003; Gray et al., 2003
		Multifilament Mesh	0.15	0.04	12.66	a	NSW Estuary General Meshnet	Gray, 2002; Gray et al., 2005
		Snapper Long Line	0.15		13.04	a	NSW Ocean Trap and Line Longline	MacBeth and Gray, 2016
		Purse Seine	0.13	0.07	11.33	a	Commonwealth Small Pelagic	AFMA Observer database
		Garfish Seine	0.04		3.85	a	NSW Ocean Haul Garfish net (hauling) - beach based	Stewart, 2007; Stewart, 2008
	Corner Inlet	Ringing Seine	1.11	0.30	52.58	a	NSW Estuary General Haul	Gray et al., 2001; Gray and Kennelly, 2003; Gray et al., 2003
		Multifilament Mesh	0.15	0.04	12.66	a	NSW Estuary General Meshnet	Gray, 2002; Gray et al., 2005

		Haul Seine	1.11	0.30	52.58	a	NSW Estuary General Haul	Gray et al., 2001; Gray and Kennelly, 2003; Gray et al., 2003
	Bait (General)	Bait Pump	0.00		0.00	d		
		Yabbie Pot	0.00		0.00	d		
	Eel	Fyke net	0.74		42.53	c	This fishery	McKinnon and Milner, 2009
	Gippsland Lakes	Multifilament Mesh	0.15	0.04	12.66	a	NSW Estuary General Meshnet	Gray, 2002; Gray et al., 2005
		Prawn Stake Net	0.24	0.15	19.03	a	NSW Prawn Set Pocket Net	Andrew et al, 1995, Gray et al, 2006, Gray, 2004
	Trawl (Inshore)	Prawn Trawl	2.00	0.53	66.68	a	NSW Ocean Prawn Trawl	Kennelly, 1993; Kennelly et al., 1998
	Gippsland Lakes (Bait)	Bait Pump	0.00		0.00	d		
	General (Sea Urchin)	Dive	0.00		0.00	d		
	Wrasse (Ocean)	Handline	0.14		12.28	a	NSW Ocean Trap and Line Handline	MacBeth and Gray, 2016
	Giant Crab	Pots	0.51		33.77	a	Tas Giant Crab	Emery et al., 2015
Western Australia	West Coast Rock Lobster Managed Fishery	Potting	0.91	0.16	47.64	a, b	SA Lobster	Leon et al., 2019
	South Coast Purse-Seine Managed Fishery	Purse Seine	0.13	0.07	11.33	a	Commonwealth Small Pelagic	AFMA Observer database
	Shark Bay Prawn Managed Fishery	Trawling	0.96		48.98	b	This fishery	DPIRD, 2019a
	Northern Demersal Scalefish Fishery	Fish Trap	0.01	0.00	1.28	a	This fishery	Newman et al., 2008
	Joint Authority Southern Demersal Gillnet and Demersal Longline Managed Fishery	Gillnet	0.85		45.95	a	This fishery	McAuley and Simpfendorfer, 2003
		Longline	0.47	0.09	31.97	a	Commonwealth Gillnet, Hook and Trap	AFMA Observer database
	Pilbara Fish Trawl (Interim) Managed Fishery	Trawling	0.52		34.21	a	This fishery	Stephenson and Chidlow, 2003
	Exmouth Gulf Prawn Managed Fishery	Trawling	0.68		40.30	b	This fishery	DPIRD, 2019b
	Shark Bay Scallop Managed Fishery	Trawling	0.50		33.33	a	This fishery	Kangas and Thomson, 2004, Kangas et al., 2007
	FBL condition 93 Purse Seine Development Zone	Purse Seine	0.13	0.07	11.33	a	Commonwealth Small Pelagic	AFMA Observer database
	Abrolhos Islands and Mid West Trawl Managed Fishery	Trawling	0.50		33.33	a	WA Shark Bay Scallop	Kangas and Thomson, 2004, Kangas et al., 2007
	Pilbara Trap Managed Fishery	Fish Trap	0.01	0.00	1.28	a	WA Northern Demersal Scalefish	Newman et al., 2008

	Kimberley Prawn Managed Fishery	Trawling	0.68		40.30	b	WA Exmouth Gulf Prawn	DPIRD, 2019b
	Abalone Managed Fishery	Diving	0.09		8.26	a	NSW Abalone	Gibson et al., 2002
	Shark Bay Crab Managed Fishery	Crab Trap	0.05		4.76	b	SA Blue Crab	PIRSA, 2009a; Svane and Hooper, 2004
		Trawling	0.96		48.98	b	WA Shark Bay Prawn	DPIRD, 2019b
	Pearl Oyster Managed Fishery	Diving	0.00		0.00	d		
	West Coast Purse Seine Fishery	Purse Seine	0.13	0.07	11.33	a	Commonwealth Small Pelagic	AFMA Observer database
	FBL condition 73 South Coast Trawl Fishery	Trawling	1.56		60.94	a	This fishery	Laurenson et al., 1993
	Nickol Bay Prawn Managed Fishery	Trawling	0.68		40.30	b	WA Exmouth Gulf Prawn	DPIRD, 2019b
	South Coast Salmon Managed Fishery	Beach Seine	0.00		0.20	a	NSW Beach Seine	MRAG, 2005
	Shark Bay Beach Seine and Mesh Net Managed Fishery	Beach Seine	0.00		0.20	a	NSW Beach Seine	MRAG, 2005
		Haul Net / Ring Net	0.01		0.99	a	WA West Coast Estuarine	Johnston et al., 2015, WAF, 2018 addendum
	Kimberley Gillnet and Barramundi Managed Fishery	Gillnet	0.32	0.20	24.17	a	NT Barramundi	NT Fisheries Observer database
	West Coast Demersal Gillnet and Demersal Longline (Interim) Managed Fishery	Gillnet	0.85		45.95	a	This fishery	McAuley and Simpfendorfer, 2003
		Longline	0.47	0.09	31.97	a	Commonwealth Gillnet, Hook and Trap	AFMA Observer database
	South West Coast Beach Net Fishery (Order)	Beach Seine	0.00		0.20	a	NSW Beach Seine	MRAG, 2005
	West Coast Estuarine Managed Fishery	Crab Trap	0.12		10.87	a	NSW Estuary General blue swimmer crab	Leland et al., 2013
		Gillnet	0.01		0.99	a	This fishery	Johnston et al., 2015, WAF, 2018 addendum
		Haul Net / Ring Net	0.01		0.99	a	This fishery	Johnston et al., 2015, WAF, 2018 addendum
	FBL condition 42 herring	Trap Net	0.00		0.00	d		
	South West Coast Salmon Managed Fishery	Beach Seine	0.00		0.20	a	NSW Beach Seine	MRAG, 2005
	South West Trawl Fishery	Trawling	1.56		60.94	a	This fishery	Laurenson et al., 1993
	West Coast Demersal Scalefish (Interim) Managed Fishery	Dropline	0.11	0.04	9.91	a	NSW Trap and Line	MacBeth and Gray, 2016
		Dropline and Hydraulic Gunwhale Mounted Reel	0.11	0.04	9.91	a	NSW Trap and Line	MacBeth and Gray, 2016
		Handheld Reel and Dropline	0.11	0.04	9.91	a	NSW Trap and Line	MacBeth and Gray, 2016

		Gunwhale Mounted Hand Operated Reel	0.11	0.04	9.91	a	NSW Trap and Line	MacBeth and Gray, 2016
		Electric Gunwhale Mounted Reel	0.11	0.04	9.91	a	NSW Trap and Line	MacBeth and Gray, 2016
		Hydraulic Gunwhale Mounted Reel	0.11	0.04	9.91	a	NSW Trap and Line	MacBeth and Gray, 2016
		Handheld Reel	0.11	0.04	9.91	a	NSW Trap and Line	MacBeth and Gray, 2016
	West Coast Deep Sea Crustacean Managed Fishery	Crab Trap	0.00		0.00	e	This fishery	How et al., 2015; WAF, 2017 addendum
		Potting	0.00		0.00	e	This fishery	How et al., 2015; WAF, 2017 addendum
	Cockburn Sound (Crab) Managed Fishery	Crab Trap	0.05		4.76	b	SA Blue Crab	PIRSA, 2009a; Svane and Hooper, 2004
	West Australian Sea Cucumber Fishery	Diving	0.00		0.00	d		Webster and Hart, 2018
	Open Access in the North Coast, Gascoyne Coast and West Coast Bioregions	Beach Seine	0.00		0.20	a	NSW Beach Seine	MRAG, 2005
		Potting	0.12		10.87	a	NSW Estuary General blue swimmer crab	Leland et al., 2013
		Squid Jigging	0.00		0.00	d		
		Gillnet	0.01		0.99	a	WA West Coast Estuarine	Johnston et al., 2015, WAF, 2018 addendum
		Hydraulic Gunwhale Mounted Reel	0.11	0.04	9.91	a	NSW Trap and Line	MacBeth and Gray, 2016
		Haul Net / Ring Net	0.01		0.99	a	WA West Coast Estuarine	Johnston et al., 2015, WAF, 2018 addendum
	Open Access in the South Coast Bioregion	Beach Seine	0.00		0.20	a	NSW Beach Seine	MRAG, 2005
		Haul Net / Ring Net	0.01		0.99	a	WA West Coast Estuarine	Johnston et al., 2015, WAF, 2018 addendum
		Handline	0.11	0.04	9.91	a	NSW Trap and Line	MacBeth and Gray, 2016
		Trolling	0.11	0.04	9.91	a	NSW Trap and Line	MacBeth and Gray, 2016
		Gillnet	0.01		0.99	a	WA West Coast Estuarine	Johnston et al., 2015, WAF, 2018 addendum
		Squid Jigging	0.00		0.00	d		
		Electric Gunwhale Mounted Reel	0.11	0.04	9.91	a	NSW Trap and Line	MacBeth and Gray, 2016
		Gunwhale Mounted Hand Operated Reel	0.11	0.04	9.91	a	NSW Trap and Line	MacBeth and Gray, 2016
		Handheld Reel	0.11	0.04	9.91	a	NSW Trap and Line	MacBeth and Gray, 2016
		Hydraulic Gunwhale Mounted Reel	0.11	0.04	9.91	a	NSW Trap and Line	MacBeth and Gray, 2016
		Dropline	0.11	0.04	9.91	a	NSW Trap and Line	MacBeth and Gray, 2016

	South Coast Estuarine Managed Fishery	Crab Trap	0.12		10.87	a	NSW Estuary General blue swimmer crab	Leland et al., 2013
		Fish Trap	0.14		12.28	c	NSW Trap and Line	Stewart and Ferrell, 2001, 2003
		Haul Net / Ring Net	0.01		0.99	a	WA West Coast Estuarine	Johnston et al., 2015, WAF, 2018 addendum
		Gillnet	0.01		0.99	a	WA West Coast Estuarine	Johnston et al., 2015, WAF, 2018 addendum
	Gascoyne Demersal Scalefish Managed Fishery	Electric Gunwhale Mounted Reel	0.11	0.04	9.91	a	NSW Trap and Line	MacBeth and Gray, 2016
		Gunwhale Mounted Hand Operated Reel	0.11	0.04	9.91	a	NSW Trap and Line	MacBeth and Gray, 2016
		Handheld Reel	0.11	0.04	9.91	a	NSW Trap and Line	MacBeth and Gray, 2016
		Hydraulic Gunwhale Mounted Reel	0.11	0.04	9.91	a	NSW Trap and Line	MacBeth and Gray, 2016
	Pilbara Line Fishery (Condition)	Electric Gunwhale Mounted Reel	0.11	0.04	9.91	a	NSW Trap and Line	MacBeth and Gray, 2016
		Handheld Reel	0.11	0.04	9.91	a	NSW Trap and Line	MacBeth and Gray, 2016
		Hydraulic Gunwhale Mounted Reel	0.11	0.04	9.91	a	NSW Trap and Line	MacBeth and Gray, 2016
	Octopus Interim Managed Fishery	Shelter Pot	0.05		4.76	b	This fishery	Hart et al., 2018
		Trigger Pot	0.05		4.76	b	This fishery	Hart et al., 2018
	Trochus Fishery	Intertidal Hand Collection	0.00		0.00	d		
	Mackerel Managed Fishery	Trolling	0.11	0.04	9.91	a	NSW Trap and Line	MacBeth and Gray, 2016
		Trolling and Jigging	0.11	0.04	9.91	a	NSW Trap and Line	MacBeth and Gray, 2016
		Jigging	0.11	0.04	9.91	a	NSW Trap and Line	MacBeth and Gray, 2016
		Handheld Reel	0.11	0.04	9.91	a	NSW Trap and Line	MacBeth and Gray, 2016
	Mandurah to Bunbury Developing Crab Fishery	Crab Trap	0.05		4.76	b	SA Blue Crab	PIRSA, 2009a, Svane and Hooper, 2004
	South Coast Crustacean Managed Fishery	Crab Trap	0.00		0.00	e	WA West Coast Deep Sea Crustacean	How et al., 2015, WAF, 2017 addendum
		Potting	0.91	0.16	47.64	a, b	SA Lobster	Leon et al., 2019
	Warnbro Sound Crab Managed Fishery	Crab Trap	0.05		4.76	b	SA Blue Crab	PIRSA, 2009a, Svane and Hooper, 2004
	Cockburn Sound (Line and Pot) Managed Fishery	Handheld Reel	0.11	0.04	9.91	a	NSW Trap and Line	MacBeth and Gray, 2016
		Squid Jigging	0.00		0.00	d		
		Shelter Pot	0.05		4.76	b	WA Octopus	Hart et al., 2018
		Octopus Pot	0.05		4.76	b	WA Octopus	Hart et al., 2018

		Handline	0.11	0.04	9.91	a	NSW Trap and Line	MacBeth and Gray, 2016
	FBL condition 74 Fish Trapping	Fish Trap	0.01	0.00	1.28	a	WA Northern Demersal Scalefish	Newman et al., 2008
South Australia	Marine Scalefish and Miscellaneous	Lines	0.08	0.02	7.24	a	This fishery	Fowler et al., 2009
		Nets	0.17	0.05	14.53	a	This fishery	Fowler et al., 2009
		Traps	0.02		1.86	c	NSW Trap and Line	Stewart and Ferrell, 2001; Stewart and Ferrell, 2003; Stewart and Hughes, 2008
		Other	0.10	0.02	9.26	a, c	This fishery and NSW Trap and Line	Fowler et al., 2009; Stewart and Ferrell, 2001; Stewart and Ferrell, 2003; Stewart and Hughes, 2008
	Prawn	Trawling	1.53	0.43	60.55	c	This fishery	Kennelly and Broadhurst, 2014; Noell et al., 2018
	Lakes and Coorong - Other	Mostly Nets	0.17	0.00	14.60	a	This fishery	Ferguson, 2010
	Lakes and Coorong - Pipis	Rakes etc.	0.20	0.05	16.53	f	This fishery	Ferguson and Hooper, 2017
	Rock Lobster (South)	Pots	0.83		45.36	a, b	This fishery	Leon et al., 2019
	Rock Lobster (North)	Pots	0.98		49.49	a, b	This fishery	Leon et al., 2019
	Abalone	Diving	0.09		8.26	a	NSW Abalone	Gibson et al., 2002
	Blue Crab	Pots	0.05		4.76	b	This fishery	PIRSA, 2009a, Svane and Hooper, 2004
	Sardine	Purse Seine	0.13	0.07	11.33	a	Commonwealth Small Pelagic	AFMA Observer database
	Giant Crab	Pots	0.51		33.78	a	Tas Giant Crab	Emery et al., 2015b
Commonwealth	Coral Sea	Bottom otter trawl	0.30		23.31	a	This fishery	AFMA Observer database
		Dropline	0.01		1.16	a	This fishery	AFMA Observer database
		Fish trap	0.00		0.00	a	This fishery	AFMA Observer database
		General diving	0.00		0.00	d		
		Hand collection (miscellaneous)	0.00		0.00	d		
		Handline (mechanised)	0.01		1.16	a	This fishery's dropline	AFMA Observer database
		Hookah diving	0.00		0.00	d		
		Hooks	0.01		1.16	a	This fishery's dropline	AFMA Observer database
		Rod and reel	0.01		1.16	a	This fishery's dropline	AFMA Observer database
		Set autolongline (demersal longline)	0.18	0.06	15.34	a	This fishery	AFMA Observer database
		Set longline (demersal longline)	0.01		0.95	a	This fishery	AFMA Observer database

		Trotline	0.01		0.95	a	This fishery's set longline	AFMA Observer database
	East Coast Deep Water	Bottom otter trawl	0.14	0.00	12.55	a	This fishery	AFMA Observer database
		Midwater otter trawl	0.06	0.02	5.47	a	This fishery	AFMA Observer database
	Eastern Tuna and Billfish	Drifting longline (pelagic longline)	0.47	0.22	31.95	a	This fishery	AFMA Observer database
		Handline (mechanised)	0.15	0.05	13.35	a	Commonwealth Gillnet, Hook and Trap dropline	AFMA Observer database
		Pole and line	0.15	0.05	13.35	a	Commonwealth Gillnet, Hook and Trap dropline	AFMA Observer database
		Rod and reel	0.15	0.05	13.35	a	Commonwealth Gillnet, Hook and Trap dropline	AFMA Observer database
		Set gillnet (demersal gillnet)	0.77	0.04	43.59	a	Commonwealth Gillnet, Hook and Trap gillnet	AFMA Observer database
		Set longline (demersal longline)	0.47	0.09	32.09	a	Commonwealth Gillnet, Hook and Trap set auto-longline	AFMA Observer database
		Trolling	0.15	0.05	13.35	a	Commonwealth Gillnet, Hook and Trap dropline	AFMA Observer database
		Trotline	0.47	0.09	32.09	a	Commonwealth Gillnet, Hook and Trap set auto-longline	AFMA Observer database
	Gillnet, Hook and Trap	Dropline	0.15	0.05	13.35	a	This fishery	AFMA Observer database
		Fish trap	4.93		83.13	a	This fishery	AFMA Observer database
		Handline (mechanised)	0.15	0.05	13.35	a	This fishery's dropline	AFMA Observer database
		Hooks	0.15	0.05	13.35	a	This fishery's dropline	AFMA Observer database
		Rod and reel	0.15	0.05	13.35	a	This fishery's dropline	AFMA Observer database
		Set autolongline (demersal longline)	0.47	0.09	32.09	a	This fishery	AFMA Observer database
		Set gillnet (demersal gillnet)	0.77	0.04	43.59	a	This fishery	AFMA Observer database
		Set longline (demersal longline)	0.47	0.09	32.09	a	This fishery's set auto longline	AFMA Observer database
		Trolling	0.15	0.05	13.35	a	This fishery's dropline	AFMA Observer database

		Trotline	0.47	0.09	32.09	a	This fishery's set auto longline	AFMA Observer database
	Great Australian Bight	Bottom otter trawl	1.51	0.13	60.15	a	This fishery	AFMA Observer database
		Bottom otter twin trawl	1.51	0.13	60.15	a	This fishery's bottom otter trawl	AFMA Observer database
		Bottom pair trawl	0.53		34.43	a	This fishery	AFMA Observer database
		Danish seine (trawl fishery)	2.38	0.90	70.40	a	This fishery	AFMA Observer database
		Midwater otter trawl	0.07	0.05	6.30	a	Commonwealth South East Trawl mid water trawl	AFMA Observer database
		Trawl	0.71		41.58	a	This fishery	AFMA Observer database
	High Seas Non-trawl	Drifting longline (pelagic longline)	0.47	0.22	31.95	a	Commonwealth Eastern Tuna and Billfish drifting longline	AFMA Observer database
		Dropline	0.12	0.08	10.83	a	This fishery	AFMA Observer database
		Handline (mechanised)	0.12	0.08	10.83	a	This fishery's dropline	AFMA Observer database
		Set autolongline (demersal longline)	0.06	0.01	5.98	a	This fishery	AFMA Observer database
		Set longline (demersal longline)	0.06	0.01	5.98	a	This fishery's set auto-longline	AFMA Observer database
	High Seas Trawl	Bottom otter trawl	0.11	0.04	9.76	a	This fishery	AFMA Observer database
		Midwater otter trawl	0.14	0.04	12.31	a	This fishery	AFMA Observer database
	Informally Managed	Purse seine	0.13	0.07	11.33	a	Commonwealth Small Pelagic	AFMA Observer database
	Kimberley Prawn Fishery	Bottom shrimp trawl (prawn trawl)	1.36	0.25	57.56	a	Commonwealth NPF banana	AFMA Observer database
	North West Slope	Bottom trawl (nephrops trawl)	0.64	0.41	38.95	a	This fishery	AFMA Observer database
	Northern Prawn	Targeting banana prawns	1.36	0.25	57.56	a	This fishery	AFMA Observer database
		Targeting tiger prawns	3.92	0.52	79.68	a	This fishery	AFMA Observer database
	Scallop	Scallop dredge	0.11		9.91	a, b	Bass Strait Scallop	Haddon et al., 2006, AFMA, 2015
	Small Pelagic	Bottom otter trawl	4.35		81.31	a	This fishery	AFMA Observer database
		Midwater otter trawl	0.04	0.02	3.63	a	This fishery	AFMA Observer database
		Purse seine	0.13	0.07	11.33	a	This fishery	AFMA Observer database
		Squid jigs (mechanised)	0.00		0.00	d		

	South East Trawl	Bottom otter trawl	0.63	0.13	38.49	a	This fishery	AFMA Observer database
		Bottom pair trawl	1.13		53.03	a	This fishery	AFMA Observer database
		Danish seine (trawl fishery)	0.96	0.09	49.02	a	This fishery	AFMA Observer database
		Midwater otter trawl	0.07	0.05	6.30	a	This fishery	AFMA Observer database
		Set gillnet (demersal gillnet)	0.77	0.04	43.59	a	Commonwealth Gillnet, Hook and Trap gillnet	AFMA Observer database
	Southern Bluefin Tuna	Dropline	0.15	0.05	13.35	a	Commonwealth Gillnet, Hook and Trap dropline	AFMA Observer database
		Handline (mechanised)	0.15	0.05	13.35	a	Commonwealth Gillnet, Hook and Trap dropline	AFMA Observer database
		Pole and line	0.15	0.05	13.35	a	Commonwealth Gillnet, Hook and Trap dropline	AFMA Observer database
		Purse seine	0.19	0.08	16.14	a	This fishery	AFMA Observer database
		Rod and reel	0.15	0.05	13.35	a	Commonwealth Gillnet, Hook and Trap dropline	AFMA Observer database
		Trolling	0.15	0.05	13.35	a	Commonwealth Gillnet, Hook and Trap dropline	AFMA Observer database
	Squid Jig	Squid jigs (mechanised)	0.00		0.00	d		
	Torres Strait	Dropline	0.15	0.05	13.35	a	Commonwealth Gillnet, Hook and Trap dropline	AFMA Observer database
		Free diving	0.00		0.00	d		
		General diving	0.00		0.00	d		
		Hand collection (miscellaneous)	0.00		0.00	d		
		Handline (hand operated)	0.15	0.05	13.35	a	Commonwealth Gillnet, Hook and Trap dropline	AFMA Observer database
		Hooks	0.15	0.05	13.35	a	Commonwealth Gillnet, Hook and Trap dropline	AFMA Observer database
		Trolling	0.15	0.05	13.35	a	Commonwealth Gillnet, Hook and Trap dropline	AFMA Observer database

	Torres Strait Prawn	Bottom shrimp trawl (prawn trawl)	0.15	0.02	13.10	a	This fishery	AFMA Observer database
	Western Deep Water	Bottom otter trawl	0.41	0.27	29.19	a	This fishery	AFMA Observer database
		Bottom pair trawl	0.41	0.27	29.19	a	This fishery's bottom otter trawl	AFMA Observer database
		Danish seine (trawl fishery)	0.41	0.27	29.19	a	This fishery's bottom otter trawl	AFMA Observer database
	Western Tuna and Billfish	Drifting longline (pelagic longline)	0.47	0.22	31.95	a	Commonwealth Eastern Tuna and Billfish drifting longline	AFMA Observer database
		Handline (mechanised)	0.15	0.05	13.35	a	Commonwealth Gillnet, Hook and Trap dropline	AFMA Observer database
		Hooks	0.15	0.05	13.35	a	Commonwealth Gillnet, Hook and Trap dropline	AFMA Observer database
		Pole and line	0.15	0.05	13.35	a	Commonwealth Gillnet, Hook and Trap dropline	AFMA Observer database
		Trolling	0.15	0.05	13.35	a	Commonwealth Gillnet, Hook and Trap dropline	AFMA Observer database

[a] Observer data

[b] Survey data

[c] Control data from experiment(s)

[d] Assumes negligible discards

[e] EM-validated logbook data

[f] Logbook data

Extrapolated Estimates

The next step to estimate annual discards for Australia's fisheries is to calculate the product of the average annual retained landings (Table 2) and the retained:discard ratios (Table 3) for each fishery/method, for each jurisdiction and for all jurisdictions to get a national estimate (Table 4). The calculations of SE's around these extrapolations used Goodman's (1960) technique for the calculation of the variance of products.

Table 4 – Annual discard estimates (and SE's) for each fishery and method with total estimates for all fisheries and methods for each jurisdiction and all jurisdictions combined (ie a national total). Derived from multiplying the data in Tables 2 and 3.

	Fishery	**Method**	**Mean Landings (t)**	**SE**	**Estimated Discards (t)**	**SE**
New South Wales	Estuary General	Meshing net	2024.02	48.43	293.15	89.68
		Hauling net (general purpose)	948.35	132.90	1051.72	318.93
		Prawn net (set pocket)	157.84	24.84	37.09	17.49
		Crab trap	111.28	11.10	15.83	2.25
		Fish trap (bottom/demersal)	105.24	18.55	14.73	2.60
		Flathead net	91.35	10.31	81.95	26.14
		Eel trap	76.16	5.38	56.36	3.98
		Prawn net (hauling)	73.75	6.09	18.60	7.30
		Handgathering for pipis and beachworms	73.60	14.41	9.20	2.10
		Prawn running net	53.01	4.81	7.29	1.14
		Seine net (prawns)	44.52	5.14	21.81	9.45
		Bait net	19.03	4.87	0.00	0.00
		Garfish net (bullringing)	18.45	4.56	0.74	0.18
		Handline	13.69	1.81	1.92	0.25
		Pilchard, anchovy and bait net - beach based	6.59	1.08	0.00	0.00
		Setline	3.58	0.63	0.47	0.08
		Dip or scoop net (prawns)	0.50		0.00	
		Hoop or lift net	0.29	0.10	0.02	0.01
	Estuary Prawn Trawl	Otter trawl net (prawns)	387.14	36.88	92.83	55.64
	Ocean Trawl	Otter trawl net (prawns)	1728.41	98.32	3458.69	941.86
		Otter trawl net (fish)	1253.93	90.15	1058.74	265.99
	Ocean Hauling	Hauling net (general purpose)	2382.16	162.68	4.76	0.33
		Purse seine net	1780.64	291.51	227.43	136.29
		Pilchard, anchovy and bait net - beach based	56.87	11.34	0.00	0.00
		Garfish net (hauling) - boat based	34.10	7.59	1.36	0.30
		Garfish net (hauling) - beach based	7.40	3.15	0.30	0.13

	Ocean Trap and Line	Fish trap (bottom/demersal)	594.51	37.68	11.30	0.72
		Handline	410.78	29.22	57.51	4.09
		Trolling	173.17	31.39	24.24	4.40
		Setline (demersal)	135.75	6.23	20.36	0.94
		Spanner crab net	111.00	12.08	34.90	4.54
		Jigging	87.09	9.73	12.19	1.36
		Dropline	72.46	13.67	5.07	0.96
		Setline	52.15	8.50	6.88	1.12
		Poling	45.28	15.57	6.34	2.18
		Trotline (bottom set)	28.06	9.43	4.21	1.41
		Driftline	16.61	7.81	2.32	1.09
	Abalone	Diving	105.77	9.78	9.52	0.88
	Lobster	Trapping	150.38	3.87	126.32	3.25
	Others	Danish seine trawl net (fish)	182.60	33.23	175.59	35.54
		Pilchard, anchovy and bait net - boat based	3.50	1.54	0.00	0.00
		Skindiving	1.63	0.94	0.00	0.00
	Special Permits	Purse seine net	93.50	19.44	11.94	7.26
		Scallop Dredge	13.48	1.28	1.48	0.14
		Submersible Lift Net	11.02	3.69	0.78	0.47
		Eel trap	5.98	0.95	4.42	0.70
New South Wales Totals			**13,746.59**	**888.65**	**6,970.40**	**2,065.70**
New South Wales Discard %					**33.65**	**9.97**
Tasmania	Abalone	Dive	2139.8	124.5	192.58	11.21
	Southern Rock Lobster	Pots	1126.7	52.6	3971.49	185.41
	Scallop	Dredge	677.9	185.7	74.57	20.43
	Octopus	Pots (unbaited)	79.5	14.3	0.00	0.00
	Giant Crab	Pots	29.4	2.8	15.00	1.43
	Scalefish	Automatic squid jig	251	183.6	0.00	0.00
		Beach seine	243.7	62.2	0.49	0.12
		Purse seine	239.6	198.6	30.60	27.27
		Graball net	105.9	5.8	38.09	2.09
		Hand line	81	2.8	11.34	0.39
		Danish seine	70.5	8.7	67.80	10.33
		Squid-jig	51.4	3.9	0.00	0.00
		Dip-net	19.3	1.5	0.00	0.00
		Small mesh net	11	1.7	7.28	1.12
		Troll	8.8	1.5	1.23	0.21
		Fish trap	8.5	0.4	0.16	0.01
		Drop-line	5.2	1	0.36	0.07
		Spear	4.2	0.3	0.00	0.00
		Hand collection	2.7	0.8	0.00	0.00
	Commercial Dive and Shellfish	Hand Collection	42.9	4.6	0.00	0.00
Tasmania Totals			**5,199.00**	**806.68**	**4,410.99**	**197.13**

Tasmania Discard %					**45.90**	**2.05**
Northern Territory	Demersal	Trap, handline, dropline, demersal trawl	2453.17	197.26	393.23	35.90
	Timor Reef	Trap, handline, dropline, demersal trawl, longline	722.93	35.60	75.39	23.75
	Barramundi	Gillnet	718.01	123.15	228.83	148.72
	Offshore Net and Line	Gillnet, longline	613.58	158.81	112.73	39.11
	Spanish Mackerel	Troll, baited line	255.23	34.11	35.73	4.78
	Mud Crab	Pot and baited gillnet	224.16	50.39	31.89	7.84
	Coastal line	Hook and line	111.88	8.36	10.63	0.79
	Trepang	Hand gathering	51.56	13.11	0.00	0.00
	Restricted Bait	Bait net	31.44	7.03	0.00	0.00
	Aquarium Display	Hand gathering	10.21	2.16	0.00	0.00
	Coastal net	Gillnet	6.53	1.54	0.33	0.08
Northern Territory Totals			**5,198.72**	**650.13**	**888.75**	**403.45**
Northern Territory Discard %					**14.60**	**6.63**
Queensland	Coral	Hand harvest	88.40	6.39	0.00	0.00
	Crayfish and Rocklobster	Hand harvest	153.40	11.93	0.00	0.00
	East Coast Pearl	Hand harvest	0.05	0.04	0.00	0.00
	Marine Aquarium Fish	Hand harvest	32.10	2.73	0.00	0.00
	Eel Fishery	Fyke and other nets	19.00	3.74	14.06	2.77
	Sea Cucumber Fishery (East Coast)	Hand harvest	346.20	12.83	0.00	0.00
	Trochus	Hand harvest	7.40	4.15	0.00	0.00
	Coral Reef Finfish	Hook and line	1388.80	33.05	222.21	5.29
	Deep Water Finfish	Hook and line	3.00	1.48	0.37	0.19
	East Coast Spanish Mackerel	Hook and line	300.20	15.47	42.03	2.17
	Gulf of Carpentaria Line	Hook and line	194.80	16.16	18.51	1.54
	Rocky Reef Finfish	Hook and line	142.40	8.81	14.85	4.71
	East Coast Inshore Finfish Fishery	Nets	4598.60	84.09	280.51	55.41
	Gulf of Carpentaria Inshore Finfish	Nets	1952.60	219.92	99.58	11.22
	Blue Swimmer Crab	Crab traps	361.60	12.27	44.12	1.50
	Mud Crabs	Crab traps	1357.20	50.02	404.45	51.05
	Spanner Crabs	Spanner crab net	1086.80	66.35	249.96	16.20
	East Coast Otter Trawl	Trawl	7482.00	259.20	25064.70	1360.11
	Gulf of Carpentaria Developmental Fin Fish Trawl	Trawl	187.60	115.93	119.88	74.08
	River and Inshore Beam Trawl	Trawl	223.80	25.89	55.95	6.47
Queensland Totals			**19,925.95**	**853.95**	**26,631.17**	**3,046.92**
Queensland Discard %					**57.20**	**6.54**
Victoria	Abalone	Dive	739.1	13.4	66.52	1.21
	Rock Lobster	Pots	319.4	5.1	354.49	95.96
	Ocean (General)	Drop Line	3.1	1.7	0.21	0.12

		Hand Line	87.0	7.8	12.18	1.10
		Shark Long Line	10.1	3.0	1.34	0.39
		Snapper Long Line	4.3	1.2	0.64	0.18
		Octopus Trap/Pot	7.6	7.6	0.00	0.00
	Westernport/Port Phillip Bay	Haul Seine	226.4	28.4	251.07	74.38
		Multifilament Mesh	71.6	19.2	10.39	4.12
		Snapper Long Line	100.9	15.7	15.14	2.36
		Purse Seine	107.9	52.0	13.78	9.69
		Garfish Seine	12.6	6.8	0.50	0.27
	Corner Inlet	Ringing Seine	176.7	8.2	195.92	53.72
		Multifilament Mesh	91.2	10.2	13.23	4.25
		Haul Seine	42.8	20.5	47.41	25.33
	Bait (General)	Bait Pump	2.6	1.3	0.00	0.00
		Yabbie Pot	3.5	1.1	0.00	0.00
	Eel	Fyke net	74.0	6.3	54.78	4.64
	Gippsland Lakes	Multifilament Mesh	149.2	13.4	21.63	6.82
		Prawn Stake Net	13.9	7.5	3.28	2.46
	Trawl (Inshore)	Prawn Trawl	178.5	24.4	357.20	106.27
	Gippsland Lakes (Bait)	Bait Pump	34.0	8.8	0.00	0.00
	General (Sea Urchin)	Dive	32.5	5.6	0.00	0.00
	Wrasse (Ocean)	Handline	25.2	2.3	3.53	0.32
	Giant Crab	Pots	7.5	2.7	3.82	1.40
Victoria Totals			**2,521.33**	**206.40**	**1,427.05**	**303.60**
Victoria Discard %					**36.14**	**7.69**
Western Australia	West Coast Rock Lobster Managed Fishery	Potting	5804.33	177.54	5281.94	942.21
	South Coast Purse-Seine Managed Fishery	Purse Seine	1997.78	106.28	255.17	149.52
	Shark Bay Prawn Managed Fishery	Trawling	1893.11	101.66	1817.39	97.60
	Northern Demersal Scalefish Fishery	Fish Trap	1159.67	33.95	15.08	0.50
	Joint Authority Southern Demersal Gillnet and Demersal Longline Managed Fishery	Gillnet	1013.44	26.00	861.43	22.10
		Longline	9.00	6.15	4.23	2.95
	Pilbara Fish Trawl (Interim) Managed Fishery	Trawling	868.56	235.39	451.65	122.40
	Exmouth Gulf Prawn Managed Fishery	Trawling	764.22	86.17	515.85	58.16
	Shark Bay Scallop Managed Fishery	Trawling	946.17	289.11	473.08	144.55
	FBL condition 93 Purse Seine Development Zone	Purse Seine	487.78	142.32	62.30	39.28
	Abrolhos Islands and Mid West Trawl Managed Fishery	Trawling	953.75	438.95	476.88	219.47
	Pilbara Trap Managed Fishery	Fish Trap	269.11	86.04	3.50	1.12
	Kimberley Prawn Managed Fishery	Trawling	236.44	24.77	159.60	16.72
	Abalone Managed Fishery	Diving	224.11	22.01	20.17	1.98
		Crab Trap	222.78	53.91	11.14	2.70

	Shark Bay Crab Managed Fishery	Trawling	182.67	36.65	175.36	35.19
	Pearl Oyster Managed Fishery	Diving	217.22	21.57	0.00	0.00
	West Coast Purse Seine Fishery	Purse Seine	206.44	52.00	26.37	16.32
	FBL condition 73 South Coast Trawl Fishery	Trawling	176.75	53.86	275.73	84.02
	Nickol Bay Prawn Managed Fishery	Trawling	120.56	24.34	81.38	16.43
	South Coast Salmon Managed Fishery	Beach Seine	120.56	30.49	0.24	0.06
	Shark Bay Beach Seine and Mesh Net Managed Fishery	Beach Seine	102.78	4.96	0.21	0.01
		Haul Net / Ring Net	52.11	22.58	0.52	0.23
	Kimberley Gillnet and Barramundi Managed Fishery	Gillnet	97.22	8.79	30.98	19.83
	West Coast Demersal Gillnet and Demersal Longline (Interim) Managed Fishery	Gillnet	88.89	16.98	75.56	14.43
		Longline	8.00	8.00	3.76	3.76
	South West Coast Beach Net Fishery (Order)	Beach Seine	80.56	8.70	0.16	0.02
	West Coast Estuarine Managed Fishery	Crab Trap	79.00	6.86	9.64	0.84
		Gillnet	35.78	5.97	0.36	0.06
		Haul Net / Ring Net	103.11	11.11	1.03	0.11
	FBL condition 42 herring	Trap Net	112.80	37.20	0.00	0.00
	South West Coast Salmon Managed Fishery	Beach Seine	53.00	16.02	0.11	0.03
	South West Trawl Fishery	Trawling	51.14	35.60	79.78	55.53
	West Coast Demersal Scalefish (Interim) Managed Fishery	Dropline	36.67	5.30	4.03	1.56
		Dropline and Hydraulic Gunwhale Mounted Reel	2.67	1.30	0.29	0.17
		Handheld Reel and Dropline	5.78	1.05	0.64	0.25
		Gunwhale Mounted Hand Operated Reel	22.00	7.45	2.42	1.17
		Electric Gunwhale Mounted Reel	58.11	4.03	6.39	2.36
		Hydraulic Gunwhale Mounted Reel	141.44	7.63	15.56	5.71
		Handheld Reel	33.44	4.09	3.68	1.40
	West Coast Deep Sea Crustacean Managed Fishery	Crab Trap	84.33	42.19	0.00	0.00
		Potting	112.78	20.36	0.00	0.00
	Cockburn Sound (Crab) Managed Fishery	Crab Trap	40.60	10.56	2.03	0.53
	West Australian Sea Cucumber Fishery	Diving	16.88	16.88	0.00	0.00
	Open Access in the North Coast, Gascoyne Coast and West Coast Bioregions	Beach Seine	10.78	4.03	0.02	0.01
		Potting	0.20	0.20	0.02	0.02
		Squid Jigging	4.11	0.72	0.00	0.00
		Gillnet	4.33	1.78	0.04	0.02
		Hydraulic Gunwhale Mounted Reel	30.00	30.00	3.30	3.30
		Haul Net / Ring Net	18.56	3.62	0.19	0.04
	Open Access in the South Coast Bioregion	Beach Seine	9.78	1.98	0.02	0.00
		Haul Net / Ring Net	0.17	0.17	0.00	0.00
		Handline	2.67	1.00	0.29	0.15

		Trolling	7.22	2.60	0.79	0.39
		Gillnet	13.00	0.93	0.13	0.01
		Squid Jigging	13.89	1.16	0.00	0.00
		Electric Gunwhale Mounted Reel	14.22	4.55	1.56	0.74
		Gunwhale Mounted Hand Operated Reel	16.67	2.74	1.83	0.72
		Handheld Reel	19.22	2.54	2.11	0.81
		Hydraulic Gunwhale Mounted Reel	32.56	4.16	3.58	1.37
		Dropline	32.67	4.62	3.59	1.39
	South Coast Estuarine Managed Fishery	Crab Trap	9.67	2.05	1.18	0.25
		Fish Trap	1.44	0.80	0.20	0.11
		Haul Net / Ring Net	13.00	1.51	0.13	0.02
		Gillnet	204.56	8.79	2.05	0.09
	Gascoyne Demersal Scalefish Managed Fishery	Electric Gunwhale Mounted Reel	4.89	2.58	0.54	0.33
		Gunwhale Mounted Hand Operated Reel	5.00	5.00	0.55	0.55
		Handheld Reel	13.44	4.95	1.48	0.74
		Hydraulic Gunwhale Mounted Reel	238.44	24.81	26.23	9.87
	Pilbara Line Fishery (Condition)	Electric Gunwhale Mounted Reel	4.89	4.89	0.54	0.54
		Handheld Reel	2.22	1.57	0.24	0.18
		Hydraulic Gunwhale Mounted Reel	72.89	12.33	8.02	3.18
	Octopus Interim Managed Fishery	Shelter Pot	4.00	1.28	0.20	0.06
		Trigger Pot	174.11	14.24	8.71	0.71
	Trochus Fishery	Intertidal Hand Collection	5.50	2.60	0.00	0.00
	Mackerel Managed Fishery	Trolling	258.22	6.74	28.40	10.35
		Trolling and Jigging	13.89	3.64	1.53	0.67
		Jigging	14.67	4.55	1.61	0.75
		Handheld Reel	2.43	2.27	0.27	0.25
	Mandurah to Bunbury Developing Crab Fishery	Crab Trap	1.22	1.22	0.06	0.06
	South Coast Crustacean Managed Fishery	Crab Trap	5.00	5.00	0.00	0.00
		Potting	90.44	7.61	82.30	16.00
	Warnbro Sound Crab Managed Fishery	Crab Trap	0.56	0.38	0.03	0.02
	Cockburn Sound (Line and Pot) Managed Fishery	Handheld Reel	0.38	0.38	0.04	0.04
		Squid Jigging	1.22	0.15	0.00	0.00
		Shelter Pot	35.50	6.13	1.78	0.31
		Octopus Pot	26.67	6.16	1.33	0.31
		Handline	0.29	0.29	0.03	0.03
	FBL condition 74 Fish Trapping	Fish Trap	0.22	0.15	0.00	0.00
Western Australia Totals			**20,728.32**	**1,659.12**	**11,390.56**	**1,409.15**
Western Australia Discard %					**35.46**	**4.39**
South Australia		Lines	1467.71	122.59	114.48	28.01

	Marine Scalefish and Miscellaneous	Nets	861.54	37.47	146.46	46.06
		Traps	239.96	31.35	4.56	0.60
		Other	114.07	3.77	11.64	2.65
	Prawn	Trawling	1986.48	108.45	3048.74	876.54
	Lakes and Coorong - Other	Mostly Nets	1190.67	31.25	203.60	5.34
	Lakes and Coorong - Pipis	Rakes etc.	433.79	29.23	85.89	21.15
	Rock Lobster (South)	Pots	1241.93	1.64	1030.80	1.36
	Rock Lobster (North)	Pots	324.54	4.87	318.05	4.77
	Abalone	Diving	755.37	33.86	67.98	3.05
	Blue Crab	Pots	635.22	13.44	31.76	0.67
	Sardine	Purse Seine	34365.41	1043.06	4389.33	2567.23
	Giant Crab	Pots	17.88	0.87	9.12	0.44
South Australia Totals			**43,634.57**	**2,800.45**	**9,462.42**	**5,427.30**
South Australia Discard %					**17.82**	**10.22**
Commonwealth	Coral Sea	Bottom otter trawl	0.97		0.29	
		Dropline	4.52	2.14	0.05	0.03
		Fish trap	36.02	0.31	0.00	0.00
		General diving	4.25	1.44	0.00	0.00
		Hand collection (miscellaneous)	0.45		0.00	
		Handline (mechanised)	7.61	4.48	0.09	0.05
		Hookah diving	3.81	0.25	0.00	0.00
		Hooks	0.60		0.01	
		Rod and reel	2.60	1.54	0.03	0.02
		Set autolongline (demersal longline)	27.20	5.10	4.93	1.92
		Set longline (demersal longline)	0.28	0.15	0.00	0.00
		Trotline	0.17		0.00	
	East Coast Deep Water	Bottom otter trawl	40.20	23.83	5.77	3.42
		Midwater otter trawl	83.03	29.40	4.81	2.16
	Eastern Tuna and Billfish	Drifting longline (pelagic longline)	4550.02	175.02	2136.66	995.39
		Handline (mechanised)	13.01	4.55	2.01	0.94
		Pole and line	0.61	0.54	0.09	0.08
		Rod and reel	0.80	0.18	0.12	0.05
		Set gillnet (demersal gillnet)	0.26	0.07	0.20	0.06
		Set longline (demersal longline)	0.95		0.45	0.08
		Trolling	0.55	0.20	0.08	0.04
		Trotline	0.01		0.00	0.00
	Gillnet, Hook and Trap	Dropline	54.13	9.86	8.34	3.11
		Fish trap	6.03	2.04	29.73	10.07
		Handline (mechanised)	19.74	3.70	3.04	1.14
		Hooks	1.65		0.25	0.08
		Rod and reel	20.87	10.45	3.22	1.85
		Set autolongline (demersal longline)	655.93	32.91	309.94	59.56

		Set gillnet (demersal gillnet)	1439.44	54.67	1112.39	73.86
		Set longline (demersal longline)	293.52	45.54	138.69	33.33
		Trolling	0.24		0.04	0.01
		Trotline	5.92		2.80	0.52
	Great Australian Bight	Bottom otter trawl	1697.14	85.59	2562.14	248.52
		Bottom otter twin trawl	9.24	2.53	13.94	3.98
		Bottom pair trawl	34.17	33.38	17.94	17.53
		Danish seine (trawl fishery)	106.45	4.81	253.22	96.73
		Midwater otter trawl	3.02	2.13	0.20	0.17
		Trawl	20.96		14.91	
	High Seas Non-trawl	Drifting longline (pelagic longline)	3.89		1.83	0.85
		Dropline	2.05	0.58	0.25	0.18
		Handline (mechanised)	3.98		0.48	0.33
		Set autolongline (demersal longline)	132.43	11.03	8.43	1.95
		Set longline (demersal longline)	5.68		0.36	0.08
	High Seas Trawl	Bottom otter trawl	295.44	134.51	31.95	18.53
		Midwater otter trawl	280.51	86.81	39.38	15.83
	Informally Managed	Purse seine	107.58	30.48	13.74	8.63
	Kimberley Prawn Fishery	Bottom shrimp trawl (prawn trawl)	70.85		96.09	17.93
	North West Slope	Bottom trawl (nephrops trawl)	53.11	6.07	33.89	22.00
	Northern Prawn	Targeting banana prawns	5011.59	481.10	6797.43	1421.32
		Targeting tiger prawns	2256.50	260.34	8849.64	1552.13
	Scallop	Scallop dredge	1736.60	405.26	191.03	44.58
	Small Pelagic	Bottom otter trawl	49.09	34.09	213.51	148.27
		Midwater otter trawl	5916.85	2791.88	222.59	154.77
		Purse seine	325.83	159.70	41.62	29.42
		Squid jigs (mechanised)	0.01		0.00	
	South East Trawl	Bottom otter trawl	7873.29	495.59	4926.19	1078.75
		Bottom pair trawl	2.01		2.27	
		Danish seine (trawl fishery)	1943.34	96.52	1868.83	192.02
		Midwater otter trawl	1217.44	517.22	81.88	61.88
		Set gillnet (demersal gillnet)	0.59		0.46	0.03
	Southern Bluefin Tuna	Dropline	0.02		0.00	0.00
		Handline (mechanised)	0.24	0.15	0.04	0.03
		Pole and line	1.90	1.15	0.29	0.19
		Purse seine	4367.52	213.58	840.32	342.27
		Rod and reel	0.82	0.77	0.13	0.12
		Trolling	0.43	0.18	0.07	0.03
	Squid Jig	Squid jigs (mechanised)	381.05	103.77	0.00	0.00
	Torres Strait	Dropline	0.44		0.07	0.02
		Free diving	8.81	1.70	0.00	0.00
		General diving	287.87	43.69	0.00	0.00
		Hand collection (miscellaneous)	8.74		0.00	

		Handline (hand operated)	31.66	2.32	4.88	1.65
		Hooks	0.47	0.22	0.07	0.04
		Trolling	80.76	4.35	12.45	4.16
	Torres Strait Prawn	Bottom shrimp trawl (prawn trawl)	454.44	57.57	68.51	12.74
	Western Deep Water	Bottom otter trawl	18.12	7.57	7.47	5.45
		Bottom pair trawl	90.85		37.45	24.63
		Danish seine (trawl fishery)	0.22		0.09	0.06
	Western Tuna and Billfish	Drifting longline (pelagic longline)	346.83	23.77	162.87	76.31
		Handline (mechanised)	9.62	1.65	1.48	0.55
		Hooks	4.02		0.62	0.20
		Pole and line	7.50		1.16	0.38
		Trolling	0.89	0.44	0.14	0.08
Commonwealth Totals			**42,538.21**	**6,998.40**	**31,186.32**	**8,268.03**
Commonwealth Discard %					**42.30**	**11.21**
National Totals			**153,492.68**	**7,887.19**	**92,367.67**	**10,660.50**
National Discard %					**37.57**	**4.34**

Summary of General Discards

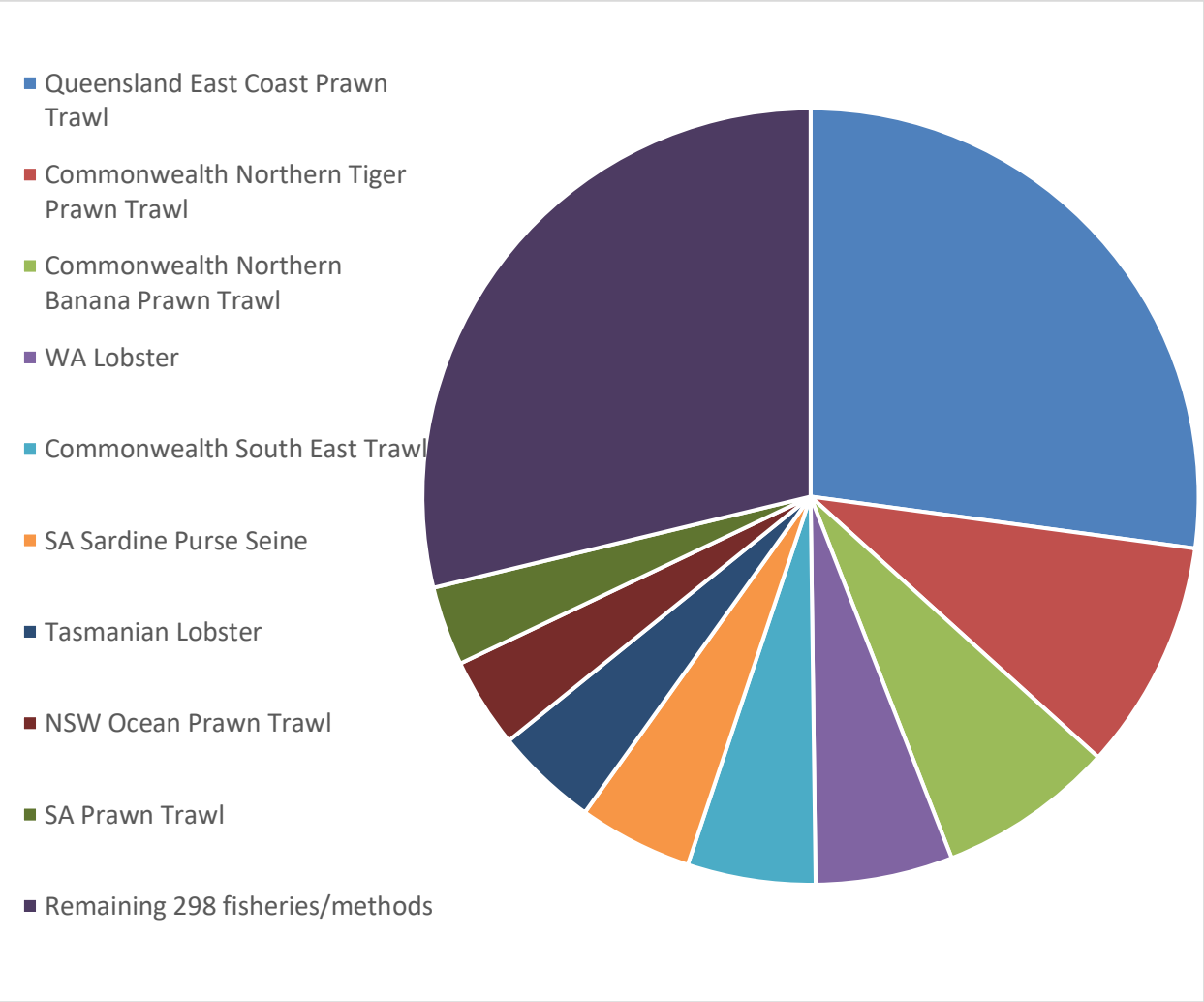
Table 5 contains a summary of the above annual estimated totals for the 8 jurisdictions and the nation, together with the relative contributions to annual landings and estimated annual discards by each jurisdiction.

Table 5 – Average annual landings, estimated annual discards, discard rates and percentage contributions for each jurisdiction and the nation (with associated SEs).

	Average annual landings (t)	**SE**	**Estimated annual discards (t)**	**SE**	**Discard rate (%)**	**SE**	**% of national landings**	**% of national discards**
New South Wales	13746.6	888.7	6970.4	2065.7	33.6	10.0	9.0	7.5
Tasmania	5199.0	806.7	4411.0	197.1	45.9	2.1	3.4	4.8
Northern Territory	5198.7	650.1	888.8	403.4	14.6	6.6	3.4	1.0
Queensland	19926.0	853.9	26631.2	3046.9	57.2	6.5	13.0	28.8
Victoria	2521.3	206.4	1427.1	303.6	36.1	7.7	1.6	1.5
Western Australia	20728.3	1659.1	11390.6	1409.1	35.5	4.4	13.5	12.3
South Australia	43634.6	2800.5	9462.4	5427.3	17.8	10.2	28.4	10.2
Commonwealth	42538.2	6998.4	31186.3	8268.0	42.3	11.2	27.7	33.8
National	**153492.7**	**7887.2**	**92367.7**	**10660.5**	**37.6**	**4.3**		

Fig. 1 shows the relative contributions of the main discarding fisheries. Nine fisheries/methods contributed 71.2% of all discards with the remaining 298 fisheries/methods contributing 28.8%. One fishery (the Queensland East Coast Prawn Trawl fishery) contributed 27.1% of all discards.

Fig. 1 – Contributions to total estimated discards of the main discarding fisheries.



Observer Versus Logbook Data

The above estimates of discards from Australia's fisheries are based on the best available, empirically-derived discard rates that mostly come from observer programmes – not data from self-reported logbooks which, in most cases, either did not exist or were considered too inaccurate to use. However, because AFMA's observer programmes cover so many Commonwealth fisheries and methods, and fishers in these fisheries are also required to submit information about discards in their logbooks, we had the opportunity to compare these two sources of what should be the similar information about discards. (see Table 6).

Table 6 - Discard estimates (and SE's) for each Commonwealth fishery/method derived from observer data and those reported on logbooks.

Fishery	Method	Observer Discarded catch (tonnes)	SE	Logbook Discarded catch (tonnes)	SE
Coral Sea	Bottom otter trawl	0.29	0.00	0.00	0.00
	Dropline	0.05	0.03	0.02	0.02
	Fish trap	0.00	0.00	0.00	0.00
	General diving	0.00	0.00	0.00	0.00
	Hand collection (miscellaneous)	0.00	0.00	0.00	0.00
	Handline (mechanised)	0.09	0.05	0.00	0.00
	Hookah diving	0.00	0.00	0.00	0.00
	Hooks	0.01	0.00	0.00	0.00
	Rod and reel	0.03	0.02	0.00	0.00
	Set autolongline (demersal longline)	4.93	1.92	1.04	0.66
	Set longline (demersal longline)	0.00	0.00	0.00	0.00
	Trotline	0.00	0.00	0.00	0.00
East Coast Deep Water	Bottom otter trawl	5.77	3.42	4.09	2.68
	Midwater otter trawl	4.81	2.16	4.35	4.25
Eastern Tuna and Billfish	Drifting longline (pelagic longline)	2136.66	995.39	198.54	94.10
	Handline (mechanised)	2.01	0.94	0.78	0.77
	Pole and line	0.09	0.08	0.00	0.00
	Rod and reel	0.12	0.05	0.00	0.00
	Set gillnet (demersal gillnet)	0.20	0.06	0.00	0.00
	Set longline (demersal longline)	0.45	0.08	0.00	0.00
	Trolling	0.08	0.04	0.01	0.00
	Trotline	0.00	0.00	0.00	0.00
Gillnet, Hook and Trap	Dropline	8.34	3.11	3.85	1.69
	Fish trap	29.73	10.07	0.00	0.00
	Handline (mechanised)	3.04	1.14	0.60	0.36
	Hooks	0.25	0.08	0.00	0.00
	Rod and reel	3.22	1.85	0.41	0.36
	Set autolongline (demersal longline)	309.94	59.56	70.00	20.61
	Set gillnet (demersal gillnet)	1112.39	73.86	258.05	52.66
	Set longline (demersal longline)	138.69	33.33	34.60	11.24
	Trolling	0.04	0.01	0.00	0.00
	Trotline	2.80	0.52	1.80	0.00
Great Australian Bight	Bottom otter trawl	2562.14	248.52	873.46	63.31
	Bottom otter twin trawl	13.94	3.98	2.74	1.18
	Bottom pair trawl	17.94	17.53	8.21	7.81
	Danish seine (trawl fishery)	253.22	96.73	32.85	18.23
	Midwater otter trawl	0.20	0.17	1.08	0.38
	Trawl	14.91	0.00	11.15	0.00
High Seas Non-trawl	Drifting longline (pelagic longline)	1.83	0.85	0.62	0.00
	Dropline	0.25	0.18	0.15	0.10
	Handline (mechanised)	0.48	0.33	0.24	0.00
	Set autolongline (demersal longline)	8.43	1.95	5.41	2.52

	Set longline (demersal longline)	0.36	0.08	0.45	0.00
High Seas Trawl	Bottom otter trawl	31.95	18.53	3.86	2.46
	Midwater otter trawl	39.38	15.83	11.30	6.34
Informally Managed	Purse seine	13.74	8.63	2.15	2.06
Kimberley Prawn Fishery	Bottom shrimp trawl (prawn trawl)	96.09	17.93	0.00	0.00
North West Slope	Bottom trawl (nephrops trawl)	33.89	22.00	0.36	0.36
Northern Prawn	Targeting banana prawns	6797.43	1421.32	0.03	0.02
	Targeting tiger prawns	8849.64	1552.13	0.02	0.02
Scallop	Scallop dredge	191.03	44.58	0.00	0.00
Small Pelagic	Bottom otter trawl	213.51	148.27	0.45	0.45
	Midwater otter trawl	222.59	154.77	78.03	35.59
	Purse seine	41.62	29.42	13.08	12.99
	Squid jigs (mechanised)	0.00	0.00	0.00	0.00
South East Trawl	Bottom otter trawl	4926.19	1078.75	1301.77	177.24
	Bottom pair trawl	2.27	0.00	5.80	0.00
	Danish seine (trawl fishery)	1868.83	192.02	213.70	50.53
	Midwater otter trawl	81.88	61.88	16.67	10.68
	Set gillnet (demersal gillnet)	0.46	0.03	0.87	0.00
Southern Bluefin Tuna	Dropline	0.00	0.00	0.00	0.00
	Handline (mechanised)	0.04	0.03	0.00	0.00
	Pole and line	0.29	0.19	0.00	0.00
	Purse seine	840.32	342.27	48.21	27.69
	Rod and reel	0.13	0.12	0.00	0.00
	Trolling	0.07	0.03	0.06	0.00
Squid Jig	Squid jigs (mechanised)	0.00	0.00	0.00	0.00
Torres Strait	Dropline	0.07	0.02	0.00	0.00
	Free diving	0.00	0.00	0.00	0.00
	General diving	0.00	0.00	0.00	0.00
	Hand collection (miscellaneous)	0.00	0.00	0.00	0.00
	Handline (hand operated)	4.88	1.65	0.00	0.00
	Hooks	0.07	0.04	0.00	0.00
	Trolling	12.45	4.16	0.00	0.00
Torres Strait Prawn	Bottom shrimp trawl (prawn trawl)	68.51	12.74	0.00	0.00
Western Deep Water	Bottom otter trawl	7.47	5.45	0.65	0.52
	Bottom pair trawl	37.45	24.63	4.45	0.00
	Danish seine (trawl fishery)	0.09	0.06	0.00	0.00
Western Tuna and Billfish	Drifting longline (pelagic longline)	162.87	76.31	0.00	0.00
	Handline (mechanised)	1.48	0.55	0.00	0.00
	Hooks	0.62	0.20	0.00	0.00
	Pole and line	1.16	0.38	0.00	0.00
	Trolling	0.14	0.08	0.00	0.00
Totals		**31,186.32**	**8,268.03**	**3,215.94**	**230.11**
Overall Discard % =		**42.30**	**11.21**	**7.03**	**0.50**

These data show a very large disparity between the two sources of discard information across all fisheries and methods - with the logbook data providing estimates that, in total, are just 10.3% of that estimated from the observer data – ie. an under-reporting rate of 89.7%.

Threatened, Endangered and Protected species (TEPS)

Whilst the above work was able to produce reasonable estimates of annual general discards for most fisheries and methods throughout Australia's 8 fisheries jurisdictions, the same cannot be said for interactions with TEPS. This is because the very nature of such species is that they are rare so their interactions with commercial fisheries are few and sporadic, making the recording of such interactions in observer programmes even rarer. Furthermore, while most jurisdictions require fishers to self-report such interactions in logbooks, fishers' willingness to do so can be influenced by the controversy that such interactions may incur.

As a result, the data that we were able to gather that describe fisheries interactions with TEPS are very few, vary greatly in detail, format and reporting methodology, and are mostly based on unvalidated, self-reported records. A notable exception to this is the information on TEPS interactions for Commonwealth fisheries due to the availability of relatively good data from AFMA's observer programmes – augmented in recent years with EM cameras in some fisheries.

Below we summarise the information available about TEPS interactions for each jurisdiction in turn:

New South Wales

For TEPS, only one fishery in NSW had any discards recorded in observer studies - the **Ocean Trap and Line** fishery - and the numbers of such interactions observed were very small (Table 7).

Table 7 – Discard estimates of the numbers of TEPS recorded in NSW's observer studies and the numbers of fishing days over which these individuals were observed.

Fishery	Method	Target spp.	Year(s)	Locations	Days Observed	All TEPS interactions during all days observed	Reference (s)
Ocean Trap and Line	Handline	Mixed finfish	2007-09	Statewide	142	1 Black Rock Cod, 1 Short-tail Shearwater, 1 Humpback Whale	MacBeth and Gray, 2016
	Dropline				77	18 Harrisons Dogfish, 3 Southern Dogfish	
	Set/Trotline				88	17 Southern Dogfish, 4 White Sharks, 2 Grey Nurse Sharks, 2 Eastern Blue Devil fish, 2 Great Hammerheads	

	Setline	Large sharks	2008-09	Several ports on North Coast	114	53 Scalloped Hammerheads, 6 White Sharks, 5 Grey Nurse Sharks, 2 Green Turtles	MacBeth et al., 2009

It is tempting to extrapolate the very limited data in Table 7 using corresponding effort data from the NSW DPI's Catch Returns Database). That is, because the average days fished/year in 2009-14 for each method were: Handline 5657 days, Dropline 673 days, Set/Trotline 304 days and Setline (Large Sharks) 513 days, and the number of observed days for these methods were 142, 77, 88 and 114, respectively, the numbers of interactions observed for each method could be multiplied by 39.8, 8.7, 3.5 and 4.5, respectively to give annual estimates of discards of these TEPS. However, the very small number of TEPS interactions recorded makes such extrapolations extremely tenuous (at best), probably erroneous, and dangerously controversial in terms of the total numbers of TEPS that would be estimated. For example, such a calculation would estimate that the handline sector of this fishery would affect approx. 40 humpback whales per year – which is, intuitively, incorrect. So we therefore do not provide such extrapolations here. This is further justified by a consideration of the relative quality of the NSW TEPS data obtained by applying the USA's Tier Classification Scheme to the NSW information (see later chapter in this report on Quality/Performance Metrics). The results (Table 21) reveal very poor information – an average of just 4.8% and a tier class of 0.3. Clearly information that yields such low quality metrics should not be used for extrapolations.

In addition to the above observer data, all commercial fishers in NSW are required to report any TEP interactions on a dedicated logbook form. We were able to obtain such data for only one complete year (2014-15) (see Table 8).

Table 8 – Number of TEPS reported as discarded in the NSW Commercial Fishers' Catch database for 2014-15.

Fishery	**Method**	**All TEPS interactions reported**
Ocean Trap and Line	Handline	1 Black Rockcod 1 Scalloped Hammerhead 1 White Shark 2 Grey Nurse Sharks 2 Great Hammerheads
	Dropline	2 White Sharks
	Trolling	1 Scalloped Hammerhead
	Setline	1 Scalloped Hammerhead
	Fish Trap	1 Leatherback Turtle
Ocean Trawl	Fish Trawl	1 Seal 6 Great Hammerheads 8 Scalloped Hammerheads
	Prawn Trawl	1 Grey Nurse Shark
Ocean Haul	Haul net	1 Grey Nurse Shark

Estuary General	Haul net	44 Green Turtles
	Crab trap	12 Green Turtles

Tasmania

Information about interactions with TEPS in Tasmania comes from some independent observer data and compulsory logbook reporting by fishers provided by the University of Tasmania. As found elsewhere in the world, the data showed that interaction rates are much higher in the observer data which throws doubt on the validity of the logbook data. Unfortunately, there is little consolidation of TEPS interactions for Tasmania's fisheries available.

In the **Rock Lobster** fishery, logbook data were considered to be too unreliable to provide meaningful estimates of TEPS interactions. But in some observer work from 1990 to 2007, a total of 7 interactions were recorded, each involving the drowning of a cormorant (F: *Phalacrocoracidae*) (data provided to Leon et al., 2019). This occurred over a total of 69,441 potlifts and, if similar rates occurred throughout the fishery, then the average annual number of cormorant deaths in lobster pots would be around 140. However, such an estimate would probably overstate actual cormorant deaths as the work was biased to shallow water. Two Sygnathids (a Pipefish and a Seahorse) were also recorded and both were released apparently unharmed.

In the **Giant Crab** fishery, no interactions were reported by fishers targeting crabs in 2013/14 and none have been recorded in any research or observer sampling on commercial vessels in the history of the fishery (UTAS, pers. comm.). For the **Octopus** fishery, Emery and Hartmann (2016) noted that protected species interactions were also minimal, seals being the only species for which interactions have been recorded. These occurrences were also rare with just 28 interactions occurring from 2000 to 2015. For the Tasmanian **Scalefish** fishery, Lyle et al (2014) do not provide any data on TEPS interactions for the commercial fishery although a number of interactions were observed in a research study involving Fur Seals (*Arctocephalus pusillus doriferus*), seabirds, Sygnathids, and Maugean Skates (*Zearaja maugeana*).

Northern Territory

Information about interactions with TEPS in the Northern Territory's commercial fisheries comes from 3 recent status reports (NTG, 2015, 2016, 2017) which summarise data from industry logbooks and observer programmes.

The **Demersal** and **Timor Reef** fisheries are required to have turtle exclusion devices and are reported to have consistently few interactions with TEPS with most interactions involving Narrow Sawfish (*Anoxypristis cuspidata*) and Scalloped Hammerhead Sharks (*Sphyrna lewini*).

The **Offshore Net and Line** fishery is also reported to have relatively few interactions with TEPS. In particular, nets are required to be set above the bottom which minimises interactions with sawfish species. However, this fishery does interact withScalloped Hammerhead Sharks and, at its peak,

approximately 50 t of this species were caught per year. A northern Australian TAC of 200 t has been set for this species.

The gears used in the **Spanish Mackerel** (trolled lures and baited lines), **Mud Crab** (pots) and **Coastal Line** fisheries (hook-and-line) are considered to pose little risk of interaction with TEPS. Also, the selective harvesting methods used in the **Trepang**, **Restricted Bait** and **Aquarium Fish/Display** fisheries are assumed to pose negligible risks of interaction with TEPS. Finally, the small number of licensees in the **Coastal Net** fishery (five), in conjunction with its restricted area, is considered to limit the risk of interactions with TEPS.

A summary of the available information on TEPS interactions for the Northern Territory is provided in Table 9.

Table 9 – Estimates of interactions between the Northern Territory's commercial fisheries and TEPS.

Fishery	Year	Source	Interactions with TEPS
Demersal	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
Timor Reef	2013-14	Observers	none
	2015	Observers	3 interactions over 35 days with two sea snakes and a Narrow Sawfish
	2016	Observers	13 interactions over 40 days with sea snakes, Narrow Sawfish, Pipefish and a Whale Shark
	2017	Observers	14 interactions over 36 days with Scalloped Hammerhead Sharks and one each of Green Sawfish, Pipefish and Grey Nurse Shark
Barramundi	2013-15	Logbooks	Less than 100 interactions per year with Saltwater Crocodiles and Sawfish
Offshore Net and Line	2013	Observers	16 interactions over 30 days with sea snakes, Narrow Sawfish and turtles
	2014	Logbooks	22 sawfish, 22 turtles, 15 Mobulid rays, two river sharks and one dolphin over 621 days
	2015	Logbooks	27 sawfish, 13 turtles, one Mobulid ray, and one dolphin over 588 days
Spanish Mackerel	2013-15	Logbooks	None
Mud Crab	2013-15	Logbooks	None
Coastal line	2013-15	Logbooks	None
Trepang	2013-15	Logbooks	None

Restricted Bait	2013-15	Logbooks	None
Aquarium Display	2013-15	Logbooks	None
Coastal net	2013-15	Logbooks	None

Queensland

The data obtained from all available sources regarding interactions with TEPS (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 programmes. Only 8 of Queensland's 22 fisheries indicated any interactions with TEPS:

The Queensland **Eel** fishery recorded a total of 2,833 interactions with protected species in fishers' logbooks in 2011 (DAFF, 2013). Most of these (2,599) were with the Krefft's River Turtle (*Emydura macquarii krefftii*), with the remainder being smaller numbers of several other turtle species.

It was mentioned in DEEDI (2010c) that the **East Coast Inshore Finfish** fishery interacted with turtle species more frequently than with other protected species but no data were available.

The **Gulf of Carpentaria Inshore Finfish** fishery is also said to have some rare incidents when marine turtles, dolphins, crocodiles, dugongs and sea snakes (F: Elapidae) are caught (Roelofs, 2004b)

For the **Blue Swimmer Crab** fishery, fishers' logbooks list four interactions with Loggerhead Turtles (*Caretta caretta*) in 2003, four in 2004, none during 2005–06 and two in 2007. Leslie (2014) notes that the fishery did not report interacting with any protected species during 2012. An observer-based study of the Moreton Bay Blue Swimmer Crab pot fishery recorded only one turtle interaction in 220 observed fishing days.

DEEDI (2011e) notes that, in an observer programme, of 1452 trap lifts observed (on 801 unique pots) in the **Mud Crab** fishery, there were no interactions with SOCI and only one captured elasmobranch (Spotted Wobbegong *Orectolobus maculatus*). But in 2010, there were two reported interactions with Water Rats (*Hydromys chrysogaster*).

In 2010 the **Spanner Crab** fishery had two recorded interactions with SOCI; one with a Green Turtle (*Chelonia mydas*) and one with a Humpback Whale (*Megaptera novaeangliae*).

Robins (1995) estimated the numbers of turtles caught in the **Queensland East Coast Otter Trawl** fishery to be an average rate of 0.068 turtles per day fished. Loggerhead (50.4%), Green (30.1%) and Flatback Turtles (*Natator depressus*) (10.9%) were the main species caught. This equated to an estimated 5295 ± 1231 turtles caught annually by the fishery. But these estimates came from a period prior to the introduction of Turtle Exclusion Devices (TEDs) in the fishery so current bycatches of such SOCI can be expected to be far less. DEEDI (2012) stated that, in 2008, just 3 Flatback Turtles, 3 Narrow Sawfish and 4 Seahorses (*Hippocampus* spp.) were caught but 1,657 sea snakes were caught and discarded. Courtney et al. (2010) estimated that 105,210 sea snakes (SE 18,288), composed of 12 species, were being discarded in the trawl fishery per year - using data

from research projects, at-sea observers and a voluntary crew member programme. This is two orders of magnitude greater than the 1,657 reported in logbooks. However, one needs to note that Courtney et al.'s (2010) estimate came from 2003-2007 data and fishing effort has declined markedly in the fishery since that time, so this estimate has likely declined.

No SOCI interactions were reported in 2009 logbooks for the **Fin Fish (Stout Whiting) Trawl** fishery (DEEDI, 2011h) and operators in the **Gulf of Carpentaria Developmental FinFish Trawl** fishery reported 5 SOCI interactions during the 2010 season including 4 Freshwater Sawfish (*Pristis pristis*) and 1 Flatback Turtle.

The above TEPS interactions are summarised in Table 10.

Table 10 – Summary of data concerning Queensland's commercial fisheries' interactions with TEPS (SOCI).

Fishery	SOCI Interactions
Coral	nil
Crayfish and Rocklobster	nil
East Coast Pearl	nil
Marine Aquarium Fish	nil
Eel Fishery	In 2011, 2833 turtles (2599 were Krefft's river turtle)
Sea Cucumber Fishery (East Coast)	nil
Trochus	nil
Coral Reef Finfish	nil
Deep Water Finfish	nil
East Coast Spanish Mackerel	nil
Gulf of Carpentaria Line	nil
Rocky Reef Finfish	nil
East Coast Inshore Finfish	Some turtles mentioned but no data
Gulf of Carpentaria Inshore Finfish	"Rarely" catch turtles, dolphins, crocodiles, dugongs and sea snakes but no data
Blue Swimmer Crab	Between 0 and 4 Loggerhead Turtles/year
Mud Crabs	In 2010, 2 water rats
Spanner Crabs	In 2010, 1 Green Turtle and 1 Humpback Whale
East Coast Otter Trawl	In 2008, 3 Flatback turtles, 3 Narrow Sawfish, 4 seahorses. In 2010, 105,210 (SE 18,288) of 12 species of sea snakes
Fin Fish (Stout Whiting) Trawl	nil
Gulf of Carpentaria Developmental Fin Fish Trawl	In 2010, 4 Freshwater Sawfish and 1 Flatback Turtle
River and Inshore Beam Trawl	nil

Victoria

Information about interactions with TEPS in Victoria comes from an observer programme run in the Lobster and Giant Crab fisheries from 2005 – 2007 (Hobday et al., 2008) and compulsory

logbook reporting by fishers who are required to report interactions with all mammal, bird, reptile and amphibian species that are native to Victoria, as well as threatened fish.

During the two and a half years of the observer study in the **Lobster** fishery, one Cormorant was captured dead in a lobster pot, a Humpback Whale was entangled by the left pectoral fin on a lobster pot line and released alive and five seahorses were captured in depths ranging from 6–37 metres. In the **Giant Crab** observer study, no interactions were observed with any avian or mammal TEPS but two Robust Pipefish (*Solegnathus robustus*) and two seahorses were captured in pots from depths between 70–90 metres and all returned to the water alive.

The logbook data provided by VFA from 2015-2018 excludes data for strata in which there were fewer than 5 operators involved so there is very little detail available concerning TEPS interactions. The list of species reported over the 4 years is given in Table 11.

Table 11 - List of Threatened, Endangered and Protected (TEP) species recorded in Victoria's logbooks from 2015-2018 incl.

Australasian Shag	Freckled Duck	Pygmy Perch (unspecified)
Australian Grayling	Fur Seal, Australian	Seabird, or waterbird, Unspecified
Australian Pied Cormorant	Fur Seal, New Zealand	Seahorse, Bigbelly
Black Duck	Great Black Cormorant	Seahorse, Unspecified
Black Faced Cormorant	Grebe	Seal, Unspecified
Blue-billed Duck	Grey Teal Duck	Shark, Greynurse
Bream, Bony (Freshwater)	Hardhead Duck	Shark, White Pointer
Chestnut Teal Duck	Hoary Headed Grebe	Short Neck Turtle
Coot	Lowland Copperhead Snake	Teal Duck unspecified
Cormorant, Unspecified	Musk Duck	Tiger Snake
Dolphin, Bottlenose	Pelican, Australian	Turtle, Unspecified
Dolphin, Unspecified	Penguin, Unspecified	Water Rat
Duck, unspecified	Pipefish, Unspecified	Waterhen
Eastern long-necked Turtle	Platypus	Whale, Humpback
		Whale, Southern Right

The total number of interactions with these species per year, and where confidentiality provisions permitted, the numbers, species and fisheries involved were:

2015: 2,245 interactions including:

- 817 Eastern Long-Necked Turtles (*Chelodina longicollis*) in the Eel fishery, and
- 153 Australian Fur Seals (*Arctocephalus pusillus doriferus*) in the Corner Inlet, Gippsland Lakes, Ocean General and Westernport/Port Phillip Bay fisheries.

2016: 605 interactions including:

- 258 Eastern Long-Necked Turtles and 42 Water Rats in the Eel fishery.

2017: 676 interactions including:

- 23 Australian Pied Cormorants (*Phalacrocorax varius*) in the Corner Inlet, Eel and Gippsland Lakes fisheries,
- 61 unspecified Cormorants and 53 Grebes (F: *Podicipedidae*) in the Eel and Gippsland Lakes fisheries,
- 128 unspecified turtles in the Eel and Rock Lobster fisheries, and
- 35 Water Rats in the Eel fishery.

2018: 1,207 interactions including:

- 14 Australian Pied Cormorants, 28 Coots (F: *Rallidae*), 16 unspecified Cormorants and 19 Grebes in the Eel and Gippsland Lakes fisheries,
- 82 Eastern Long-Necked Turtles, 712 unspecified turtles and 71 Water Rats in the Eel fishery, and
- 17 Australian Fur Seals in the Corner Inlet, Eel, Westernport/Port Phillip Bay, Rock Lobster and Inshore Trawl fisheries.

The above data clearly show the dominance of the Eel fishery as the main one interacting with TEPS in Victoria.

Western Australia

Most information about interactions with TEPS in Western Australia comes from logbook reporting by fishers who are required to report interactions with all protected and listed species. Mostly these data are not validated by observer programmes or onboard video. The information (combined across all fisheries and methods) has been provided by WA Fisheries for the past 3 years in Appendices of the annual Status Reports of the Fisheries and Aquatic Resources of Western Australia (see http://www.fish.wa.gov.au/About-Us/Publications/Pages/State-of-the-Fisheries-report.aspx). As an example, the following is the table from the most recent status report (Gaughan et al., 2019) for reported interactions during 2017.

Table 12 - Number of Threatened, Endangered and Protected (TEP) species recorded in logbooks in 2017 for all fisheries in Western Australia (from Gaughan et al., 2019).

Common Name	Release Condition			Total
	Alive	Dead	Unknown	
Bird (unspec.)		1		1
Cormorant (unspec.)	19	16		35
Duck, swan or goose (unspec.)	5	26		31
Shearwater (unspec.)	283	37		320
Dwarf Sawfish		2		2
Grey Nurse Shark	28	18		46
Green Sawfish	102	26		128
Narrow Sawfish	35	10		45
Sawfish (unspec.)	67	30	32	129
Queensland Groper	1			1

Sygnathid (unspec.)	440	25	61	526
White Shark	12	2		14
Green Turtle	3	3	5	11
Loggerhead Turtle			23	23
Saltwater Crocodile	9	1		10
Sea Snake (unspec.)	5492	712	6	6210
Crocodile (unspec.)	31	38	2	71
Turtle (unspec.)	14	5	86	105
Whale	1			1
Common Dolphin	1			1
Dolphin (unspec.)	2	14	1	17
TOTAL:				**7,727**

Similar data are available for 2015 and 2016. The totals for these 3 years are:

2015: 2,912 animals of which 2,429 were sea snakes (83%)
2016: 8,168 animals of which 7,079 were sea snakes (87%)
2017: 7,727 animals of which 6,210 were sea snakes (80%)

In addition to the above combined data about all commercial fisheries in WA, there is also information for some fisheries/methods from the same reports and papers cited in the earlier section about general discards. This information is summarised below. Most of the information comes from unvalidated logbook data.

For the **Rock Lobster** fishery, de Lestang et al. (2019) noted that in 2017 there were no interactions with sea lions reported whilst whale entanglements between 1990 and 2010 ranged from 0 to 6 per year, averaging just over 1 entanglement annually. However in 2011 there was an increase in whale entanglements which ultimately peaked at 17 in 2013. This was said to be due to increased fishing during the whale migration period when the lobster season was extended to 12 months. In 2018 there were 8 entanglements recorded.

For the **Exmouth Gulf Prawn** fishery, Kangas et al. (2015)'s Table 12.1 provides the following information about TEPS interactions:

Table 13 – TEPS interactions in the Exmouth Gulf Prawn fishery – from Kangas et al. (2015).

Table 12.1. Reported interactions with ETP species by the Exmouth Gulf Prawn Managed Fishery from 2007 – 2013. Return status indicated when known (A: Alive; D: Dead; U: Unknown)[1].

Year	Marine Turtles			Sea snakes			Seahorses			Sawfish		
	A	D	U	A	D	U	A	D	U	A	D	U
2007						13						
2008	12					103			1			
2009	3					80						
2010	7			113	2	37			4			7
2011	28			449	48				4			23
2012	5		1			70						3
2013	10			105	6				1			14

[1] Since 2010, reporting in the EGPMF fishery has improved and has been able to provide returned status for some species.

Western Australian Marine Stewardship Council Report Series No.1, 2015 109

Wakefield et al. (2014 and 2017) noted that, for the **Pilbara Fish Trawl (Interim)** Fishery, interactions with Sea Snakes, Marine Turtles, Seahorses, Sea Dragons, Pipefish and Sawfish are significant issues with dolphins being a key problem. However, no data were provided.

Gaughan and Santoro (2018) is the most recent annual Status Report of the Fisheries and Aquatic Resources of Western Australia and contains summaries of information about various fisheries' interactions with TEPS. The information in that report is summarized below:

There were no reported interactions between TEPS and the **Sea Cucumber** fishery since the introduction of the current logbooks in 2007. Nor were there any reported interactions in the **West Coast Estuarine** fishery in 2016 or 2017. For the **Octopus** and **Cockburn Sound (Line and Pot)** fisheries, reported interactions were with one Southern Right Whale (*Eubalaena australis*) in 1994, 13 Humpback Whales between 2010 and 2013, and two more in 2014 and 2015. In 2016 there were no reported entanglements with whales in that fishery.

For the **Kimberley Prawn** fishery, 72 Sea Snakes were recorded as being caught in 2016 with 58 returned to the sea alive, 10 with status unknown and 4 returned dead. Four Sawfish were recorded as captured with three returned to the sea alive and 1 recorded dead. For the **Nickol Bay Prawn, West Coast Purse Seine** and **West Coast Deep Sea Crustacean** fisheries, there were no reported TEPS interactions in 2016.

For the **South Coast Estuarine** fishery, whilst no data were provided, it was noted that New Zealand Fur Seals (*Arctocephalus forsteri*) and Australian Sea Lions (*Neophoca cinerea*) are occasionally surrounded by beach seine nets but are released immediately by the fishers. Birds such as pelicans, cormorants and shearwaters were also noted to sometimes interact with the nets.

Gaughan and Santoro (2018) noted that bycatch of TEPS is minimal in the **Shark Bay Beach Seine and Mesh Net** fishery and if any listed species such as dugongs, dolphins or marine turtles are caught, they are immediately released. For the **Kimberley Gillnet and Barramundi** fishery, interactions were reported for Crocodiles (F: *Crocodylidae*) and Sawfish in 2016. And catches of

the Speartooth Shark (*Glyphis glyphis*) and the Northern River Shark (*G. garricki*) occurred but no data were provided.

In the **South West Trawl** fishery, one turtle was reported as captured and returned alive in 2016.

The **South Coast Crustacean** fishery operates in areas adjacent to Australian Sea Lion colonies but in the 2015/16 season there were no sea lion or whale interactions attributed to the fishery. Turtles can also get caught in the float rigs of lobster pots in the fishery but in 2015/16 no turtles were reported to have been entangled.

In 2016, the **Pilbara and Kimberley Trap** fisheries reported interactions of 213 and 26 sea snakes, respectively.

The **South Coast Purse Seine** fishery had DPIRD observers on board vessels during 2017 and 2018 to obtain independent estimates of the level of bycatch. For trips when the net was deployed, they recorded 30 Flesh-footed Shearwaters (*Puffinus carneipes*) mortalities from 51 trips in 2017, and 32 from 52 such trips in 2018.

South Australia

Information about interactions with TEPS in South Australia comes from logbook reporting by fishers who are required to report interactions with all such species. All data are well-summarised in annual reports by SARDI, the ninth being completed in September, 2019 (Goldsworthy and Boyle, 2019 - see Table 14). As noted by these authors, only data from the Sardine fishery are validated by an observer programme which targets 10% of fishing effort (see also Goldsworthy, 2018).

Table 14 - Number of TEPS recorded in logbooks in 2017/18 for all fisheries in South Australia (from Goldsworthy and Boyle, 2019).

Table 1. Total number of reported TEPS interactions and number of individuals (in parentheses) reported to interact with each South Australian Fishery in 2017/18.

Fishery	Cetaceans	Pinnipeds	Birds	Fish	Total
Sardine Fishery	88 (335)	1 (2)			**89 (337)**
Lakes and Coorong Fishery		630 (2771)	3 (3)		**633 (2774)**
GSV Prawn Fishery					
SG Prawn Fishery				49 (127)	**49 (127)**
WC Prawn Fishery				11 (12)	**11 (12)**
Marine Scalefish Fishery			1 (3)		**1 (3)**
Abalone Fisheries				2 (2)	**2 (2)**
Blue Crab Fishery					
Charter Boat Fishery					
Northen Zone Rock Lobster Fishery					
Southern Zone Rock Lobster Fishery					
Total	**88 (335)**	**631 (2773)**	**4 (6)**	**62 (141)**	**785 (3255)**

Commonwealth

Information about interactions with TEPS in Commonwealth fisheries comes from observer programmes (by fishery and method) and from compulsory logbook reporting (by fishery) from 2011 to 2018. As was the case for general discards, the data on TEPS interactions for Australia's Commonwealth fisheries are the best of any jurisdiction in Australia. Indeed, our experience with these sorts of datasets indicate that the availability of the Commonwealth data from observers and logbooks allows one of the best comparisons of such information about TEPS interactions in the world. Tables 15 and 16 list the TEPS identified in the observer and logbook databases, respectively, over the 9 years. They show that the observer information recorded a total of 106 species during this period whilst the logbook data recorded 79.

Table 15 - List of TEPS recorded in the observer programme from 2011 to 2018.

Albatrosses	Giant Grouper	Pacific (Olive) Ridely Turtle	Sperm Whale
Australian Butterfly Ray	Giant Manta Ray	Pacific Gregory	Spine-Bellied Seasnake
Australian fur seal	Golden Seasnake	Penguins	Spiny Pipehorse
Australian sea lion	Goldstripe Sardinella	Petrels	Spinysnout Pipefish
Banded Eagle Ray	Great-Winged Petrel	Petrels Prions and Shearwaters	Squilla Mantis Shrimps
beaked seasnake	Green Sawfish	Pinstripe Wrasse	Stagger-Banded Seasnake
Bentstick Pipefish	Green Turtle	Pipefish Solehnathus sp 2	Stokes' Seasnake
Black Browed Albatross	Greeneye Dogfishes (mixed)	Porbeagle	Straightstick Pipefish
Black-Faced Cormorant	Harrisson's Dogfish	Potbelly Seahorse	Terns
Black-Headed Seasnake	Hawksbill Turtle	Reef Shallows Seasnake	Tiger Pipefish
Black-Spotted Whipray	Horned Seasnake	Ribboned Pipefish	Turtle-Headed Seasnake
Bottlenose Dolphin	Hydrophis ornatus	Robust Pipehorse	Turtles
Buller's Albatross	Large-Headed Seasnake	Sawfishes	Unknown or other
Cape Petrel	Leatherback Turtle	Seahorses - Hippocampid	Wandering Albatross
Common Dolphin	Loggerhead Turtle	Seahorses and pipefishes	Warty Mantis Shrimp
Common Seadragon	Long Snouted Lancetfish	Sea snakes	Wedge Tailed Shearwater
Coral Prawn	Longfin Mako	Shark Ray	Whale shark
Cormorants	Long-Finned Pilot Whale	Short Tailed Shearwater	White Chinned Petrel
Crested Pipefish	Masked Booby	Shortfin Mako	White Faced Storm Petrel
Dwarf Sawfish	Minke Whale	Short-Finned Pilot Whale	White Shark
Eared Seals	Narrow Sawfish	Short-Nosed Seasnake	Whitespotted Guitarfish
Elegant Seasnake	New Zealand Fur Seal	Shy Albatross	Whitings
Fairy Prion	No catch or interaction	Small-Headed Seasnake	Wilsons Storm Petrel
Flatback Turtle	Northern Giant Petrel	Sooty Shearwater	Yellow Nosed Albatross

Flesh Footed Shearwater	Northern Spiny Seahorse	Southern Sand Flathead	Yellow-Bellied Seasnake
Freshwater Sawfish	Olive-Headed Seasnake	Spectacled Seasnake	Yellowtail Scad
Frigatebirds	Ornate Rock Lobster		

Table 16 - List of TEPS recorded in fishers' logbooks from 2011 to 2018.

Albatrosses	Dugong	Loggerhead Turtle	Short Tailed Shearwater
Antarctic Fur Seal	Dwarf Sawfish	Longfin Mako	Shortfin Mako
Australian Fur Seal	Fairy Prion	Long-Finned Pilot Whale	Short-Finned Pilot Whale
Australian Gannet	False Killer Whale	Melon-Headed Whale	Shy Albatross
Australian Sea Lion	Fiveline Snapper	Minke Whale	Silky Shark
Baleen Whales	Flatback Turtle	Narrow Sawfish	Sooty Shearwater
Basking Shark	Flesh Footed Shearwater	New Zealand fur seal	Spiny Pipehorse
Bentfin Devilray	Freshwater Sawfish	Pacific (Olive) Ridely Turtle	Storm-petrels
Birds	Green Sawfish	Pacific Gull	Terns
Black Browed Albatross	Green Turtle	Petrels Prions and Shearwaters	Toothed whales
Black Marlin	Greeneye Dogfish	Porbeagle	Turtles
Blue Marlin	Grey Nurse Shark	Providence Petrel	Wandering Albatross
Bottlenose Dolphin	Grey-Headed Albatross	Red Cormorant	Whale shark
Buller's Albatross	Harrisson's Dogfish	Sawfishes	Whales (mixed)
Cape Petrel	Hawksbill Turtle	Seahorses and pipefishes	White Chinned Petrel
Common Dolphin	Humpback Whale	Sealions	White Faced Storm Petrel
Common Sawshark	Imperial Shag	Seals	White Shark
Cormorants	Killer Whales	Sea snakes	Wilsons Storm Petrel
Cuvier's Beaked Whale	Leatherback Turtle	Shearwaters	Yellow Nosed Albatross
Dolphins	Little Penguin		

Tables 17 and 18 provide the mean annual number (and SE) of TEPS recorded by observers and in logbooks, respectively, for each fishery where data were available.

Table 17. Mean (SE) number per year of TEPS recorded by observers for each fishery where data were available.

	Mean	**SE**
Australian Fishing Zone	1.22	0.17
Coral Sea	0.11	0.04
East Coast Deep Water	0.11	0.04
Eastern Tuna and Billfish	96.89	11.08
Gillnet, Hook and Trap	41.11	5.60
Great Australian Bight	5.33	1.30
High Seas	0.78	0.07
North West Slope	2.00	0.67

Northern Prawn	337.44	19.62
Scallop	0.00	0.00
Small Pelagic	19.22	4.09
South East Trawl	180.56	18.98
Southern Bluefin Tuna	0.00	0.00
Torres Strait Prawn	129.78	13.38
Western Deep Water	0.00	0.00
Western Tuna and Billfish	4.44	1.08
TOTAL	**822.22**	**54.46**

Table 18. Mean (SE) number per year of TEPS recorded in logbooks for each fishery where data were available.

	Mean	**SE**
Coral Sea	0.78	0.18
Eastern Tuna and Billfish	4077.56	127.45
Gillnet, Hook and Trap	331.22	12.96
Great Australian Bight	1.44	0.18
High Seas Non-trawl	12.67	3.04
Kimberley Prawn Fishery	2.00	0.67
North West Slope	2.11	0.70
Northern Prawn	8677.44	179.42
Small Pelagic	21.78	4.08
South East Trawl	273.44	17.43
Torres Strait Prawn	1024.56	50.87
Unknown or unspecified	3.44	0.69
Western Tuna and Billfish	486.56	21.27
TOTAL	**14,916.89**	**226.96**

Using the known number of days observed by observers in each fishery and the reported numbers of days fished by each fishery in logbooks, we are able to extrapolate the mean estimates from the observer data (Table 17) to provide total estimated TEPS interactions for each fishery and compare these to the total number of TEPS interactions reported in logbooks. This involved multiplying the average annual number of TEPS interactions recorded by observers per day by the average number of days fished by each fishery in a year. In doing this, we could only include fisheries where the logbook and observer data overlapped, so we removed 3 fisheries from this comparison: the Australian Fishing Zone, Squid jig and Torres St (non-trawl). The results are provided in Table 19.

Table 19 – A comparison of the annual mean number of TEPS interactions estimated from the observer programme (extrapolated by total fishing effort) with those recorded in logbooks.

	Observer data	SE	Logbook data	SE
Coral Sea	1	0	1	0
East Coast Deep Water	0	0	0	0
Eastern Tuna and Billfish	3347	384	4078	127
Gillnet, Hook and Trap	1241	169	331	13
Great Australian Bight	206	50	1	0
High Seas	20	2	13	3
North West Slope	26	9	2	1
Northern Prawn	19520	1136	8677	179
Scallop	0	0	0	0
Small Pelagic	56	13	22	4
South East Trawl	6508	684	273	17
Southern Bluefin Tuna	0	0	0	0
Torres Strait Prawn	6558	710	1025	51
Western Deep Water	0	0	0	0
Western Tuna and Billfish	132	32	487	21
Totals	**37,616**	**1563**	**14,910**	**228**

As was the case for general discards (Table 6), the information in Table 19 shows a disparity in the number of TEPS interactions as estimated by the observer programme and that recorded in fishers' logbooks. But the disparity is much less for TEPS interactions than was the case for general discards, with the logbook information showing 39.6% of the estimated TEPS interactions derived from the observer information – an under-reporting rate of 60.4%. For general discards this rate was 89.7% (Table 6).

In recent years (2015 onwards) AFMA has run an EM programme using cameras to record TEPS interactions on boats using drifting longlines in the **Eastern Tuna and Billfish** fishery and auto-longlines and set gillnets in the **Gillnet, Hook and Trap** fishery. The numbers of TEPS interactions recorded from the 3 most recent complete years of the programme (where 10% of footage is examined) are provided in Table 20. Also included are logbook reports of TEPS interactions for the same sectors for the past 9 years.

Table 20 – TEPS interactions recorded by the EM Programme in 2016-2018 compared to interactions reported by fishers on logbooks from 2010 to 2018 in 3 Commonwealth fisheries/methods.

			2010	2011	2012	2013	2014	2015	2016	2017	2018
Electronic Monitoring	**Eastern Tuna and Billfish**	**Drifting longline**							153	221	203
	Gillnet, Hook and Trap	**Auto-Longline**							24	14	15
		Set gillnet							29	29	32

Logbook information	**Eastern Tuna and Billfish**	**Drifting longline**	2854	2562	3326	3450	3648	5531	4903	5550	4870
	Gillnet, Hook and Trap	**Auto-Longline**	64	70	206	52	35	99	78	54	110
		Set gillnet	160	264	215	102	175	142	258	246	284

The above data show a significant increase in logbook reporting of TEPS interactions since the introduction of the EM programme mid-way through 2015 for the Eastern Tuna and Billfish fishery and the Gillnet, Hook and Trap fishery's set gillnet sector. This shows that the function of EM in validating and improving TEPS reporting by fishers is confirmed.

If one multiplies the EM data in Table 20 by 10 to account for the 10% of video footage being examined, one would expect some similarity between the two datasets. This is seen for the Gillnet, Hook and Trap fishery's set gillnet sector but not for the Eastern Tuna and Billfish fishery (which shows fishers reporting approx. double that predicted from the EM data) and nor for the Gillnet, Hook and Trap fishery's auto-longline sector (which shows fishers reporting less than that predicted). Discussions with AFMA staff revealed that such discrepancies lie in the taxonomic detail used by fishers when reporting the incidental capture of birds and sharks (in particular Mako Sharks, *Isurus* spp.).

Summary of TEPS information

Consolidating all the above information about TEPS interactions across all of Australia's jurisdictions to annual estimates was not possible. This was due to the varying nature, amount, consistency and quality of data among jurisdictions. Some jurisdictions report on TEPS interactions by fishery, some by method, some by species, some by total number across all species, some by a combination of all these, and some do not report on such interactions at all. Some have observer data, fewer have EM data and most rely on self-reported information from fishers without any validation. The exception to this is the information for Australia's Commonwealth fisheries which, due to their long-running observer and (more recent) EM programmes, provide quite good data about TEPS interactions. These differences among jurisdictions in data about TEPS interactions are also reflected in the quality/performance metrics discussed in the next chapter of this report.

Despite the varying and (mostly) inaccurate nature of TEPS reporting throughout Australia's jurisdictions, two issues stand out from the data assembled above. These are the domination of the number of interactions by those involving sea snakes in northern trawl fisheries (numbering in the 10's to 100's of thousands per year) and turtles in eel fisheries (numbering in the thousands per year). These two groups of species account for the vast majority of TEPS interactions throughout Australia' fisheries with all other species interacting at levels that are orders of magnitude less.

Quality/Performance Metrics

Table 21 contains a summary (by jurisdiction) of the results from an application of the USA's National Bycatch Report's 22 Tier Classification criteria for estimating the quality/performance of discard estimates and TEPS interactions to the Australian information. The 12,012 individual scores for each fishery/method for general discards and TEPS interactions are contained in Appendices 1 and 2, respectively. Whilst the total points possible for each method/fishery is 73 using the US scheme, we express these scores as percentages. The 5 tiers used in the scheme are ranked from 0 (for fisheries/methods with no data) through to 4 (those with the best quality information). It is important to note that the scores in the US scheme do not account for the relative level of discards that are estimated to have come from each fishery/method. That is, ideally, having better quality data for those fisheries/methods with high discards should elevate the overall quality score for the jurisdiction. We have therefore also provided the percentage scores weighted by the amount of discards estimated to be associated with each fishery/method (from Table 4).

Table 21 – The quality of information about Australia's discard and TEPS interactions derived from an application of the USA's Tier Classification Criteria (see Appendices 1 and 2 for detailed scores). Also added to the general discard information is a weighted % score taking account of the relative quantity of discards estimated for each fishery/method (from Table 4).

	General Discards			**TEPS Interactions**	
Jurisdiction	**Average quality score (%)**	**Average quality score weighted by discards**	**Average Tier:**	**Average quality score (%)**	**Average Tier:**
New South Wales	42.7	59.2	1.5	4.8	0.3
Tasmania	37.2	54.7	1.3	6.2	1.0
Northern Territory	43.8	58.5	1.5	10.3	1.0
Queensland	35.7	66.1	1.4	8.9	1.1
Victoria	26.2	31.6	1.1	6.6	1.1
Western Australia	28.2	28.2	1.1	7.5	1.1
South Australia	36.9	31.8	1.2	18.4	1.2
Commonwealth	42.7	69.6	1.6	49.0	1.8
National	**36.1**	**57.6**	**1.3**	**10.8**	**1.0**

For general discards, the results show that Australia has an average weighted national score of 57.6% and an average tier of 1.3. For TEPS interactions, the quality of data available in Australia's commercial fisheries is worse - a national average score of 10.8% and a tier of 1.0. The exception is for Commonwealth fisheries with a score of 49% and a tier of 1.8.

Discussion

This report delivers three new pieces of information about bycatch in Australia's commercial fisheries during the decade 2010-19: (i) estimates of discards by fishery, method, jurisdiction and nationally; (ii) a summary of information about fisheries' interactions with TEPS; and (iii) estimates of the quality of the information used to generate (i) and (ii) above. By achieving these outputs, this report provides: (a) a methodology that may be used by other jurisdictions and countries to estimate and report on bycatch; and (b) a baseline to be used by Australia in the future to track performance in managing discards, TEPS interactions and the quality of bycatch information. The three new pieces of information are discussed in detail throughout the rest of this chapter.

General Discards

The results obtained in this study required many assumptions to be made when extrapolating the limited number of empirically derived discard ratios by total retained catches to obtain discard estimates for individual fisheries, methods and jurisdictions. Very often surrogate ratios from other, similar fisheries/methods from the same or another jurisdiction had to be used which may not accurately reflect the true situation. But this is an unavoidable problem for those fisheries/methods where there are no observer data or other ways to estimate discards. Obviously, it would have been ideal to have at least some empirical data for those fisheries/methods that lack any discard ratios – especially for high-discarding fisheries but also for those that are thought (or assumed) to have low discards, where even small-scale observer studies done occasionally (or even just once) would have helped. But a positive corollary is that this study has now identified the most important gaps to fill in this regard for Australia's fisheries – gaps which are already beginning to be filled as a result of this work (eg for Southern Rock Lobster fisheries – Leon et al., 2019).

Notwithstanding the assumptions required, the quantity and quality of discard ratios found throughout Australia enabled us to calculate reasonably robust estimates of the level of discards occurring. Table 5 summarises the results and shows that, overall, during the last decade, all of Australia's commercial fisheries annually discarded 37.6% (SE 4.3%) of what was caught, or 92,368t (SE 10,661t). Whilst this rate is quite high compared to, for example, the USA's 17% for just its federally managed fisheries (NMFS, 2011), it is significantly less than the 55.3% estimated for Australia by FAO's 2nd global decadal report (Kelleher, 2005) and similar to the 39.8% estimated in the database in FAO's most recent decadal report (Perez-Roda et al., 2019). These trends suggest that, over the past 20 years, Australia's commercial fisheries have significantly reduced their discards – although our latest estimate of 37.6% obviously still leaves plenty of room for improvement. And a more detailed examination of the data reveals where such improvements might best focus.

Table 5 shows that 62.6% of Australia's discards came from just 2 jurisdictions - the Commonwealth (33.8%) and Queensland (28.8%) and Fig. 1 shows that only 9 fisheries/methods contributed 71.2% of all discards, with the remaining 298 fisheries/methods contributing just 28.8%. Clearly, effort to reduce discards further in Australia should focus on the former

fisheries/methods and in particular on the Queensland East Coast Prawn Trawl fishery which alone contributed 27.1% of all of Australia's discards. It is important to note that in recent years, significant reductions in fishing effort have occurred in this fishery which have probably reduced discard levels.

Of the other 7 highest discarding fisheries/methods, 5 are also trawl fisheries - the Commonwealth's Northern Prawn and Southeast Trawl fisheries, and NSW and South Australia's Prawn Trawl fisheries. Because of the gear used (with relatively small mesh), prawn trawling is well-known as the least selective fishing method used throughout the world – especially in warmer waters where the quantity and diversity of the fauna caught is greatest (Kelleher, 2005; Perez-Roda, 2019). So it is not surprising that Queensland's large East Coast Prawn Trawl fishery (which mainly operates in warmer waters) dominated annual discards nationally with an estimated 25,065 tonnes (Table 4) at a discard rate of 77% (Table 3). This level of discarding is also comparable to Australia's other major tropical prawn trawl fishery, the Commonwealth's Northern Prawn fishery with an estimated 8,850 tonnes discarded at a rate of 79.7% when targeting Tiger Prawns and 6,797 tonnes at 57.6% when targeting Banana Prawns (Tables 3 and 4). Such high levels of discards in prawn trawls are the main reason for the significant amount of research that has occurred throughout the world (and particularly in Australia) to modify these methods so that they fish more selectively (see Broadhurst et al., 2006; McHugh et al., 2017 for reviews). Modifications such as various grids and square mesh panels have been shown to reduce discards in these fisheries but despite this, our results suggest that there remains significant work to be done in this field.

Two other high discarding fisheries are the Western Australian and Tasmanian Rock Lobster fisheries - perhaps the most surprising result from the above summary. Most people would consider lobster trapping as a reasonably selective fishing method, yet this study estimated that 47.6% and 77.9% of catches are discarded in the Western Australian and Tasmanian Rock Lobster fisheries, respectively (Table 3). It is important to note, however, that most of these discards are undersize (and/or berried female) lobsters – which are required by regulations to be released and are believed to have very high survival rates after discarding (see Mills and Gardner, 2006; Green and Gardner, 2009; Emery et al., 2016) - so the actual impact of such discarding on populations is likely to be minimal. In any case, and as a consequence of the results of this present study, Tasmania, Victoria and South Australia recently completed a comprehensive project to examine and improve bycatch reporting in Australia's Southern Rock Lobster fishery (Leon et al., 2019).

In addition to the above general findings, there are several additional points worth noting for each jurisdiction:

The most obvious issue for NSW was its quite dated discard ratios, many of which were based on observer work done over 20 years ago. Much may have changed during the intervening years with regards to fishing practices in NSW so an obvious priority for improvement in discard reporting in this jurisdiction would be to update the old ratios through repeated observer programmes and/or other bycatch monitoring methods (like camera-audited industry logbooks - McElderry et al,

2007). However, notwithstanding the age of the ratios, the information for NSW proved sufficient to calculate good estimates of discards (with reasonably small variances) across quite a diverse array of fisheries/methods - which also provided a useful pool of surrogates that were used to fill many gaps in other jurisdictions.

For Tasmania, the results showed the dominant contribution that the Southern Rock Lobster fishery made to total discards (90%). Discard estimates for other fisheries were quite low, in part due to their use of quite benign methods such as hand-gathering - which were assumed to have negligible discards. For other fisheries/methods, however, estimates suffered from having to use surrogate ratios from NSW and other jurisdictions. But, due to the sizes of the fisheries involved, and the dominant contribution from the Southern Rock Lobster fishery, it is difficult to argue that better data for other fisheries would make much difference to the overall pattern - a pattern which implies that, at least in comparison to the Southern Rock Lobster fishery, most fisheries in Tasmania have quite modest levels of discarding.

For Queensland and, as noted above, for Australia nationally, discards were dominated by the East Coast Otter Trawl fishery. But estimates for the other fisheries in Queensland suffered from our lack of access to Queensland's observer database - requiring many assumptions to be made including the use of ratios from other jurisdictions and number/weight conversions. However, as was the case for Tasmania above, due to the relative sizes of the fisheries involved, and the dominant contribution from the trawl fishery to total discards, it is difficult to argue that gaining access to the Queensland observer database for other fisheries would make much difference to the overall pattern. A pattern which implies that, at least in comparison to the trawl fishery, most fisheries in Queensland have quite low levels of discarding.

The Northern Territory showed the lowest levels of discarding of all of Australia's jurisdictions - just 14.6%. The greatest quantity of discards occurred in the Demersal and Barramundi fisheries (together representing 72.8% of total discards in the Territory), with less occurring in the Offshore Net and Line and Timor Reef fisheries (22%) and much smaller amounts occurring in other fisheries. These results suggest that the current application of the Northern Territory's observer effort to the 4 highest discarding fisheries is appropriate.

For Victoria, the estimates indicated annual levels of discards of around 1,427 tonnes. However, this must be a significant underestimate of the true amount of discarding occurring in the state due to our inability to ascribe ratios to a very large proportion of total landings in Victoria. This was because confidentiality provisions precluded the release of catch data for 41.5% of the total catch, meaning that the total discards estimated here came while catching just 58.5% of the total landings for the state. It is important to note that, whilst similar confidentiality provisions exist in other jurisdictions, it proved to be particularly problematic in Victoria due to the relatively small size of the state's commercial fisheries and the consequently low numbers of operators working in many. However, if one was to make the (very significant) assumption that, in catching the unapportioned landings in Victoria, such fisheries/methods have, on average, similar discard rates as the apportioned ones, then total discards for the jurisdiction (and Australia) could be an extra

1,012 tonnes per year. Another issue to note for Victoria's estimates is the very significant use of surrogate discard rates from NSW and other jurisdictions due to the almost complete lack of observer data for the state.

For Western Australia, the vast majority of fisheries/methods (77 of 89) showed very few discards - just 5% of the total for the jurisdiction. This is due to a combination of the relatively small landings of many of these 77 fisheries/methods (used to extrapolate discard rates) and the use of quite benign methods in some (such as hand-gathering, jigging, octopus potting, etc.) which were shown, or assumed, to have low discard rates. So most of Western Australia's discards (62.4%) came from just two fisheries (Western Rock Lobster – 46.4% and Shark Bay Prawn Trawl - 16%). But, as was the case for Victoria above and other jurisdictions, the underlying problem with estimating discards for Western Australia was having to use surrogate rates from other fisheries in the state, South Australia, NSW, the Northern Territory and the Commonwealth. That is, there were only a relatively few instances (13) where actual empirical measures of discards were available for Western Australia's fisheries/methods (this is also reflected in the quite low quality metric for this jurisdiction seen in Table 21 and Appendix 1). Clearly, having more empirical estimates of discards (from observer programmes and/or video monitoring/validation of logbook information), and particularly for key fisheries like the WA lobster fishery, would improve this situation.

As for Western Australia, most of South Australia's fisheries had relatively few discards due to a combination of the relatively small landings of several of these fisheries and the use of relatively benign methods in some. The largest number of discards for this jurisdiction came from the Sardine fishery but this was due to applying a modest (and surrogate) discard rate to its exceptionally large quantity of landings (Australia's largest). Indeed, like several other jurisdictions, South Australia's data suffered from having to use surrogate discard rates from other fisheries in other jurisdictions for 3 of the 9 fisheries. An additional problem for South Australia was having to apply an average discard rate across different methods listed as "other" in the Marine Scalefish and Miscellaneous fishery due to the unavailability of method-specific landings data for those sectors.

For Australia's Commonwealth fisheries, we saw the best discard information of all Australia's jurisdictions due to the availability of data from AFMA's long-running observer programmes. The results showed the dominant contribution to discards in the jurisdiction from the Northern Prawn fishery (50.2% of the total). In comparison, estimates for other Commonwealth fisheries were relatively low, with the next highest coming from the South East Trawl and Great Australian Bight Trawl fisheries (22.1% and 9.2%, respectively). These results are consistent with most studies about discards which highlight trawling (and prawn trawling in particular) as having, in general, the highest discard quantities and rates. Whilst most Commonwealth fisheries/methods had discard ratios available from observer programmes, there were some where we had to use rates from similar methods used in other fisheries. While this was not ideal, the levels of the discards involved in these cases, and the dominant contributions from the above-mentioned fisheries, suggest that

having better data from all fisheries for which we lacked direct estimates would make little difference to the overall pattern - a pattern which implies that, at least in comparison to its trawl fisheries, most of Australia's Commonwealth fisheries have quite modest levels of discarding.

The Commonwealth's observer-based discard data was supplemented by data about discards that fishers are required to submit on their logbooks. The completeness of this information allowed a comparison of these two sources of discard information (Table 6) which showed that logbook data under-estimated levels of general discards (as estimated from the observer data) by 89.7% - confirming the often-stated but rarely-proven assertion that self-reported information from fishers about discards are not always accurate.

Threatened, Endangered and Protected Species Interactions

Whilst this project was able to produce reasonable estimates of general discards for most fisheries and methods in all jurisdictions in Australia, the same cannot be said for interactions with TEPS. As mentioned earlier, this is because of two main factors: (i) such species are, by their very nature, rare, so interactions between them and commercial fisheries are also rare and sporadic; and (ii) fishers' willingness to self-report such interactions on logbooks can be influenced by the controversy that such interactions may incur. As a result, the data available from Australia's fisheries that quantify such interactions are very few with very large variances.

Whilst it is tempting to extrapolate the very little observer data about such interactions to whole fisheries and jurisdictions using total catch and/or effort multipliers (as done in this study for general discards), the very small number of TEPS interactions recorded makes such extrapolations extremely tenuous (at best), probably erroneous, and dangerously controversial in terms of the total numbers of interactions that could be estimated. We therefore do not provide such extrapolations here. This is further justified by considering the relative quality of the data regarding TEPS interactions shown in Table 21 and Appendix 2. The results reveal very low quality scores for such information – an average national score of just 10.7% - so clearly such data should not be used for extrapolations.

The exception to this is the very good TEPS information available from Australia's Commonwealth observer programmes (Table 17) which permitted meaningful extrapolations to be made to a fishery level (Table 19). The results showed that quite a large number of TEPS interacted with these fisheries with 106 species recorded by observers over a 9 year period with 37,616 interactions per year. However, it is worth noting that 61.7% of these interactions led to animals being released alive and that 36.3% of interactions involved sea snakes, 65.3% being released alive. But, as was the case for general discards, the largest number of these interactions occurred in trawl fisheries with the Northern Prawn fishery recording by far the largest (52% of all interactions). – most of which involved sea snakes. Clearly, more work is required to develop bycatch reduction solutions for such species in this fishery.

Further, as was the case above for general discards, the Commonwealth's datasets allowed a comparison between the numbers of TEPS interactions estimated from observer information with

that reported by fishers in industry logbooks (Table 19). This comparison showed that, overall, fishers under-reported TEPS interactions by 60.4% of that estimated by the observer data, which is much better than the under-reporting rate for general discards (see above). Furthermore, this situation has improved in recent years due to the implementation of an EM programme leading to more accurate industry reporting in some fisheries (Table 20).

This study found one other example comparing estimates of TEPS interactions recorded in logbooks with those obtained from more independent means. This also involved sea snakes and showed that 105,210 (SE 18,288) sea snakes, composed of 12 species, were estimated to be caught in the Queensland East Coast Trawl fishery per year using data from research projects, at-sea observers and a voluntary crew member programme (Courtney et al. 2010) compared to estimates of just 1,657 from logbook data during the same period (DEEDI, 2012) – 2 orders of magnitude less.

Notwithstanding the above example, information about TEPS interactions from Australia's 7 non-Commonwealth jurisdictions was, for the most part, so scarce and unreliable that it was impossible to provide annual estimates. But these jurisdictions are far from being alone in not having the information required to estimate such interactions. This is a common issue throughout the world, even for jurisdictions that run observer programmes for the express purpose of providing such information and, indeed for any survey, in any field of science, that tries to extrapolate rare events to total estimates using an inadequate sample size. When dealing with rare events, the only sure way to estimate total interactions for a fishery is to increase the sample size to such a level that variances around the average numbers of interactions are reduced to an acceptable level. And of course, the best way to achieve this is via 100% observer coverage – as done in several fisheries like those covered by IATTC's tuna-dolphin observer programme (Hall, 1998). But such programmes are expensive – far too expensive for the scale of most of the fisheries we have in Australia – and possibly unnecessary, given the relative number of TEPS interactions that, intuitively, our fisheries may have.

In recent years, a potential solution to this issue is emerging where cameras are used to monitor fisheries operations (van Helmond et al., 2019). Such programmes can nominally provide 100% coverage and so capture all interactions with TEPS (and other species). A problem is the cost associated with humans having to view footage/images – but this is resolved by randomly viewing a fraction of the information as a means to verify (and improve) fishers' logbook recordings of interactions. Where this has been done, a marked improvement in the reporting of TEPS interactions has usually ensued. In Australia's Commonwealth fisheries, we have an example of such a successful application (Table 20) where improvements in logbook reporting occurred following the introduction of camera technology. And further improvements in the technology are in development where image recognition software could, within a few years, be able to derive data from footage/images without the need for human viewers. We believe that it will not be long until such developments, combined with more streamlined tools to aid the electronic reporting of catches and bycatches by fishers, and faster, cheaper data transfers, will lead to the "holy grail" of

industry-based data collection from fisheries: simple, hand-held, real-time data collection tools whose data are validated by video from EM cameras.

Quality/Performance Metrics

Table 21 and Appendices 1 and 2 contain the results from the application of the USA's Tier Classification system for scoring the quality of bycatch estimates to the information gathered here on discards and TEPS interactions in Australia. Of the 307 commercial fisheries/methods in Australia, 267 had some sort of discard estimate determined and were therefore assessed using the USA system. The other 40 were the intuitively highly selective fisheries involving hand-gathering, spearing, etc. which we assumed had negligible bycatches and so did not require a quality metric.

For general discards, the results showed that Australia had quite reasonable quality scores for most jurisdictions with an average weighted national score of 57.6%. The best performing jurisdiction was the Commonwealth (69.9%) – due to its long-running and quite comprehensive observer and (more recent) EM programmes. Further, jurisdictions with at least some observer data (especially those that cover high discarding fisheries/methods) also scored well (NSW, Northern Territory, Tasmania and Queensland) whilst Victoria, South Australia and Western Australia scored the lowest due to their scarcity of observer data and the need to substitute many discard rates from other fisheries/methods/jurisdictions. A notable exception to this is the quite good quality score for Western Australia's West Coast Deep Sea Crustacean fishery due to the use of video to validate the zero discards reported in logbooks, and South Australia's Sardine fishery whose logbook data were validated by an observer programme.

For TEPS interactions, the quality of data available for Australia's commercial fisheries is far worse - a national average score of just 10.8%. The exceptions are Commonwealth fisheries – again due to the observer and recent EM programmes – with a score of 49%, and the quite good quality score for South Australia's Sardine fishery whose TEPS logbook data were validated by an observer programme. But, as we discussed above, Australia is far from alone in having poor data on TEPS interactions as most jurisdictions have problems in obtaining reasonable estimates of interactions with rare species to allow fishery- or method- wide extrapolations. Even the USA, with its large number of observer programmes (several of which are specifically designed to just focus on TEPS interactions), has far lower tier scores for TEPS interactions than for general discards (NMFS, 2011).

We can compare Australia's quality metrics with those derived by NMFS (2011) for USA federally managed fisheries – at least in terms of average tier classes. For general discards, Australia's overall average tier class was 1.3 whilst the US's was 2.0. For TEPS interactions, Australia's was 1.0 and US's was 1.8. These results reflect the far fewer (and many quite dated) observer programmes in most of Australia's jurisdictions than in the US – which is understandable given that US federal fisheries tend to be far larger (and more valuable) than those in Australia and therefore can afford to run large observer programmes. Indeed, considering the relatively small size and value of

Australia's commercial fisheries compared to those in the US, a weighted quality metric of 57.6% for general discards would, by most international standards, be considered quite satisfactory. More direct (and relevant) comparisons are, however, between the Tier classes for the US's federally managed fisheries (see above –2.0 for general discards and 1.8 for TEPS) and Australia's Commonwealth managed fisheries (1.6 for general discards and 1.8 for TEPS – Table 21). This result shows that federally managed fisheries in both countries have reasonably similar quality data about bycatches due to their extensive observer programmes.

But a more important use of these quality metrics is in providing a baseline measure against which future metrics can be compared to allow one to gauge improvements (or declines) in our information about discards and TEPS interactions. And they also allow one to identify priorities for future bycatch monitoring programmes whether by human observers and/or EM programmes that audit industry reporting. That is, such programmes would ideally focus on the main discarding fisheries identified in this study (especially oceanic trawl fisheries) and eventually lead to improvements in these metrics over time.

Conclusions

This project has provided the first assembly of baseline information and metrics about bycatch in Australia. It is anticipated that subsequent reports (perhaps every decade or so) will be done to track our 8 jurisdictions' progress in managing and reporting on such issues. The work has also identified the key gaps in our information and where future work in this field should focus. In particular:

- To better estimate bycatches, future monitoring programmes in Australia should: (i) focus on getting at least some empirical data from fisheries where we have no discard data at all; (ii) but mainly concentrate on particularly problematic and non-selective fishing gears (such as trawling), with (iii) less focus on those gear types that have been identified in this study as having relatively few discards. This is not to say that we need many ongoing (and often expensive) observer and EM programmes, but strategically-located and -timed programmes that examine certain fisheries periodically. Such a system of "rolling" observer (and/or EM) programmes will greatly improve the quality of discard information for Australia at a relatively modest expense.
- Substantial effort needs to focus on better ways to monitor rare interactions with TEPS, perhaps by embracing current work occurring in the field of EM using cameras to augment and audit industry-based reporting - as is occurring with some success in several fisheries overseas and in certain Commonwealth fisheries in Australia.
- Finally, efforts to reduce discards should focus on those fisheries identified here as having particularly high discards (ie. oceanic trawl and lobster fisheries) by developing more selective gears, better handling practices, better implementation of existing modifications and/or other management actions like reductions in fishing effort.

By examining the bycatch information available for Australia's fisheries jurisdictions, this study developed a methodology by which any jurisdiction, in any country, can compile, summarise and

report on discards and TEPS interactions in their fisheries. This methodology involves a relatively simple, five stage process that yields estimates of rates and annual quantities of discards (with associated variances) for the jurisdiction and the various fisheries within it, in addition to estimates of the relative quality of the information used.

Such an approach will enable jurisdictions to periodically report to their numerous audiences on the status of bycatches in their fisheries and the quality of the information used to determine it. And, as we saw in the opening paragraphs of this report, such audiences include the many state, national and international agencies, processes, agreements and other instruments that seek and/or require such information. These include stock assessments, Ecosystem-based Fisheries Management initiatives, FAO's Code of Conduct for Responsible Fisheries, assessments by eco-labelling organisations, the EU's Common Fisheries Policy and Landing Obligation, as well as the most important stakeholders of all – the perpetual owners of all fisheries discards and TEPS – the general public.

Acknowledgements

This study would not have been possible without the vision and support of the Fisheries Research and Development Corporation's staff, especially Crispian Ashby and Patrick Hone. We also thank the many people in all of Australia's 8 marine fisheries jurisdictions who contributed data and other information to the project and reviewed drafts of this report for their jurisdiction. These included Adrianne Laird, Angelo Tsolos, Bob Creese, Caleb Gardner, Charles Gray, Dave Reilly, David Makin, David Power, Dennis Reid, Emily Fisher, Geoff Liggins, Joanne Klemke, John Garvey, John Stewart, Kate Simpson, Mat Hourston, Matt Broadhurst, Monique Nelis, Nick Perkins, Nick Rayns, Paul Fildes, Rafael Leon, Rick Fletcher, Rowan Chick, Ryan Murphy, Steve Mayfield, Thor Saunders, Tim Emery, Toby Jeavons, Tony Courtney, Travis Dowling and Will Macbeth. We also thank US National Marine Fisheries Service scientists Bill Karp and Lee Benaka and Archipelago Marine Research's Howard McElderry for helpful discussions regarding this work and Peta Kennelly for assistance with compiling the final document. This study was funded by FRDC projects 2015-208 and 2018-114.

References

AFMA (2015). Bass Strait Central Zone Scallop Fishery Bycatch and Discarding Workplan - 1 May 2015 to 31 March 2017, 7pp.

Alverson, D.L., M.H. Freeberg, S.A. Murawski and J.G. Pope. (1994). A global assessment of fisheries bycatch and discards. FAO Fisheries Technical Paper No. 339. Rome, FAO. 233 pp.

Andersen, C., K. Clarke, J. Higgs and S. Ryan (2004). Ecological assessment of the Queensland coral reef fin fish fishery. A report to the Australian Government Department of Environment and

Heritage on the ecologically sustainable management of a multi-species line fishery in a coral reef environment. QDPIF, 149pp.

Andrew, N.L., T. Jones, C. Terry and R. Pratt (1995). By-catch of an Australian stow net fishery for school prawns (*Metapenaeus macleayi*). Fisheries Research 22: 119-136.

Andrew, N.L and Pepperell, J.G. (1992). The by-catch of shrimp trawl fisheries. Oceanography and Marine Biology Annual Reviews, 30:527-565.

Bellchambers, L., Mantel, P., Chandrapavan, A., Pember, M. and Evans, S. (2012). Western Rock Lobster Ecology – The State of Knowledge Marine Stewardship Council Principle 2: Maintenance of Ecosystem. Fisheries Research Report No. 236. Department of Fisheries, Western Australia. 128p.

Broadhurst, M.K, P.A Butcher and B.R. Cullis (2015a). Effects of Mesh Size and Escape Gaps on Discarding in an Australian Giant Mud Crab (*Scylla serrata*) Trap Fishery. PLOS ONE, Vol 9, Issue 9, 106414.

Broadhurst, M.K., P. A. Butcher, B. R. Cullis and D.J. Tolhurst (2015b). Influences of twine diameter and mesh area on the efficiency and durability of baited hoop nets targeting portunids. Fisheries Management and Ecology, 22: 488–500

Broadhurst, M.K., Suuronen, P. and Hulme, A. (2006). Estimating collateral mortality from towed fishing gear. Fish Fish. 7: 180–218. doi: 10.1111/j.1467-2979.2006.00213.x

Brown, I.W., M.C. Dunning, S. Hansford and L. Gwynne (2001). Ecological Assessment Queensland Spanner Crab Fishery. Queensland Fisheries Service, 35pp.

Butcher, P.A., J.C. Leland, M.K. Broadhurst, B.D. Paterson and D.G. Mayer (2012). Giant mud crab (*Scylla serrata*): relative efficiencies of common baited traps and impacts on discards. ICES Journal of Marine Science, 69(8): 1511–1522.

Carrick, N. (1997). A preliminary assessment of bycatch from the Spencer Gulf Prawn Fishery. South Australia. Fisheries Assessment Series 97/02. 57 pp.

Courtney, A.J., B.L. Schemel, R. Wallace, M.J Campbell, D.G. Mayer and B. Young (2010). Reducing the impact of Queensland's trawl fisheries on protected sea snakes. Report to the Fisheries Research and Development Corporation. Project No. 2005/053. ISBN: 978-0-7345-0418-0. 121 pp.

Currie, D.R., Dixon, C.D., Roberts, S.D., Hooper, G.E., Sorokin, S.J. and Ward, T.M. (2009). Fishery independent by-catch survey to inform risk assessment of the Spencer Gulf Prawn Trawl Fishery. Report to PIRSA Fisheries. South Australian Research and Development Institute (Aquatic Sciences), Adelaide. 121pp.

DAFF (2012a). East Coast Bêche-de-mer Fishery 2010–11 fishing year report. Department of Agriculture, Fisheries and Forestry, 14pp.

DAFF (2012b). Performance Measurement System Blue Swimmer Crab Fishery Version 2 – August 2012. Department of Agriculture, Fisheries and Forestry, 21pp.

DAFF (2013). Queensland Eel Fishery 2011 Fishing Year Report, Department of Agriculture, Fisheries and Forestry, 10pp.

Dannevig, H. C. (1904). Preliminary report upon the prawning industry in Port Jackson. The Government of the State of New South Wales, William Applegate Gullick - Government Printer (38508-A), Sydney, 17 pp.

de Lestang S, How J and Caputi N (2019). Western Australian Marine Stewardship Council Report Series Western Rock Lobster Resource Addendum 1 May 2019, 20p.

DEEDI (2009). Annual status report 2009 River and Inshore Beam Trawl Fishery. Department of Employment, Economic Development and Innovation, 14pp.

DEEDI (2010a). Annual status report 2010 East Coast Trochus Fishery. Department of Employment, Economic Development and Innovation, 7pp.

DEEDI (2010b). Annual status report 2010 Deep Water Fin Fish Fishery. Department of Employment, Economic Development and Innovation, 8pp.

DEEDI (2010c). Annual status report 2009 East Coast Inshore Fin Fish Fishery. Department of Employment, Economic Development and Innovation, 16pp.

DEEDI (2011a). Annual status report 2010 Coral Fishery. Department of Employment, Economic Development and Innovation, 13pp.

DEEDI (2011b). Annual status report 2011 Commercial Crayfish and Rocklobster Fishery. Department of Employment, Economic Development and Innovation, 8pp.

DEEDI (2011c). Annual status report 2010 East Coast Spanish Mackerel Fishery. Department of Employment, Economic Development and Innovation, 13pp.

DEEDI (2011d). Annual status report 2011 Rocky Reef Fin Fish Fishery. The State of Queensland, Department of Employment, Economic Development and Innovation 2011. 14pp.

DEEDI (2011e). Annual status report 2011 Mud Crab Fishery. Department of Employment, Economic Development and Innovation, 12pp.

DEEDI (2011f). Annual status report 2011 Queensland Spanner Crab Fishery. Department of Employment, Economic Development and Innovation, 12pp.

DEEDI (2011g). Annual status report 2011 Gulf of Carpentaria Developmental Fin Fish Trawl Fishery. Department of Employment, Economic Development and Innovation, 7pp.

DEEDI (2011h). Annual status report 2010 Fin Fish (Stout Whiting) Trawl Fishery. Department of Employment, Economic Development and Innovation, 13pp.

DEEDI (2012). Annual status report 2011 East Coast Otter Trawl Fishery. Department of Employment, Economic Development and Innovation, 29pp.

DEH (2004a). The Dept of Environment and Heritage's Assessment of the ecological sustainability of management arrangements for the Pilbara Trap Managed Fishery (ISBN: 0642550980), 38pp. https://www.environment.gov.au/system/files/pages/fc63cd2c-d3fe-49d1-bd5e-c402c862250e/files/pilbara-trap-assessment.pdf

DEH (2004b). The Dept of Environment and Heritage's Assessment of the ecological sustainability of management arrangements for the Western Australian Kimberley Prawn Managed Fishery. 37pp. https://www.environment.gov.au/system/files/pages/83cf097b-b57c-4727-8e28-0de22fc5c49f/files/kimberley-prawn-assessment.pdf

DEH (2004c). The Dept of Environment and Heritage's Assessment of the ecological sustainability of management arrangements for the Onslow and Nickol Bay Prawn Managed Fisheries. 24pp. https://www.environment.gov.au/system/files/pages/0068ec7f-9798-4c66-b71b-c14aaab8eb36/files/onslow-nickol-bay-assessment.pdf

DEH (2004d). Assessment of the Western Australian Mackerel Fishery. 23pp. https://library.dbca.wa.gov.au/static/FullTextFiles/070727.pdf

DEH (2005). Assessment of the Tasmanian Scallop Fishery. Commonwealth Government Department of the Environment and Heritage. 29pp.

DPIRD (2019a). Ecosystem Based Fisheries Management (EBFM) Risk Assessment of the Shark Bay Invertebrate Fisheries (DRAFT). Department of Primary Industries and Regional Development, Western Australia, 26pp.

DPIRD (2019b). Ecosystem Based Fisheries Management (EBFM) Risk Assessment of the Exmouth Gulf Prawn Managed Fishery (DRAFT). Department of Primary Industries and Regional Development, Western Australia, 17 pp.

Emery, T.J. and K. Hartmann (2016). Tasmanian Octopus Fishery Assessment 2014/15, 28pp.

Emery, T.J., Bell, J. Lyle, J and K. Hartmann (2015a). Tasmanian Scalefish Fishery Assessment 2013/14, 199pp.

Emery, T.J., Hartmann, K. and C. Gardner (2015b). Tasmanian Giant Crab Fishery - 13/14, 37pp

Emery, T.J., Hartmann, K., Green, B.S. and C. Gardner (2016). Handled with care: Minimal impacts of appendage damage on the growth and productivity of the southern rock lobster (*Jasus edwardsii*). Fisheries Research 175,75–86.

FAO (2011). International Guidelines on Bycatch Management and Reduction of Discards, Food and Agriculture Organisation of the United Nations, Rome 2011. ISBN 978-92-5-006952-4, 73pp.

FAO (2015). Report of the Expert workshop on the methodology to assess and quantify the extent and impact of fisheries bycatch and discards. Casablanca, Morocco, 26-28 May 2015, FAO Rome, 2015, 71pp.

Ferguson, G.J. (2010). Gear interaction of non-targeted species in the Lakes and Coorong commercial and recreational fisheries of South Australia, Final Report to FRDC for Project No. 2005/061. South Australian research and Development Institute (Aquatic Sciences), Adelaide, F2010/000239-1, SARDI Research Report Series No. 436, 56 pp.

Ferguson, G.J and Hooper, G.E. (2017). Assessment of the South Australian Pipi (*Donax deltoides*) Fishery in 2016/17. Fishery Assessment Report for PIRSA Fisheries and Aquaculture. South Australian Research and Development Institute (Aquatic Sciences), Adelaide, SARDI Publication No. F2007/000550-2. SARDI Research Report Series No. 957. 47pp.

Fowler, A.J., M. Lloyd and D. Schmarr (2009). A preliminary consideration of by-catch in the marine Scalefish fishery of South Australia. South Australian Research and Development Institute (Aquatic Sciences). Adelaide, F2009/000097-1. SARDI Research Report Series No. 365. 79pp.

Gaughan, D and T. Leary, (2004). West Coast purse seine managed fishery status report. In, Department of Fisheries Status of the Fisheries report 2004.05.

Gaughan, D.J. and Santoro, K. (eds). (2018). Status Reports of the Fisheries and Aquatic Resources of Western Australia 2016/17: The State of the Fisheries. Department of Primary Industries and Regional Development, Western Australia. 238pp.

Gaughan, D.J., Molony, B. and Santoro, K. (eds). (2019). Status Reports of the Fisheries and Aquatic Resources of Western Australia 2017/18: The State of the Fisheries. Department of Primary Industries and Regional Development, Western Australia. 240pp.

Gibson, P.T., D.G. Worthington, C. Blount and N.L. Andrew (2002). Incidental damage of Blacklip Abalone (*Haliotis rubra*) by commercial divers in New South Wales, Australia. J. Shellfish Research, 21: 787-792.

Goldsworthy, S.D. (2018). Effectiveness of the Industry Code of Practice in mitigating interactions between short-beaked common dolphins and the South Australian Sardine Fishery: 2017-18 Report to PIRSA Fisheries and Aquaculture. SARDI, Adelaide. SARDI Publication No. F2010/000726-9. SARDI Research Report Series No. 1000. 36pp.

Goldsworthy, S.D and M. Boyle (2019). Operational interactions with Threatened, Endangered or Protected Species in South Australian managed Fisheries: 2017/18. SARDI, Adelaide. SARDI Publication No. F22009/000544-9. SARDI Research Report Series No. 1032. 39pp.

Goodman, L.A. (1960). On the exact variance of products. J. American Statistical Association, Vol. 55, 708-713.

Gray, C.A. (2001). Spatial variation in by-catch from a prawn seine-net fishery in a south-east Australian coastal lagoon. Mar. Freshwater Res., 2001, 52, 987–993.

Gray, C.A. (2002). Management implications of discarding in an estuarine multi-species gill net fishery. Fisheries Research 56: 177–192.

Gray, C.A. (2004). An overview of commercial fishing in Lake Illawarra: trends in reported catch and effort, bycatch and discarding. Wetlands (Australia) 21: 156-167.

Gray, C.A. (2016). Evaluation of fishery-dependent sampling strategies for monitoring a small-scale beach clam fishery. Fisheries Research, 177, 24-30 (doi:10.1016/j.fishres.2016.01.007).

Gray, C.A., D.D. Johnson, D.J. Young and M.K. Broadhurst (2004). Discards from the commercial gillnet fishery for dusky flathead, *Platycephalus fuscus*, in New South Wales, Australia: spatial variability and initial effects of change in minimum legal length of target species. Fisheries Management and Ecology, 2004, 11: 323–333.

Gray, C.A., D.D. Johnson, M.K. Broadhurst and D.J. Young (2005). Seasonal, spatial and gear-related influences on relationships between retained and discarded catches in a multi-species gillnet fishery. Fisheries Research 75: 56–72.

Gray, C.A., D.J. Young and M.K. Broadhurst (2006). A comparison of catches and bycatches from three non-trawl penaeid-fishing gears used in an Australian estuary. Asian Fisheries Science 19:117-130.

Gray, C.A. and S.J. Kennelly (2003). Catch characteristics of the commercial beach-seine fisheries in two Australian barrier estuaries. Fisheries Research 63: 405–422.

Gray, C.A., S.J. Kennelly and K.E. Hodgson (2003). Low levels of bycatch from estuarine prawn seining in New South Wales, Australia. Fisheries Research 64: 37–54.

Gray, C.A., S.J. Kennelly, K.E. Hodgson, C.J.T. Ashby and M.L. Beatson (2001). Retained and discarded catches from commercial beach-seining in Botany Bay, Australia. Fisheries Research 5: 205-219.

Green, B.S. and Gardner, C. (2009). Surviving a sea-change: survival of Southern rock lobster (*Jasus edwardsii*) translocated to a site of fast growth. ICES Journal of Marine Science. ICES Journal of Marine Science, 66 (4) pp. 656-664.

Haddon, M., Harrington, J.J. and J. Semmens (2006). Juvenile Scallop Discard Rates and Bed Dynamics: Testing the Management Rules for Scallops in Bass Strait. FRDC Project 2003/017 175pp.

Hall, M.A. (1998). An ecological view of the tuna-dolphin problem: impacts and trade-offs. Reviews in Fish Biology and Fisheries, 8: 1-34.

Halliday, I., J. Ley, A. Tobin, R. Garrett, N. Gribble and D. Maye (2001). The effects of net fishing: addressing biodiversity and bycatch issues in Queensland inshore waters. FRDC Project No. 97/206, ISBN 0 7345 0150 1, 103pp.

Hart, A., Strain, L., Hesp, A., Fisher, E., Webster, F., Brand-Gardner, S. and Walters, S. (2017). Marine Stewardship Council Full Assessment Report Western Australian Abalone Managed Fishery. Department of Fisheries, Western Australia. 288pp.

Hart, A.M., Murphy, D.M., Harry, A.V. and Fisher, E.A. (2018). Western Australian Marine Stewardship Council Report Series No. 14: Resource Assessment Report Western Australian Octopus Resource. Department of Primary Industries and Regional Development, Western Australia. 114pp.:

Hartmann, K. and C. Gardner (2011). Tasmanian Giant Crab Fishery - 09/10. University of Tasmania, IMAS, 37pp.

Hobday, D.K., Reilly, D.J. and Flint,R. (2008). Monitoring of by-catch and interactions with threatened, endangered and protected species in the Victorian southern rock lobster and Giant Crab fisheries. Fisheries Victoria Research Report Series No. 39.

How, J.R., Webster, F.J., Travaille, K.L., Nardi, K. and Harry, A.V. (2015). Western Australian Marine Stewardship Council Report Series No. 4: West Coast Deep Sea Crustacean Managed Fishery. Department of Fisheries, Western Australia. 172pp.

Johnston, D.J., Smith, K.A., Brown, J.I., Travaille, K.L., Crowe, F., Oliver, R.K. and Fisher, E.A. (2015). Western Australian Marine Stewardship Council Report Series No. 3: West Coast Estuarine Managed Fishery (Area 2: Peel-Harvey Estuary) and Peel-Harvey Estuary Blue Swimmer Crab Recreational Fishery. Department of Fisheries, Western Australia. 284pp.

Justinian (533). The Codex Justinianus.

Kangas, M. and Thomson, A. (2004). Implementation and assessment of bycatch reduction devices in the Shark Bay and Exmouth Gulf trawl fisheries. Final Report to the FRDC on Project No. 2000/189. Department of Fisheries, WA, 70 pp.

Kangas, M.I., Morrison, S., Unsworth, P., Lai, E., Wright, I. and Thomson, A. (2007). Development of biodiversity and habitat monitoring systems for key trawl fisheries in Western Australia. Final

report to the FRDC on Project No. 2002/038. Fisheries Research Report No. 160. Department of Fisheries, Western Australia, 334 pp.

Kangas, M.I., Sporer, E.C., Hesp, S.A., Travaille, K.L, Moore, N., Cavalli, P. and Fisher, E.A. (2015) Western Australian Marine Stewardship Council Report Series No. 1, 2015. Exmouth Gulf Prawn Managed Fishery ISSN: 2205-3670 (Print) ISBN: 978-1-921845-95-6 (Print) ISSN: 2205-3689 (Online) ISBN: 978-1-921845-96-3 (Online).

Kelleher, K. (2005). Discards in the world's marine fisheries. An update. FAO Fisheries Technical Paper No. 470. Rome, FAO. 152pp.

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

Kennelly, S.J. and Broadhurst, M.K. (2014). Mitigating the bycatch of giant cuttlefish *Sepia apama* and blue swimmer crabs *Portunus armatus* in an Australian penaeid-trawl fishery. Endangered Species Research, Vol. 26, pp. 161–166.

Kennelly, S.J. and G.W. Liggins (1992). Preliminary report on the by-catch of prawn trawling in the Hawkesbury River. NSW Fisheries internal publication.

Kennelly, S.J. (1993). Study of the by-catch of the NSW east coast trawl fishery. Final report to the Fisheries Research and Development Corporation. Project No. 88/108. ISBN 0 7310 2096 0, 520 pp.

Kennelly, S.J. (2015). Progress in the monitoring and management of bycatch and discards. Pages 24-27 in Report of the Expert Workshop on the Methodology to Assess and Quantify the Extent and Impact of Fisheries Bycatch and Discards. Casablanca, Morocco, 26-28 May 2015, FAO Rome, 2015, 71pp.

Kennelly, S.J., G.W. Liggins and M.K. Broadhurst (1992). By-catch from prawn trawling in the Hawkesbury River - interactions with juvenile mulloway. Australian Society of Fish Biology Annual Conference, Adelaide, S.A. Australian Society of Fish Biology Newsletter Vol. 22 (2), pp. 37-38.

Kennelly, S.J., G.W. Liggins and M.K. Broadhurst (1998). Retained and discarded by-catch from oceanic prawn trawling in New South Wales, Australia. Fisheries Research, Vol. 36, pp. 217-236.

Laurenson, L.J.B., P. Unsworth, J.W. Penn and R.C.J. Lenanton (1993). The impact of trawling for saucer scallops and western king prawns on the benthic communities in coastal waters off south-western Australia. WA Fisheries Research Report No. 100, 93pp.

Leland, J.C., P.A. Butcher, M.K. Broadhurst, B.D Paterson and D.G. Mayer, (2013). Relative trap efficiency for recreationally caught eastern Australian blue swimmer crab (*Portunus pelagicus*) and associated injury and mortality of discards. Fisheries Research 14: 304– 311

Leon, R., Perkins, N., McLeay, L., Reilly, D. and Kennelly, S.J. (2019). Ensuring monitoring and management of bycatch in Southern Rock Lobster Fisheries is best practice. Final Report. FRDC Project No 2017-082.

Leslie, M. (2014). Blue Swimmer Crab 2012 fishing year report. Department of Agriculture, Fisheries and Forestry, 12pp.

Liggins, G.W. and S.J. Kennelly (1996). By-catch from prawn trawling in the Clarence River estuary, New South Wales, Australia. Fisheries Research, Vol. 25, pp. 347-367.

Liggins, G.W. (1996). The interaction between fish trawling (in NSW) and other commercial and recreational fisheries. FRDC Project No. 92/79. ISBN 0 7310 9402 6, 40pp.

Liggins, G.W., S.J. Kennelly and M.K. Broadhurst (1996). Observer-based survey of by-catch from prawn trawling in Botany Bay and Port Jackson, New South Wales. Marine and Freshwater Research, Vol. 47, pp. 877-888.

Lyle, J.M., Bell, J.D., Chuwen, B.M, Barrett, N., Tracey, S.R. and Buxton, C.D. (2014). Assessing the impacts of gillnetting in Tasmania: implications for by-catch and biodiversity. Institute for Marine and Antarctic Studies, University of Tasmania, CC BY 3.0. 176pp.

MacBeth, W.G. and C.A. Gray (2008). Differences in Catch Composition among Types of Commercial Penaeid-Seining Operations in an Australian Estuary. Asian Fisheries Science 21:339-353.

Macbeth, W.G. and C.A. Gray (2016). Observer-based study of commercial line fishing in waters off New South Wales. Fisheries Final Report Series No. 148. ISSN 1837-2112, 151p.

Macbeth, W.G., P.T. Geraghty, V.M. Peddemors and C.A. Gray (2009). Observer-based study of targeted commercial fishing for large shark species in waters off northern New South Wales. Industry and Investment NSW – Fisheries Final Report Series, No. 114, ISSN 1837-2112, 82pp.

McHugh, M.J., Broadhurst, M.K. and Sterling, D.J. (2017). Choosing anterior-gear modifications to reduce the global environmental impacts of penaeid trawls. Rev. Fish Biol. Fish. 27, 111–134. doi: 10.1007/s11160-016-9459-5

Mackie M.C., Lewis P.D., Kennedy J., Saville K., Crowe F., Newman, S.J. and Smith K.A. (2010). Department of Fisheries Western ESD Report Series No. 7, ISSN: 1448 - 3599 ISBN: 1 921258 85 3. 84pp.

Magna Carta (1215). The Great Charter of Runnymede, England.

Mapstone, B.D., C.R. Davies, S.J. Slade, A. Jones, K.J. Kane and A.J. Williams (2001). Effects of live fish trading and targeting spawning aggregations on fleet dynamics, catch characteristics, and resource exploitation by the Queensland commercial demersal reef line fishery. FRDC Project No. 96/138. CRC Reef Research Centre Townsville, 72pp.

McAuley, R. and Simpfendorfer C. (2003). Catch composition of the Western Australian temperate demersal gillnet and demersal longline fisheries, 1994 to 1999, Fisheries Research Report No. 146, Department of Fisheries, Western Australia, 78 pp.

McElderry H.; McCullough, D.; Schrader, J. and Illingworth, J. (2007): Pilot study to test the effectiveness of electronic monitoring in Canterbury fisheries. DOC Research and Development Series 264. Department of Conservation, Wellington. 27p

McKinnon, L.J. and Milner, G.L. (2009). Empowering Industry RandD: Trials of gear modifications to reduce bycatch in freshwater fyke nets. FRDC Project 2008/17. ISBN: 978-0-646-52242-5. 23pp.

McShane, P.E., Hall, S.E. and N.A. Carrick (1998). Trophic consequences of prawn trawling: Linking by-catch to benthos. In: "Establishing meaningful targets for by-catch reduction in Australian fisheries." (Eds. C. Buxton and S. Eayrs), Australian Society for Fishing Biology Workshop Proceedings, Hobart, Sept. 1998, pp. 106-12.

Mills, D.J., Gardner, C. and Johnson, C.R. (2006). Experimental reseeding of juvenile spiny lobsters (*Jasus edwardsii*): comparing survival of wild and naïve stocks at multiple sites. Aquaculture, 254: 256–268

MRAG, (2005). Observer-Based Surveys of Ocean Haul Netting from Beaches in New South Wales. Final Report, NSWDPI, December 2005. 42pp.

Nardi, A, D. Gaughan, R. Lenanton and S.J. Newman (2007). South Coast Purse Seine Managed Fishery Status Report. https://www.environment.gov.au/system/files/pages/0867f14a-9942-4048-b121-5f0d7c884788/files/purse-seine-appendix4-08.pdf

Newman, S.J., Smith, K.A., Skepper, C.L. and Stephenson, P.C. (2008). ESD Report Series No. 6, June ISSN: 1448 - 3599 ISBN: 1 921258 20 9

NMFS (2011). U.S. National Bycatch Report. W.A. Karp, L.L. Desfosse, S.G. Brooke, Editors. U.S. Dept. Commerce, NOAA Tech. Memo. NMFS-F/SPO-117E, 508 pp.

Noell, C.J, Broadhurst, M.K. and S.J. Kennelly (2018). Refining a Nordmøre-grid for the Spencer Gulf penaeid-trawl fishery. PLoSONE 13(11): e0207117.https://doi. org/10.1371/journal.pone.0207117.

NSW DPI, (2004). Environmental Impact Statement on the Lobster fishery in NSW. Public Consultation Document, ISBN 1 920812 07 05, Pages 104-133.

NTG (2015). Status of Key Northern Territory Fish Stocks Report 2013. Northern Territory Government. Department of Primary Industry and Fisheries. Fishery Report No. 114. 101pp.

NTG (2016). Status of Key Northern Territory Fish Stocks Report 2014. Northern Territory Government. Department of Primary Industry and Fisheries. Fishery Report No. 115, 106pp.

NTG (2017). Status of Key Northern Territory Fish Stocks Report 2015. Northern Territory Government. Department of Primary Industry and Resources. Fishery Report No. 118, 109pp.

Pérez Roda, M.A., Gilman, E., Huntington, T., Kennelly, S.J., Suuronen, P., Chaloupka, M. and Medley, P. (2019). A third assessment of global marine fisheries discards. FAO Fisheries and Aquaculture Technical Paper No. 633. 78pp. FAO, Rome.

PIRSA (2009a). Ecologically Sustainable Development (ESD) Risk Assessment of the South Australian Commercial Blue Crab Fishery. Primary Industries and Resources South Australia. 88 pages.

PIRSA (2009b). South Australian Fisheries Management Series, Ecological Assessment of the South Australian Sardines (*Sardinops sagax*) Fishery Reassessment Report. Prepared by the Fisheries Division of Primary Industries and Resources South Australia, 22pp.

PIRSA (2018). Draft Ecologically Sustainable Development Risk Assessment of Commercial Fishing for Giant Crabs In South Australia.

Robins, J. (1995). Estimated catch and mortality of sea turtles from the East Coast Otter Trawl Fishery of Queensland, Australia. Biological Conservation 74(3), pages 157-167

Robins, J.B. and A.J. Courtney (1998). Status report on bycatch within the Queensland Trawl Fishery, Australian Society for Fish Biology, 45pp.

Roelofs, A. (2004a). Ecological Assessment of the Gulf of Carpentaria Line Fishery - A report to the Australian Government Department of the Environment and Heritage on the sustainable management of a multi-species tropical line fishery. Queensland Fisheries Service (QFS), 69pp.

Roelofs, A. (2004b). Ecological Assessment of the Gulf of Carpentaria Inshore Finfish Fishery - A report to Environment Australia on the sustainable management of a multi-species tropical gillnet fishery. Queensland Fisheries Service, 90pp.

Ryan, S., Clarke, K. and Higgs, J. (2003). Ecological Assessment of the Queensland Coral Reef Fin Fish Fishery. A report to Environment Australia on sustainable management of the multi-species coral reef fin fish fishery. Brisbane. Department of Primary Industries, Queensland. 163 pp.

SOQ (2013). Gulf of Carpentaria Line Fishery 2011 fishing year report. State of Queensland, 7pp.

Stephenson, PC. and J Chidlow (2003). Bycatch in the Pilbara trawl fishery. Natural Heritage Trust Report Final Report, 74pp. ISBN: 1877098302

Stewart, J. (2007). Observer study in the Estuary General sea garfish haul net fishery in NSW. NSW Department of Primary Industries – Fisheries Final Report Series, ISSN 1449-9967, No. 87. 23pp.

Stewart, J. (2008). An Observer-based Assessment of the Estuarine Fishery for Eastern Sea Garfish (*Hyporhamphus australis*) in Australia. Asian Fisheries Science 21:469-481.

Stewart, J. and D.J. Ferrell (2001). Mesh selectivity in the NSW demersal trap fishery. FRDC Project No. 98/138, NSW Fisheries Final Report Series, No. 35, ISSN 1440-3544, 86pp.

Stewart, J. and D.J. Ferrell (2003). Mesh selectivity in the New South Wales demersal trap fishery. Fisheries Research 59: 379-392.

Stewart, J. and J.M. Hughes (2008). Determining appropriate sizes at harvest for species shared by the commercial trap and recreational fisheries in New South Wales. FRDC Project No. 2004/035, NSW Department of Primary Industries – Fisheries Final Report Series, No. 97, ISSN 1449-9967, 282pp.

Svane, I. and Hooper, G.E. (2004) Blue Swimmer Crab (*Portunus pelagicus*) fishery. Fishery Assessment Report to PIRSA for the Blue Crab Fishery Management Committee. SARDI Aquatic Sciences Publication No. RD03/0274-2.

van Helmond, A.T.M., Mortensen, L.O., Plet-Hansen, K.S., Ulrich. C., Needle, C.L., Oesterwind, D., Kindt-Larsen, L., Catchpole, T., Mangi, S., Zimmermann, C., Olesen, H.J., Bailey, N., Bergsson, H., Dalskov, J., Elson, J., Hosken, M., Peterson, L., McElderry, H., Ruiz, J., Pierre, J.P., Dykstra, C., and J. Jaap Poos (2019) Electronic monitoring in fisheries: Lessons from global experiences and future opportunities. Fish and Fisheries 21: 162-189. doi.org/10.1111/faf.12425

WAF (2017). Western Australian Marine Stewardship Council Report Series West Coast Deep Sea Crustacean Managed Fishery Addendum October 2017, 22pp. http://www.fish.wa.gov.au/Documents/wamsc_reports/wamsc_report_no_4_addendum.pdf

WAF (2018). Western Australian Marine Stewardship Council Report Series West Coast Estuarine Managed Fishery (Area 2: Peel-Harvey Estuary) and Peel-Harvey Estuary Blue Swimmer Crab Recreational Fishery Addendum 2 May 2018. http://www.fish.wa.gov.au/Documents/wamsc_reports/wamsc_report_no_3_addendum_2.pdf

Wakefield C.B., Blight S., Dorman S.R., Denham A., Newman S.J., Wakeford J., Molony B.W., Thomson A.W., Syers C., and O'Donoghue S. (2014). Independent observations of catches and subsurface mitigation efficiencies of modified trawl nets for endangered, threatened and protected megafauna bycatch in the Pilbara Fish Trawl Fishery. Fisheries Research Report, No. 244, Department of Fisheries, Western Australia. 40 p.

Wakefield C.B., Santana-Garcon J., Dorman S.R., Blight S., Denham A., Wakeford J., Molony B.W., and Newman S.J. (2017). Performance of bycatch reduction devices varies for chondrichthyan, reptile and cetacean mitigation in demersal fish trawls: assimilating subsurface interactions and unaccounted mortality. ICES Journal of Marine Science 74 (1): 343-358.

Wang, N., Courtney, A. J., Campbell, M. J., and Yang, W.H. (2019). Quantifying long-term discards from Queensland's (Australia) east Coast otter trawl fishery. – ICES Journal of Marine Science, doi:10.1093/icesjms/fsz205.

Webster, F. and Hart, A. (2018). Western Australian Marine Stewardship Council Report Series No. 13: Ecosystem Based Fisheries Management (EBFM) Risk Assessment of the Western Australian Sea Cucumber Fishery. Department of Primary Industries and Regional Development, Western Australia. 74pp.

Appendix 1

Spreadsheet used to score general discards data according to the US Tier Classification system.

			Adequacy of Bycatch Data																		Quality of the Bycatch Estimate								
			Observer Data										Industry Data	Supplementary Data						Database/IT	Analytical Approach								
			Longevity of Observer Data	Sampling Frame	Sampling Design of Vessels	Sampling Design of Trips	Sampling Design of Hauls	Spatial Coverage	Temporal Coverage	Vessel-Selection Bias	Observer Bias	Data Quality Control	Score	Data available as expansion factors for unobserved components	Data available for stratification	Data available for imputation	Data available for model covariates	Industry data verified	Score	Assumptions Identified, Tested, and Appropriate	Peer Reviewed / Published Design	Peer Reviewed / Published Analytical Approach	Statistical Bias of Estimators	Measures of Uncertainty	% score	Tier:	% score weighted by estimated discards	Note
Maximum Scores			**5**	**3**	**4**	**4**	**4**	**2**	**2**	**2**	**2**	**5**	**2**	**2**	**2**	**2**	**2**	**2**	**2**	**10**	**4**	**4**	**4**	**4**	**100**			
NSW	**Estuary General**	**Meshing net**	1	3	2	2	3	2	2	1	2	4	0	2	2	2	2	0	2	3	4	4	0	2	61.64	2	2.59	
		Hauling net (general purpose)	1	3	2	2	3	2	2	1	2	4	0	2	2	2	2	0	2	3	4	4	0	2	61.64	2	9.30	
		Prawn net (set pocket)	1	3	2	2	3	1	2	1	2	4	0	2	2	2	2	0	2	3	4	4	0	2	60.27	2	0.32	
		Crab trap	0	0	0	0	0	0	0	0	0	0	0	2	2	2	2	0	2	3	0	4	0	2	26.03	1	0.06	
		Fish trap (bottom/demersal)	1	2	1	1	3	2	2	1	2	2	1	2	2	2	2	0	2	3	2	4	0	2	53.42	2	0.11	
		Flathead net	1	3	2	2	3	2	2	1	2	3	0	2	2	2	2	0	2	3	4	4	0	2	60.27	2	0.71	
		Eel trap	0	0	0	0	0	0	0	0	0	0	0	2	2	2	2	0	2	3	0	4	0	2	26.03	1	0.00	
		Prawn net (hauling)	1	3	2	2	3	2	2	1	2	4	0	2	2	2	2	0	2	3	4	4	0	2	61.64	2	0.16	
		Handgathering	4	3	1	2	3	2	2	2	2	4	0	2	2	2	2	0	2	3	4	4	0	2	65.75	2	0.09	
		Prawn running net	1	3	2	2	3	2	2	1	2	4	0	2	2	2	2	0	2	3	4	4	0	2	61.64	2	0.06	
		Seine net (prawns)	1	3	2	2	3	2	2	1	2	4	0	2	2	2	2	0	2	3	4	4	0	2	61.64	2	0.19	
		Bait net																										1
		Garfish net (bullringing)	0	0	0	0	0	0	0	0	0	0	0	2	2	2	2	0	2	3	0	4	0	2	26.03	1	0.00	
		Handline	0	0	0	0	0	0	0	0	0	0	0	2	2	2	2	0	2	3	0	4	0	2	26.03	1	0.01	
		Pilchard, anchovy & bait net - beach based																										1
		Setline	0	0	0	0	0	0	0	0	0	0	0	2	2	2	2	0	2	3	0	4	0	2	26.03	1	0.00	
		Dip or scoop net (prawns)																										1
		Hoop or lift net	1	1	1	1	0	1	1	0	0	1	0	2	2	2	2	0	2	3	2	4	0	2	38.36	1	0.00	
	Estuary Prawn Trawl	**Otter trawl net (prawns)**	1	3	2	3	3	2	2	1	2	4	0	2	2	2	2	0	2	3	4	4	0	2	63.01	2	0.84	
	Ocean Trawl	**Otter trawl net (prawns)**	1	3	2	3	3	2	2	1	2	4	0	2	2	2	2	0	2	3	4	4	0	2	63.01	2	31.27	
		Otter trawl net (fish)	1	3	2	3	3	2	2	1	2	4	0	2	2	2	2	0	2	3	4	4	0	2	63.01	2	9.57	
	Ocean Hauling	**Hauling net (general purpose)**	2	3	2	2	3	2	2	1	2	3	0	2	2	2	2	0	2	3	4	4	0	2	61.64	2	0.04	
		Purse seine net	0	0	0	0	0	0	0	0	0	0	0	2	2	2	2	0	2	3	0	4	0	2	26.03	1	0.85	
		Pilchard, anchovy & bait net - beach based	0	0	0	0	0	0	0	0	0	0	0	2	2	2	2	0	2	3	0	4	0	2	26.03	1	0.00	
		Garfish net (hauling) - boat based	0	0	0	0	0	0	0	0	0	0	0	2	2	2	2	0	2	3	0	4	0	2	26.03	1	0.01	
		Garfish net (hauling) - beach based	2	3	2	2	3	1	2	1	2	3	0	2	2	2	2	0	2	3	4	4	0	2	60.27	2	0.00	
	Ocean Trap & Line	**Fish trap (bottom/demersal)**	0	0	0	0	0	0	0	0	0	0	0	2	2	2	2	0	2	3	0	4	0	2	26.03	1	0.04	
		Handline	2	3	2	3	3	2	2	1	2	3	0	2	2	2	2	0	2	3	4	4	0	2	63.01	2	0.52	
		Trolling	0	0	0	0	0	0	0	0	0	0	0	2	2	2	2	0	2	3	0	4	0	2	26.03	1	0.09	
		Setline (demersal)	2	3	2	3	3	2	2	1	2	3	0	2	2	2	2	0	2	3	4	4	0	2	63.01	2	0.18	
		Spanner crab net	0	0	0	0	0	0	0	0	0	0	0	2	2	2	2	0	2	3	0	4	0	2	26.03	1	0.13	
		Jigging	0	0	0	0	0	0	0	0	0	0	0	2	2	2	2	0	2	3	0	4	0	2	26.03	1	0.05	
		Dropline	2	3	2	3	3	2	2	1	2	3	0	2	2	2	2	0	2	3	2	4	0	2	60.27	2	0.04	
		Setline	2	3	2	3	3	2	2	1	2	3	0	2	2	2	2	0	2	3	2	4	0	2	60.27	2	0.06	
		Poling	0	0	0	0	0	0	0	0	0	0	0	2	2	2	2	0	2	3	0	4	0	2	26.03	1	0.02	
		Trotline (bottom set)	0	0	0	0	0	0	0	0	0	0	0	2	2	2	2	0	2	3	0	4	0	2	26.03	1	0.02	
		Driftline	0	0	0	0	0	0	0	0	0	0	0	2	2	2	2	0	2	3	0	4	0	2	26.03	1	0.01	
	Abalone	**Diving**	0	0	0	0	0	0	0	0	0	0	1	2	2	2	2	0	2	3	0	4	0	2	27.40	1	0.04	
	Lobster	**Trapping**	1	2	2	2	3	2	2	2	2	3	1	2	2	2	2	0	2	3	2	4	0	2	58.90	2	1.07	
	Others	**Danish seine trawl net (fish)**	0	0	0	0	0	0	0	0	0	0	0	2	2	2	2	0	2	3	0	4	0	2	26.03	1	0.66	
		Pilchard, anchovy & bait net - boat based																										1
		Skindiving																										1
	Special Permits	**Purse seine net**	0	0	0	0	0	0	0	0	0	0	0	2	2	2	2	0	2	3	0	4	0	2	26.03	1	0.04	
		Scallop Dredge	0	0	0	0	0	0	0	0	0	0	0	2	2	2	2	0	2	3	0	4	0	2	26.03	1	0.01	
		Submersible Lift Net	0	0	0	0	0	0	0	0	0	0	0	2	2	2	2	0	2	3	0	4	0	2	26.03	1	0.00	
		Eel trap	0	0	0	0	0	0	0	0	0	0	0	2	2	2	2	0	2	3	0	4	0	2	26.03	1	0.02	
																							average scores:		**42.70**	**1.46**	**59.19**	

Tasmania	Abalone	Dive	0	0	0	0	0	0	0	0	0	0	0	2	2	2	2	0	2	3	0	4	0	2	26.03	1	1.14			
	Southern Rock Lobster	Pots	4	2	1	3	3	1	1	0	2	3	2	2	2	2	2	0	2	3	2	2	2	1	57.53	2	51.80			
	Scallop	Dredge	0	0	0	0	0	0	0	0	0	0	2	2	2	2	2	0	2	3	0	4	0	2	28.77	1	0.49			
	Octopus	Pots (unbaited)																												1
	Giant Crab	Pots	4	2	2	2	2	2	2	2	2	3	2	2	2	2	2	0	2	3	2	4	0	2	63.01	2	0.21			
		Automatic squid jig																												1
		Beach seine	0	0	0	0	0	0	0	0	0	0	0	2	2	2	2	0	2	3	0	4	0	2	26.03	1	0.00			
		Purse seine	0	0	0	0	0	0	0	0	0	0	0	2	2	2	2	0	2	3	0	4	0	2	26.03	1	0.00			
		Graball net	4	2	2	2	2	2	2	2	2	3	2	2	2	2	2	0	2	3	2	4	0	2	63.01	2	0.54			
		Hand line	0	0	0	0	0	0	0	0	0	0	0	2	2	2	2	0	2	3	0	4	0	2	26.03	1	0.07			
		Danish seine	0	0	0	0	0	0	0	0	0	0	0	2	2	2	2	0	2	3	0	4	0	2	26.03	1	0.40			
	Scalefish	Squid-jig																												1
		Dip-net																												1
		Small mesh net	4	2	2	2	2	2	2	2	2	3	2	2	2	2	2	0	2	3	2	4	0	2	63.01	2	0.00			
		Troll	0	0	0	0	0	0	0	0	0	0	0	2	2	2	2	0	2	3	0	4	0	2	26.03	1	0.00			
		Fish trap	0	0	0	0	0	0	0	0	0	0	0	2	2	2	2	0	2	3	0	4	0	2	26.03	1	0.00			
		Drop-line	0	0	0	0	0	0	0	0	0	0	0	2	2	2	2	0	2	3	0	4	0	2	26.03	1	0.00			
		Spear																												1
		Hand collection																												1
	Commercial Dive and Shellfish	Hand Collection																												1
																							average scores:		37.20	1.31	54.66			
NT		Demersal	5	2	2	2	2	2	2	2	2	3	2	2	2	2	2	0	2	3	0	4	0	2	61.64	2	27.27	2		
		Timor Reef	5	2	2	2	2	2	2	2	2	3	2	2	2	2	2	0	2	3	0	4	0	2	61.64	2	5.23			
		Barramundi	5	2	2	2	2	2	2	2	2	3	2	2	2	2	2	0	2	3	0	4	0	2	61.64	2	15.87			
		Offshore Net and Line	5	2	2	2	2	2	2	2	2	3	2	2	2	2	2	0	2	3	0	4	0	2	61.64	2	7.82			
		Spanish Mackerel	0	0	0	0	0	0	0	0	0	0	0	2	2	2	2	0	2	3	0	4	0	2	26.03	1	1.05			
		Mud Crab	0	0	0	0	0	0	0	0	0	0	0	2	2	2	2	0	2	3	0	4	0	2	26.03	1	0.93			
		Coastal line	0	0	0	0	0	0	0	0	0	0	0	2	2	2	2	0	2	3	0	4	0	2	26.03	1	0.31			
		Trepang																												1
		Restricted Bait																												1
		Aquarium Display																												1
		Coastal net	0	0	0	0	0	0	0	0	0	0	0	2	2	2	2	0	2	3	0	4	0	2	26.03	1	0.00			
																							average scores:		43.84	1.50	58.48			
QLD		Coral																												1
		Crayfish and Rocklobster																												1
		East Coast Pearl																												1
		Marine Aquarium Fish																												1
		Eel Fishery	0	0	0	0	0	0	0	0	0	0	0	2	2	2	2	0	2	3	0	4	0	2	26.03	1	0.0137			
		Sea Cucumber Fishery (East Coast)																												1
		Trochus																												1
		Coral Reef Finfish	2	2	2	2	3	1	1	0	2	3	0	2	2	2	2	0	2	3	0	4	0	2	50.68	2	0.4229			
		Deep Water Finfish	0	0	0	0	0	0	0	0	0	0	0	2	2	2	2	0	2	3	0	4	0	2	26.03	1	0.0004			
		East Coast Spanish Mackerel	0	0	0	0	0	0	0	0	0	0	0	2	2	2	2	0	2	3	0	4	0	2	26.03	1	0.0411			
		Gulf of Carpentaria Line	0	0	0	0	0	0	0	0	0	0	0	2	2	2	2	0	2	3	0	4	0	2	26.03	1	0.0181			
		Rocky Reef Finfish	0	0	0	0	0	0	0	0	0	0	0	2	2	2	2	0	2	3	0	4	0	2	26.03	1	0.0145			
		East Coast Inshore Finfish Fishery	1	1	1	1	3	2	2	0	2	2	0	2	2	2	2	0	2	3	0	4	0	2	46.58	2	0.0000			
		Gulf of Carpentaria Inshore Finfish	1	1	1	1	3	2	2	0	2	2	0	2	2	2	2	0	2	3	0	4	0	2	46.58	2	0.1742			
		Blue Swimmer Crab	0	0	0	0	0	0	0	0	0	0	0	2	2	2	2	0	2	3	0	4	0	2	26.03	1	0.0431			
		Mud Crabs	0	0	0	0	0	0	0	0	0	0	0	2	2	2	2	0	2	3	0	4	0	2	26.03	1	0.3953			
		Spanner Crabs	0	0	0	0	0	0	0	0	0	0	0	2	2	2	2	0	2	3	0	4	0	2	26.03	1	0.2443			
		East Coast Otter Trawl	4	3	3	2	4	2	2	2	2	4	0	2	2	2	2	0	2	3	3	4	0	2	68.49	3	64.4643			
		Gulf of Carpentaria Developmental Fin Fish Trawl	0	0	0	0	0	0	0	0	0	0	2	2	2	2	2	0	2	3	0	4	0	2	28.77	1	0.1295			
		River and Inshore Beam Trawl	3	2	1	1	3	2	2	0	2	2	0	2	2	2	2	0	2	3	0	4	0	2	50.68	2	0.1065			
																							average scores:		35.71	1.43	66.067835			

Victoria	**Abalone**	**Dive**	0	0	0	0	0	0	0	0	0	0	0	2	2	2	2	0	1	3	0	4	0	2	24.66	1	1.15			
	Rock Lobster	**Pots**	4	2	3	3	3	1	1	1	2	4	0	2	2	1	2	1	0	2	2	0	0	2	52.05	2	12.93			
	Ocean (General)	**Drop Line**	0	0	0	0	0	0	0	0	0	0	0	2	2	2	2	0	1	3	0	4	0	2	24.66	1	0.00			
		Hand Line	0	0	0	0	0	0	0	0	0	0	0	2	2	2	2	0	1	3	0	4	0	2	24.66	1	0.21			
		Shark Long Line	0	0	0	0	0	0	0	0	0	0	0	2	2	2	2	0	1	3	0	4	0	2	24.66	1	0.02			
		Snapper Long Line	0	0	0	0	0	0	0	0	0	0	0	2	2	2	2	0	1	3	0	4	0	2	24.66	1	0.01			
		Octopus Trap/Pot																												1
	Westernport/Port Phillip Bay	**Haul Seine**	0	0	0	0	0	0	0	0	0	0	0	2	2	2	2	0	1	3	0	4	0	2	24.66	1	4.34			
		Multifilament Mesh	0	0	0	0	0	0	0	0	0	0	0	2	2	2	2	0	1	3	0	4	0	2	24.66	1	0.18			
		Snapper Long Line	0	0	0	0	0	0	0	0	0	0	0	2	2	2	2	0	1	3	0	4	0	2	24.66	1	0.26			
		Purse Seine	0	0	0	0	0	0	0	0	0	0	0	2	2	2	2	0	1	3	0	4	0	2	24.66	1	0.24			
		Garfish Seine	0	0	0	0	0	0	0	0	0	0	0	2	2	2	2	0	1	3	0	4	0	2	24.66	1	0.01			
	Corner Inlet	**Ringing Seine**	0	0	0	0	0	0	0	0	0	0	0	2	2	2	2	0	1	3	0	4	0	2	24.66	1	3.39			
		Multifilament Mesh	0	0	0	0	0	0	0	0	0	0	0	2	2	2	2	0	1	3	0	4	0	2	24.66	1	0.23			
		Haul Seine	0	0	0	0	0	0	0	0	0	0	0	2	2	2	2	0	1	3	0	4	0	2	24.66	1	0.82			
	Bait (General)	**Bait Pump**																												1
		Yabbie Pot																												1
	Eel	**Fyke net**	0	0	0	0	0	0	0	0	0	0	2	2	2	2	2	0	1	3	0	4	0	2	27.40	1	1.05			
	Gippsland Lakes	**Multifilament Mesh**	0	0	0	0	0	0	0	0	0	0	0	2	2	2	2	0	1	3	0	4	0	2	24.66	1	0.37			
		Prawn Stake Net	0	0	0	0	0	0	0	0	0	0	0	2	2	2	2	0	1	3	0	4	0	2	24.66	1	0.06			
	Trawl (Inshore)	**Prawn Trawl**	0	0	0	0	0	0	0	0	0	0	0	2	2	2	2	0	1	3	0	4	0	2	24.66	1	6.17			
	Gippsland Lakes (Bait)	**Bait Pump**																												1
	General (Sea Urchin)	**Dive**																												1
	Wrasse (Ocean)	**Handline**	0	0	0	0	0	0	0	0	0	0	0	2	2	2	2	0	1	3	0	4	0	2	24.66	1	0.06			
	Giant Crab	**Pots**	0	0	0	0	0	0	0	0	0	0	0	2	2	2	2	0	1	3	0	4	0	2	24.66	1	0.07			
																							average scores:		**26.16**	**1.05**	**31.57**			

WA	West Coast Rock Lobster	Potting	0	0	0	0	0	0	0	0	0	0	0	2	2	2	2	0	2	3	0	4	0	2	26.03	1	12.07			
	South Coast Purse-Seine	Purse Seine	0	0	0	0	0	0	0	0	0	0	0	2	2	2	2	0	2	3	0	4	0	2	26.03	1	0.58			
	Shark Bay Prawn	Trawling	0	0	0	0	0	0	0	0	0	0	0	2	2	2	2	0	2	3	0	4	0	2	26.03	1	4.15			
	Northern Demersal Scalefish Fishery	Fish Trap	2	2	0	0	0	1	1	0	0	2	0	2	2	2	2	0	2	3	2	4	0	2	39.73	1	0.05			
	Joint Authority Southern Demersal Gillnet and Demersal Longline	Gillnet	1	1	0	0	0	1	1	0	0	2	0	2	2	2	2	0	2	3	2	4	0	2	36.99	1	2.80			
		Longline	0	0	0	0	0	0	0	0	0	0	0	2	2	2	2	0	2	3	0	4	0	2	26.03	1	0.01			
	Pilbara Fish Trawl (Interim)	Trawling	2	2	0	0	0	1	1	0	0	2	0	2	2	2	2	0	2	3	2	4	0	2	39.73	1	1.58			
	Exmouth Gulf Prawn	Trawling	0	0	0	0	0	0	0	0	0	0	0	2	2	2	2	0	2	3	0	4	0	2	26.03	1	1.18			
	Shark Bay Scallop	Trawling	1	1	0	0	0	1	1	0	0	2	0	2	2	2	2	0	2	3	2	4	0	2	36.99	1	1.54			
	FBL condition 93 Purse Seine Development Zone	Purse Seine	0	0	0	0	0	0	0	0	0	0	0	2	2	2	2	0	2	3	0	4	0	2	26.03	1	0.14			
	Abrolhos Islands and Mid West Trawl	Trawling	1	1	0	0	0	1	1	0	0	2	0	2	2	2	2	0	2	3	0	4	0	2	34.25	1	1.43			
	Pilbara Trap	Fish Trap	0	0	0	0	0	0	0	0	0	0	0	2	2	2	2	0	2	3	0	4	0	2	26.03	1	0.01			
	Kimberley Prawn	Trawling	0	0	0	0	0	0	0	0	0	0	0	2	2	2	2	0	2	3	0	4	0	2	26.03	1	0.36			
	Abalone	Diving	0	0	0	0	0	0	0	0	0	0	0	2	2	2	2	0	2	3	0	4	0	2	26.03	1	0.05			
	Shark Bay Crab	Crab Trap	0	0	0	0	0	0	0	0	0	0	0	2	2	2	2	0	2	3	0	4	0	2	26.03	1	0.03			
		Trawling	0	0	0	0	0	0	0	0	0	0	0	2	2	2	2	0	2	3	0	4	0	2	26.03	1	0.40			
	Pearl Oyster	Diving																												1
	West Coast Purse Seine Fishery	Purse Seine	0	0	0	0	0	0	0	0	0	0	0	2	2	2	2	0	2	3	0	4	0	2	26.03	1	0.06			
	FBL condition 73 South Coast Trawl Fishery	Trawling	0	0	0	0	0	0	0	0	0	0	0	2	2	2	2	0	2	3	0	4	0	2	26.03	1	0.63			
	Nickol Bay Prawn	Trawling	0	0	0	0	0	0	0	0	0	0	0	2	2	2	2	0	2	3	0	4	0	2	26.03	1	0.19			
	South Coast Salmon	Beach Seine	0	0	0	0	0	0	0	0	0	0	0	2	2	2	2	0	2	3	0	4	0	2	26.03	1	0.00			
	Shark Bay Beach Seine and Mesh Net	Beach Seine	0	0	0	0	0	0	0	0	0	0	0	2	2	2	2	0	2	3	0	4	0	2	26.03	1	0.00			
		Haul Net / Ring Net	0	0	0	0	0	0	0	0	0	0	0	2	2	2	2	0	2	3	0	4	0	2	26.03	1	0.00			
	Kimberley Gillnet and Barramundi	Gillnet	0	0	0	0	0	0	0	0	0	0	0	2	2	2	2	0	2	3	0	4	0	2	26.03	1	0.07			
	West Coast Demersal Gillnet and Demersal Longline (Interim)	Gillnet	0	0	0	0	0	0	0	0	0	0	0	2	2	2	2	0	2	3	0	4	0	2	26.03	1	0.17			
		Longline	0	0	0	0	0	0	0	0	0	0	0	2	2	2	2	0	2	3	0	4	0	2	26.03	1	0.01			
	South West Coast Beach Net Fishery (Order)	Beach Seine	0	0	0	0	0	0	0	0	0	0	0	2	2	2	2	0	2	3	0	4	0	2	26.03	1	0.00			
	West Coast Estuarine	Crab Trap	0	0	0	0	0	0	0	0	0	0	0	2	2	2	2	0	2	3	0	4	0	2	26.03	1	0.02			
		Gillnet	4	3	0	0	0	2	2	0	0	2	0	2	2	2	2	0	2	3	2	4	0	2	46.58	2	0.00			
		Haul Net / Ring Net	4	3	0	0	0	2	2	0	0	2	0	2	2	2	2	0	2	3	2	4	0	2	46.58	2	0.00			
	FBL condition 42 herring	Trap Net																												1
	South West Coast Salmon	Beach Seine	0	0	0	0	0	0	0	0	0	0	0	2	2	2	2	0	2	3	0	4	0	2	26.03	1	0.00			
	South West Trawl Fishery	Trawling	0	0	0	0	0	0	0	0	0	0	0	2	2	2	2	0	2	3	0	4	0	2	26.03	1	0.18			
	West Coast Demersal Scalefish (Interim)	Dropline	0	0	0	0	0	0	0	0	0	0	0	2	2	2	2	0	2	3	0	4	0	2	26.03	1	0.01			
		Dropline and Hydraulic Gunwhale Mounted Reel	0	0	0	0	0	0	0	0	0	0	0	2	2	2	2	0	2	3	0	4	0	2	26.03	1	0.00			
		Handheld Reel and Dropline	0	0	0	0	0	0	0	0	0	0	0	2	2	2	2	0	2	3	0	4	0	2	26.03	1	0.00			
		Gunwhale Mounted Hand Operated Reel	0	0	0	0	0	0	0	0	0	0	0	2	2	2	2	0	2	3	0	4	0	2	26.03	1	0.01			
		Electric Gunwhale Mounted Reel	0	0	0	0	0	0	0	0	0	0	0	2	2	2	2	0	2	3	0	4	0	2	26.03	1	0.01			
		Hydraulic Gunwhale Mounted Reel	0	0	0	0	0	0	0	0	0	0	0	2	2	2	2	0	2	3	0	4	0	2	26.03	1	0.04			
		Handheld Reel	0	0	0	0	0	0	0	0	0	0	0	2	2	2	2	0	2	3	0	4	0	2	26.03	1	0.01			
	West Coast Deep Sea Crustacean	Crab Trap	4	2	3	3	3	2	2	2	2	3	2	2	2	2	2	2	2	3	0	4	0	2	67.12	3	0.00			
		Potting	4	2	3	3	3	2	2	2	2	3	2	2	2	2	2	2	2	3	0	4	0	2	67.12	3	0.00			
	Cockburn Sound (Crab)	Crab Trap	0	0	0	0	0	0	0	0	0	0	0	2	2	2	2	0	2	3	0	4	0	2	26.03	1	0.00			

	West Australian Sea Cucumber Fishery	Diving																													1
	Open Access in the North Coast, Gascoyne Coast and West Coast Bioregions	Beach Seine	0	0	0	0	0	0	0	0	0	0	0	2	2	2	2	0	2	3	0	4	0	2	26.03	1	0.00				
		Potting	0	0	0	0	0	0	0	0	0	0	0	2	2	2	2	0	2	3	0	4	0	2	26.03	1	0.00				
		Squid Jigging																													1
		Gillnet	0	0	0	0	0	0	0	0	0	0	0	2	2	2	2	0	2	3	0	4	0	2	26.03	1	0.00				
		Hydraulic Gunwhale Mounted Reel	0	0	0	0	0	0	0	0	0	0	0	2	2	2	2	0	2	3	0	4	0	2	26.03	1	0.01				
		Haul Net / Ring Net	0	0	0	0	0	0	0	0	0	0	0	2	2	2	2	0	2	3	0	4	0	2	26.03	1	0.00				
	Open Access in the South Coast Bioregion	Beach Seine	0	0	0	0	0	0	0	0	0	0	0	2	2	2	2	0	2	3	0	4	0	2	26.03	1	0.00				
		Haul Net / Ring Net	0	0	0	0	0	0	0	0	0	0	0	2	2	2	2	0	2	3	0	4	0	2	26.03	1	0.00				
		Handline	0	0	0	0	0	0	0	0	0	0	0	2	2	2	2	0	2	3	0	4	0	2	26.03	1	0.00				
		Trolling	0	0	0	0	0	0	0	0	0	0	0	2	2	2	2	0	2	3	0	4	0	2	26.03	1	0.00				
		Gillnet	0	0	0	0	0	0	0	0	0	0	0	2	2	2	2	0	2	3	0	4	0	2	26.03	1	0.00				
		Squid Jigging																													1
		Electric Gunwhale Mounted Reel	0	0	0	0	0	0	0	0	0	0	0	2	2	2	2	0	2	3	0	4	0	2	26.03	1	0.00				
		Gunwhale Mounted Hand Operated Reel	0	0	0	0	0	0	0	0	0	0	0	2	2	2	2	0	2	3	0	4	0	2	26.03	1	0.00				
		Handheld Reel	0	0	0	0	0	0	0	0	0	0	0	2	2	2	2	0	2	3	0	4	0	2	26.03	1	0.00				
		Hydraulic Gunwhale Mounted Reel	0	0	0	0	0	0	0	0	0	0	0	2	2	2	2	0	2	3	0	4	0	2	26.03	1	0.01				
		Dropline	0	0	0	0	0	0	0	0	0	0	0	2	2	2	2	0	2	3	0	4	0	2	26.03	1	0.01				
	South Coast Estuarine	Crab Trap	0	0	0	0	0	0	0	0	0	0	0	2	2	2	2	0	2	3	0	4	0	2	26.03	1	0.00				
		Fish Trap	0	0	0	0	0	0	0	0	0	0	0	2	2	2	2	0	2	3	0	4	0	2	26.03	1	0.00				
		Haul Net / Ring Net	0	0	0	0	0	0	0	0	0	0	0	2	2	2	2	0	2	3	0	4	0	2	26.03	1	0.00				
		Gillnet	0	0	0	0	0	0	0	0	0	0	0	2	2	2	2	0	2	3	0	4	0	2	26.03	1	0.00				
	Gascoyne Demersal Scalefish	Electric Gunwhale Mounted Reel	0	0	0	0	0	0	0	0	0	0	0	2	2	2	2	0	2	3	0	4	0	2	26.03	1	0.00				
		Gunwhale Mounted Hand Operated Reel	0	0	0	0	0	0	0	0	0	0	0	2	2	2	2	0	2	3	0	4	0	2	26.03	1	0.00				
		Handheld Reel	0	0	0	0	0	0	0	0	0	0	0	2	2	2	2	0	2	3	0	4	0	2	26.03	1	0.00				
		Hydraulic Gunwhale Mounted Reel	0	0	0	0	0	0	0	0	0	0	0	2	2	2	2	0	2	3	0	4	0	2	26.03	1	0.06				
	Pilbara Line Fishery (Condition)	Electric Gunwhale Mounted Reel	0	0	0	0	0	0	0	0	0	0	0	2	2	2	2	0	2	3	0	4	0	2	26.03	1	0.00				
		Handheld Reel	0	0	0	0	0	0	0	0	0	0	0	2	2	2	2	0	2	3	0	4	0	2	26.03	1	0.00				
		Hydraulic Gunwhale Mounted Reel	0	0	0	0	0	0	0	0	0	0	0	2	2	2	2	0	2	3	0	4	0	2	26.03	1	0.02				
	Octopus Interim	Shelter Pot	0	0	0	0	0	0	0	0	0	0	0	2	2	2	2	0	2	3	0	4	0	2	26.03	1	0.00				
		Trigger Pot	0	0	0	0	0	0	0	0	0	0	0	2	2	2	2	0	2	3	0	4	0	2	26.03	1	0.02				
	Trochus Fishery	Intertidal Hand Collection																													1
	Mackerel	Trolling	0	0	0	0	0	0	0	0	0	0	0	2	2	2	2	0	2	3	0	4	0	2	26.03	1	0.06				
		Trolling and Jigging	0	0	0	0	0	0	0	0	0	0	0	2	2	2	2	0	2	3	0	4	0	2	26.03	1	0.00				
		Jigging	0	0	0	0	0	0	0	0	0	0	0	2	2	2	2	0	2	3	0	4	0	2	26.03	1	0.00				
		Handheld Reel	0	0	0	0	0	0	0	0	0	0	0	2	2	2	2	0	2	3	0	4	0	2	26.03	1	0.00				
	Mandurah to Bunbury Developing Crab Fishery	Crab Trap	0	0	0	0	0	0	0	0	0	0	0	2	2	2	2	0	2	3	0	4	0	2	26.03	1	0.00				
	South Coast Crustacean	Crab Trap	0	0	0	0	0	0	0	0	0	0	0	2	2	2	2	0	2	3	0	4	0	2	26.03	1	0.00				
		Potting	0	0	0	0	0	0	0	0	0	0	0	2	2	2	2	0	2	3	0	4	0	2	26.03	1	0.19				
	Warnbro Sound Crab	Crab Trap	0	0	0	0	0	0	0	0	0	0	0	2	2	2	2	0	2	3	0	4	0	2	26.03	1	0.00				
	Cockburn Sound (Line and Pot)	Handheld Reel	0	0	0	0	0	0	0	0	0	0	0	2	2	2	2	0	2	3	0	4	0	2	26.03	1	0.00				
		Squid Jigging																													1
		Shelter Pot	0	0	0	0	0	0	0	0	0	0	0	2	2	2	2	0	2	3	0	4	0	2	26.03	1	0.00				
		Octopus Pot	0	0	0	0	0	0	0	0	0	0	0	2	2	2	2	0	2	3	0	4	0	2	26.03	1	0.00				
		Handline	0	0	0	0	0	0	0	0	0	0	0	2	2	2	2	0	2	3	0	4	0	2	26.03	1	0.00				
	FBL condition 74 Fish Trapping	Fish Trap	0	0	0	0	0	0	0	0	0	0	0	2	2	2	2	0	2	3	0	4	0	2	26.03	1	0.00				
																							average scores:		**28.23**	**1.07**	**28.22**				

SA	**Marine Scalefish and Miscellaneous**	**Lines**	1	1	1	0	4	1	1	0	0	1	0	2	2	2	2	0	2	3	0	4	0	2	39.73	1	0.48
		Nets	1	1	1	0	4	1	1	0	0	1	0	2	2	2	2	0	2	3	0	4	0	2	39.73	1	0.61
		Traps	0	0	0	0	0	0	0	0	0	0	0	2	2	2	2	0	2	3	0	4	0	2	26.03	1	0.01
		Other	0	0	0	0	0	0	0	0	0	0	0	2	2	2	2	0	2	3	0	4	0	2	26.03	1	0.03
	Prawn	**Trawling**	0	0	0	0	0	0	0	0	0	0	0	2	2	2	2	0	2	3	0	4	0	2	26.03	1	8.39
	Lakes and Coorong - Other	**Mostly Nets**	4	2	3	3	3	1	1	0	1	3	0	2	2	2	2	0	2	3	2	4	0	2	57.53	2	1.24
	Lakes and Coorong - Pipis	**Rakes etc.**	0	0	0	0	0	0	0	0	0	0	0	2	2	2	2	0	2	3	0	4	0	2	26.03	1	0.24
	Rock Lobster (South)	**Pots**	5	2	3	3	3	1	1	0	2	3	2	2	2	2	2	0	2	3	2	2	0	1	58.90	2	6.42
	Rock Lobster (North)	**Pots**	5	2	3	3	3	1	1	0	2	3	2	2	2	2	2	0	2	3	2	2	0	1	58.90	2	1.98
	Abalone	**Diving**	0	0	0	0	0	0	0	0	0	0	0	2	2	2	2	0	2	3	0	4	0	2	26.03	1	0.19
	Blue Crab	**Pots**	2	0	1	0	4	1	1	0	0	3	0	2	2	2	2	0	2	3	0	4	0	2	42.47	1	0.14
	Sardine	**Purse Seine**	0	0	0	0	0	0	0	0	0	0	0	2	2	2	2	0	2	3	0	4	0	2	26.03	1	12.07
	Giant Crab	**Pots**	0	0	0	0	0	0	0	0	0	0	0	2	2	2	2	0	2	3	0	4	0	2	26.03	1	0.03
	Totals																											
																							average scores:		**36.88**	**1.23**	**31.82**

C'wealth	Coral Sea	Bottom otter trawl	3	2	2	2	4	1	1	1	1	5	0	2	2	2	2	0	2	3	2	4	0	2	58.90	2	0.00				
		Dropline	3	2	2	2	4	1	1	1	1	5	2	2	2	2	2	0	2	3	2	4	0	2	61.64	2	0.00				
		Fish trap	3	2	2	2	4	1	1	1	1	5		2	2	2	2	0	2	3	2	4	0	2	58.90	2	0.00				
		General diving																													1
		Hand collection (miscellaneous)																													1
		Handline (mechanised)	0	0	0	0	0	0	0	0	0	0	0	2	2	2	2	0	2	3	0	4	0	2	26.03	1	0.00				
		Hookah diving																													1
		Hooks	0	0	0	0	0	0	0	0	0	0	0	2	2	2	2	0	2	3	0	4	0	1	24.66	1	0.00				
		Rod and reel	0	0	0	0	0	0	0	0	0	0	0	2	2	2	2	0	2	3	0	4	0	2	26.03	1	0.00				
		Set autolongline (demersal longline)	3	2	2	2	4	1	1	1	1	5	2	2	2	2	2	0	2	3	2	4	0	2	61.64	2	0.01				
		Set longline (demersal longline)	3	2	2	2	4	1	1	1	1	5	0	2	2	2	2	0	2	3	2	4	0	2	58.90	2	0.00				
		Trotline	0	0	0	0	0	0	0	0	0	0	0	2	2	2	2	0	2	3	0	4	0	1	24.66	1	0.00				
	East Coast Deep Water	Bottom otter trawl	3	2	2	2	4	1	1	1	1	5	2	2	2	2	2	0	2	3	2	4	0	2	61.64	2	0.01				
		Midwater otter trawl	3	2	2	2	4	1	1	1	1	5	2	2	2	2	2	0	2	3	2	4	0	2	61.64	2	0.01				
	Eastern Tuna and Billfish	Drifting longline (pelagic longline)	4	3	3	3	2	2	2	1	2	5	2	2	2	2	2	2	2	3	2	4	0	2	71.23	3	4.88				
		Handline (mechanised)	0	0	0	0	0	0	0	0	0	0	2	2	2	2	2	0	2	3	0	4	0	2	28.77	1	0.00				
		Pole and line	0	0	0	0	0	0	0	0	0	0	0	2	2	2	2	0	2	3	0	4	0	2	26.03	1	0.00				
		Rod and reel	0	0	0	0	0	0	0	0	0	0	0	2	2	2	2	0	2	3	0	4	0	2	26.03	1	0.00				
		Set gillnet (demersal gillnet)	0	0	0	0	0	0	0	0	0	0	0	2	2	2	2	0	2	3	0	4	0	2	26.03	1	0.00				
		Set longline (demersal longline)	0	0	0	0	0	0	0	0	0	0	0	2	2	2	2	0	2	3	0	4	0	2	26.03	1	0.00				
		Trolling	0	0	0	0	0	0	0	0	0	0		2	2	2	2	0	2	3	0	4	0	2	26.03	1	0.00				
		Trotline	0	0	0	0	0	0	0	0	0	0	0	2	2	2	2	0	2	3	0	4	0	2	26.03	1	0.00				
	Gillnet, Hook and Trap	Dropline	3	2	2	2	4	1	1	1	1	5	2	2	2	2	2	0	2	3	2	4	0	2	61.64	2	0.02				
		Fish trap	3	2	2	2	4	1	1	1	1	5	0	2	2	2	2	0	2	3	2	4	0	2	58.90	2	0.06				
		Handline (mechanised)	0	0	0	0	0	0	0	0	0	0	2	2	2	2	2	0	2	3	0	4	0	2	28.77	1	0.00				
		Hooks	0	0	0	0	0	0	0	0	0	0	0	2	2	2	2	0	2	3	0	4	0	2	26.03	1	0.00				
		Rod and reel	0	0	0	0	0	0	0	0	0	0	2	2	2	2	2	0	2	3	0	4	0	2	28.77	1	0.00				
		Set autolongline (demersal longline)	5	3	4	4	2	2	2	2	2	5	2	2	2	2	2	2	2	3	2	4	0	2	76.71	3	0.76				
		Set gillnet (demersal gillnet)	5	3	4	4	2	2	2	2	2	5	2	2	2	2	2	2	2	3	2	4	0	2	76.71	3	2.74				
		Set longline (demersal longline)	2	1	1	2	2	2	2	0	0	0	2	2	2	2	2	0	2	3	2	4	0	2	47.95	2	0.21				
		Trolling	0	0	0	0	0	0	0	0	0	0		2	2	2	2	0	2	3	0	4	0	2	26.03	1	0.00				
		Trotline	0	0	0	0	0	0	0	0	0	0	2	2	2	2	2	0	2	3	0	4	0	2	28.77	1	0.00				
	Great Australian Bight	Bottom otter trawl	5	3	4	4	2	2	2	2	2	5	2	2	2	2	2	0	2	3	2	4	0	2	73.97	3	6.08				
		Bottom otter twin trawl	0	0	0	0	0	0	0	0	0	0	2	2	2	2	2	0	2	3	0	4	0	2	28.77	1	0.01				
		Bottom pair trawl	1	1	0	0	0	0	0	0	0	5	2	2	2	2	2	0	2	3	2	4	0	2	41.10	1	0.02				
		Danish seine (trawl fishery)	1	1	0	0	0	0	0	0	0	5	2	2	2	2	2	0	2	3	2	4	0	2	41.10	1	0.33				
		Midwater otter trawl	0	0	0	0	0	0	0	0	0	0	2	2	2	2	2	0	2	3	0	4	0	2	28.77	1	0.00				
		Trawl	1	1	0	0	0	0	0	0	0	5	2	2	2	2	2	0	2	3	2	4	0	1	39.73	1	0.02				
	High Seas Non-trawl	Drifting longline (pelagic longline)	0	0	0	0	0	0	0	0	0	0	2	2	2	2	2	0	2	3	0	4	0	2	28.77	1	0.00				
		Dropline	4	3	3	3	2	2	2	1	2	5	2	2	2	2	2	0	2	3	2	4	0	2	68.49	3	0.00				
		Handline (mechanised)	0	0	0	0	0	0	0	0	0	0	2	2	2	2	2	0	2	3	0	4	0	2	28.77	1	0.00				
		Set autolongline (demersal longline)	4	3	3	3	2	2	2	1	2	5	2	2	2	2	2	0	2	3	2	4	0	2	68.49	3	0.02				
		Set longline (demersal longline)	0	0	0	0	0	0	0	0	0	0	2	2	2	2	2	0	2	3	0	4	0	2	28.77	1	0.00				

	High Seas Trawl	**Bottom otter trawl**	5	3	4	4	2	2	2	2	2	5	2	2	2	2	2	0	2	3	2	4	0	2	73.97	3	0.08				
		Midwater otter trawl	5	3	4	4	2	2	2	2	2	5	2	2	2	2	2	0	2	3	2	4	0	2	73.97	3	0.09				
	Informally Managed	**Purse seine**	0	0	0	0	0	0	0	0	0	0	2	2	2	2	2	0	2	3	0	4	0	2	28.77	1	0.01				
	Kimberley Prawn Fishery	**Bottom shrimp trawl (prawn trawl)**	0	0	0	0	0	0	0	0	0	0	0	2	2	2	2	0	2	3	0	4	0	2	26.03	1	0.08				
	North West Slope	**Bottom trawl (nephrops trawl)**	2	2	2	2	4	1	1	1	1	5	1	2	2	2	2	0	2	3	2	4	0	2	58.90	2	0.06				
	Northern Prawn	**Targeting banana prawns**	5	3	3	3	4	1	1	1	1	5	2	2	2	2	2	0	2	3	2	4	0	2	68.49	3	14.93				
		Targeting tiger prawns	5	3	3	3	4	1	1	1	1	5	2	2	2	2	2	0	2	3	2	4	0	2	68.49	3	19.44				
	Scallop	**Scallop dredge**	0	0	0	0	0	0	0	0	0	0	0	2	2	2	2	0	2	3	0	4	0	2	26.03	1	0.16				
	Small Pelagic	**Bottom otter trawl**	3	1	0	0	0	0	0	0	0	5	1	2	2	2	2	0	2	3	2	4	0	2	42.47	1	0.29				
		Midwater otter trawl	4	3	3	3	2	2	2	1	2	5	2	2	2	2	2	0	2	3	2	4	0	2	68.49	3	0.49				
		Purse seine	2	1	1	1	0	1	1	1	1	5	2	2	2	2	2	0	2	3	2	4	0	2	50.68	2	0.07				
		Squid jigs (mechanised)																													1
	South East Trawl	**Bottom otter trawl**	5	3	4	4	2	2	2	2	2	5	2	2	2	2	2	0	2	3	2	4	0	2	73.97	3	11.68				
		Bottom pair trawl	1	1	0	0	0	0	0	0	0	5	2	2	2	2	2	0	2	3	2	4	0	1	39.73	1	0.00				
		Danish seine (trawl fishery)	5	3	4	4	2	2	2	2	2	5	2	2	2	2	2	0	2	3	2	4	0	2	73.97	3	4.43				
		Midwater otter trawl	5	3	4	4	2	2	2	2	2	5	2	2	2	2	2	0	2	3	2	4	0	2	73.97	3	0.19				
		Set gillnet (demersal gillnet)	0	0	0	0	0	0	0	0	0	0	2	2	2	2	2	0	2	3	0	4	0	2	28.77	1	0.00				
	Southern Bluefin Tuna	**Dropline**	0	0	0	0	0	0	0	0	0	0	0	2	2	2	2	0	2	3	0	4	0	2	26.03	1	0.00				
		Handline (mechanised)	0	0	0	0	0	0	0	0	0	0	0	2	2	2	2	0	2	3	0	4	0	2	26.03	1	0.00				
		Pole and line	0	0	0	0	0	0	0	0	0	0	0	2	2	2	2	0	2	3	0	4	0	2	26.03	1	0.00				
		Purse seine	5	3	4	4	2	2	2	2	2	5	2	2	2	2	2	0	2	3	2	4	0	2	73.97	3	1.99				
		Rod and reel	0	0	0	0	0	0	0	0	0	0	0	2	2	2	2	0	2	3	0	4	0	2	26.03	1	0.00				
		Trolling	0	0	0	0	0	0	0	0	0	0	0	2	2	2	2	0	2	3	0	4	0	2	26.03	1	0.00				
	Squid Jig	**Squid jigs (mechanised)**																													1
	Torres Strait	**Dropline**	0	0	0	0	0	0	0	0	0	0	0	2	2	2	2	0	2	3	0	4	0	2	26.03	1	0.00				
		Free diving																													1
		General diving																													1
		Hand collection (miscellaneous)																													1
		Handline (hand operated)	0	0	0	0	0	0	0	0	0	0	0	2	2	2	2	0	2	3	0	4	0	2	26.03	1	0.00				
		Hooks	0	0	0	0	0	0	0	0	0	0	0	2	2	2	2	0	2	3	0	4	0	2	26.03	1	0.00				
		Trolling	0	0	0	0	0	0	0	0	0	0		2	2	2	2	0	2	3	0	4	0	2	26.03	1	0.01				
	Torres Strait Prawn	**Bottom shrimp trawl (prawn trawl)**	5	3	4	4	2	2	2	2	2	5	0	2	2	2	2	0	2	3	2	4	0	2	71.23	3	0.16				
	Western Deep Water	**Bottom otter trawl**	1	1	0	0	0	0	0	0	0	5	2	2	2	2	2	0	2	3	2	4	0	2	41.10	1	0.01				
		Bottom pair trawl	0	0	0	0	0	0	0	0	0	0	2	2	2	2	2	0	2	3	0	4	0	2	28.77	1	0.03				
		Danish seine (trawl fishery)	0	0	0	0	0	0	0	0	0	0	0	2	2	2	2	0	2	3	0	4	0	2	26.03	1	0.00				
	Western Tuna and Billfish	**Drifting longline (pelagic longline)**	0	0	0	0	0	0	0	0	0	0	0	2	2	2	2	0	2	3	0	4	0	2	26.03	1	0.14				
		Handline (mechanised)	0	0	0	0	0	0	0	0	0	0	0	2	2	2	2	0	2	3	0	4	0	2	26.03	1	0.00				
		Hooks	0	0	0	0	0	0	0	0	0	0	0	2	2	2	2	0	2	3	0	4	0	2	26.03	1	0.00				
		Pole and line	0	0	0	0	0	0	0	0	0	0	0	2	2	2	2	0	2	3	0	4	0	2	26.03	1	0.00				
		Trolling	0	0	0	0	0	0	0	0	0	0		2	2	2	2	0	2	3	0	4	0	2	26.03	1	0.00				
																							average scores:		**42.67**	**1.59**	**69.56**				
	1 - assumes zero discards and no need to quantify discards and therefore a quality metric is not applicable																														

Appendix 2

Spreadsheet used to score TEPS data according to the US Tier Classification system.

			Adequacy of Bycatch Data																		Quality of the Bycatch Estimate								
			Observer Data										Industry Data	Supplementary Data						Database/IT	Analytical Approach								
			Longevity of Observer Data	Sampling Frame	Sampling Design of Vessels	Sampling Design of Trips	Sampling Design of Hauls	Spatial Coverage	Temporal Coverage	Vessel-Selection Bias	Observer Bias	Data Quality Control	Score	Data available as expansion factors for unobserved components	Data available for stratification	Data available for imputation	Data available for model covariates	Industry data verified	Score	Assumptions Identified, Tested, and Appropriate	Peer Reviewed / Published Design	Peer Reviewed / Published Analytical Approach	Statistical Bias of Estimators	Measures of Uncertainty	TOTAL	% score	Tier:	Note
Maximum Scores			**5**	**3**	**4**	**4**	**4**	**2**	**2**	**2**	**2**	**5**	**2**	**2**	**2**	**2**	**2**	**2**	**2**	**10**	**4**	**4**	**4**	**4**	**73**	**100**		
NSW	**Estuary General**	**Meshing net**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0	
		Hauling net (general purpose)	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	2	0	0	0	0	0	4	5.48	1	
		Prawn net (set pocket)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0	
		Crab trap	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	2	0	0	0	0	0	4	5.48	1	
		Fish trap (bottom/demersal)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0	
		Flathead net	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0	
		Eel trap	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0	
		Prawn net (hauling)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0	
		Handgathering																										1
		Prawn running net	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0	
		Seine net (prawns)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0	
		Bait net																										1
		Garfish net (bullringing)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0	
		Handline	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0	
		Pilchard, anchovy & bait net - beach based	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0	
		Setline	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0	
		Dip or scoop net (prawns)																										1
		Hoop or lift net																										1
	Estuary Prawn Trawl	**Otter trawl net (prawns)**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0	
	Ocean Trawl	**Otter trawl net (prawns)**	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	2	0	0	0	0	0	4	5.48	1	
		Otter trawl net (fish)	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	2	0	0	0	0	0	4	5.48	1	
	Ocean Hauling	**Hauling net (general purpose)**	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	2	0	0	0	0	0	4	5.48	1	
		Purse seine net	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0	
		Pilchard, anchovy & bait net - beach based	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0	
		Garfish net (hauling) - boat based	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0	
		Garfish net (hauling) - beach based	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0	
	Ocean Trap & Line	**Fish trap (bottom/demersal)**	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	2	2.74	1	
		Handline	2	3	2	3	3	2	2	1	2	3	2	0	0	0	0	0	1	1	1	1	0	0	29	39.73	1	
		Trolling	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	2	2.74	1	
		Setline (demersal)	2	3	2	3	3	2	2	1	2	3	2	0	0	0	0	0	1	1	1	1	0	0	29	39.73	1	
		Spanner crab net	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	2	2.74	1	
		Jigging	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0	
		Dropline	2	3	2	3	3	2	2	1	2	3	2	0	0	0	0	0	1	1	1	1	0	0	29	39.73	1	
		Setline	2	3	2	3	3	2	2	1	2	3	0	0	0	0	0	0	1	1	1	1	0	0	27	36.99	1	
		Poling	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0	
		Trotline (bottom set)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0	
		Driftline	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0	
	Abalone	**Diving**																										1
	Lobster	**Trapping**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0	
	Others	**Danish seine trawl net (fish)**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0	
		Pilchard, anchovy & bait net - boat based	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0	
		Skindiving																										1
	Special Permits	**Purse seine net**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0	
		Scallop Dredge	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0	
		Submersible Lift Net	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0	
		Eel trap	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0	
																							average scores:		**3.50**	**4.79**	**0.30**	

Tasmania	Abalone	Dive																											1
	Southern Rock Lobster	Pots	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	1	0	0	0	0	0	3	4.11	1		
	Scallop	Dredge	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	1	0	0	0	0	0	3	4.11	1		
	Octopus	Pots (unbaited)	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	1	0	0	0	0	0	3	4.11	1		
	Giant Crab	Pots	4	2	0	0	0	2	2	2	2	3	2	0	0	0	0	0	2	0	0	2	0	0	23	31.51	1		
		Automatic squid jig																											1
		Beach seine	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	1	0	0	0	0	0	3	4.11	1		
		Purse seine	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	1	0	0	0	0	0	3	4.11	1		
		Graball net	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	1	0	0	0	0	0	3	4.11	1		
		Hand line	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	1	0	0	0	0	0	3	4.11	1		
		Danish seine	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	1	0	0	0	0	0	3	4.11	1		
	Scalefish	Squid-jig																											1
		Dip-net																											1
		Small mesh net	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	1	0	0	0	0	0	3	4.11	1		
		Troll	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	1	0	0	0	0	0	3	4.11	1		
		Fish trap	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	1	0	0	0	0	0	3	4.11	1		
		Drop-line	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	1	0	0	0	0	0	3	4.11	1		
		Spear																											1
		Hand collection																											1
	Commercial Dive and Shellfish	Hand Collection																											1
																								average scores:		4.54	6.22	1.00	
NT		Demersal	5	0	0	0	0	0	0	0	0	2	2	0	0	0	0	0	2	0	0	0	0	0	11	15.07	1		
		Timor Reef	5	0	0	0	0	0	0	0	0	2	2	0	0	0	0	0	2	0	0	0	0	0	11	15.07	1		
		Barramundi	5	0	0	0	0	0	0	0	0	2	2	0	0	0	0	0	2	0	0	0	0	0	11	15.07	1		
		Offshore Net and Line	5	0	0	0	0	0	0	0	0	2	2	0	0	0	0	0	2	0	0	0	0	0	11	15.07	1		
		Spanish Mackerel	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	2	0	0	0	0	0	4	5.48	1		
		Mud Crab	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	2	0	0	0	0	0	4	5.48	1		
		Coastal line	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	2	0	0	0	0	0	4	5.48	1		
		Trepang																											1
		Restricted Bait																											1
		Aquarium Display																											1
		Coastal net	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	2	0	0	0	0	0	4	5.48	1		
																								average scores:		7.50	10.27	1.00	
QLD		Coral																											1
		Crayfish and Rocklobster	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	1	0	0	0	0	0	3	4.11	1		
		East Coast Pearl																											1
		Marine Aquarium Fish																											1
		Eel Fishery	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	1	0	0	0	0	0	3	4.11	1		
		Sea Cucumber Fishery (East Coast)																											1
		Trochus																											1
		Coral Reef Finfish	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	1	0	0	0	0	0	3	4.11	1		
		Deep Water Finfish	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	1	0	0	0	0	0	3	4.11	1		
		East Coast Spanish Mackerel	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	1	0	0	0	0	0	3	4.11	1		
		Gulf of Carpentaria Line	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	1	0	0	0	0	0	3	4.11	1		
		Rocky Reef Finfish	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	1	0	0	0	0	0	3	4.11	1		
		East Coast Inshore Finfish Fishery	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	1	0	0	0	0	0	3	4.11	1		
		Gulf of Carpentaria Inshore Finfish	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	1	0	0	0	0	0	3	4.11	1		
		Blue Swimmer Crab	2	2	1	1	1	1	1	0	0	2	2	0	0	0	0	0	1	0	0	0	0	0	14	19.18	1		
		Mud Crabs	2	2	1	1	1	1	1	0	0	2	2	0	0	0	0	0	1	0	0	0	0	0	14	19.18	1		
		Spanner Crabs	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	1	0	0	0	0	0	3	4.11	1		
		East Coast Otter Trawl	3	2	3	2	3	2	2	0	2	2	2	2	0	0	0	0	1	1	2	2	0	2	33	45.21	2		
		Gulf of Carpentaria Developmental Fin Fish Trawl	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	1	0	0	0	0	0	3	4.11	1		
		River and Inshore Beam Trawl	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	1	0	0	0	0	0	3	4.11	1		
																								average scores:		6.47	8.86	1.07	

Victoria	Abalone	Dive																											1
	Rock Lobster	Pots	4	2	3	3	3	1	1	1	2	4	2	0	2	1	2	1	0	2	2	0	0	2	38	52.05	2	
	Ocean (General)	Drop Line	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	1	0	0	0	0	0	3	4.11	1	
		Hand Line	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	1	0	0	0	0	0	3	4.11	1	
		Shark Long Line	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	1	0	0	0	0	0	3	4.11	1	
		Snapper Long Line	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	1	0	0	0	0	0	3	4.11	1	
		Octopus Trap/Pot	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	1	0	0	0	0	0	3	4.11	1	
	Westernport/Port Phillip Bay	Haul Seine	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	1	0	0	0	0	0	3	4.11	1	
		Multifilament Mesh	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	1	0	0	0	0	0	3	4.11	1	
		Snapper Long Line	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	1	0	0	0	0	0	3	4.11	1	
		Purse Seine	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	1	0	0	0	0	0	3	4.11	1	
		Garfish Seine	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	1	0	0	0	0	0	3	4.11	1	
	Corner Inlet	Ringing Seine	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	1	0	0	0	0	0	3	4.11	1	
		Multifilament Mesh	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	1	0	0	0	0	0	3	4.11	1	
		Haul Seine	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	1	0	0	0	0	0	3	4.11	1	
	Bait (General)	Bait Pump																										1
		Yabbie Pot																										1
	Eel	Fyke net	0	0	0	0	0	0	0	0	0	0	2	1	0	1	0	0	1	0	0	0	0	0	5	6.85	1	
	Gippsland Lakes	Multifilament Mesh	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	1	0	0	0	0	0	3	4.11	1	
		Prawn Stake Net	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	1	0	0	0	0	0	3	4.11	1	
	Trawl (Inshore)	Prawn Trawl	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	1	0	0	0	0	0	3	4.11	1	
	Gippsland Lakes (Bait)	Bait Pump																										1
	General (Sea Urchin)	Dive																										1
	Wrasse (Ocean)	Handline	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	1	0	0	0	0	0	3	4.11	1	
	Giant Crab	Pots	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	1	0	0	0	0	0	3	4.11	1	
																							average scores:		4.85	6.64	1.05	

WA	West Coast Rock Lobster	Potting	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	2	0	0	0	0	0	4	5.48	1	
	South Coast Purse-Seine	Purse Seine	4	2	2	2	2	2	2	2	2	3	2	1	1	2	2	0	2	0	0	0	0	0	33	45.21	2	
	Shark Bay Prawn	Trawling	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	2	0	0	0	0	0	4	5.48	1	
	Northern Demersal Scalefish Fishery	Fish Trap	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	2	0	0	0	0	0	4	5.48	1	
	Joint Authority Southern Demersal Gillnet and Demersal Longline	Gillnet	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	2	0	0	0	0	0	4	5.48	1	
		Longline	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	2	0	0	0	0	0	4	5.48	1	
	Pilbara Fish Trawl (Interim)	Trawling	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	2	0	0	0	0	0	4	5.48	1	
	Exmouth Gulf Prawn	Trawling	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	2	0	0	0	0	0	4	5.48	1	
	Shark Bay Scallop	Trawling	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	2	0	0	0	0	0	4	5.48	1	
	FBL condition 93 Purse Seine Development Zone	Purse Seine	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	2	0	0	0	0	0	4	5.48	1	
	Abrolhos Islands and Mid West Trawl	Trawling	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	2	0	0	0	0	0	4	5.48	1	
	Pilbara Trap	Fish Trap	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	2	0	0	0	0	0	4	5.48	1	
	Kimberley Prawn	Trawling	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	2	0	0	0	0	0	4	5.48	1	
	Abalone	Diving	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	2	0	0	0	0	0	4	5.48	1	
	Shark Bay Crab	Crab Trap	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	2	0	0	0	0	0	4	5.48	1	
		Trawling	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	2	0	0	0	0	0	4	5.48	1	
	Pearl Oyster	Diving																										1
	West Coast Purse Seine Fishery	Purse Seine	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	2	0	0	0	0	0	4	5.48	1	
	FBL condition 73 South Coast Trawl Fishery	Trawling	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	2	0	0	0	0	0	4	5.48	1	
	Nickol Bay Prawn	Trawling	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	2	0	0	0	0	0	4	5.48	1	
	South Coast Salmon	Beach Seine	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	2	0	0	0	0	0	4	5.48	1	
	Shark Bay Beach Seine and Mesh Net	Beach Seine	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	2	0	0	0	0	0	4	5.48	1	
		Haul Net / Ring Net	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	2	0	0	0	0	0	4	5.48	1	
	Kimberley Gillnet and Barramundi	Gillnet	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	2	0	0	0	0	0	4	5.48	1	
	West Coast Demersal Gillnet and Demersal Longline (Interim)	Gillnet	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	2	0	0	0	0	0	4	5.48	1	
		Longline	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	2	0	0	0	0	0	4	5.48	1	
	South West Coast Beach Net Fishery (Order)	Beach Seine	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	2	0	0	0	0	0	4	5.48	1	
	West Coast Estuarine	Crab Trap	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	2	0	0	0	0	0	4	5.48	1	
		Gillnet	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	2	0	0	0	0	0	4	5.48	1	
		Haul Net / Ring Net	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	2	0	0	0	0	0	4	5.48	1	
	FBL condition 42 herring	Trap Net																										1
	South West Coast Salmon	Beach Seine	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	2	0	0	0	0	0	4	5.48	1	
	South West Trawl Fishery	Trawling	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	2	0	0	0	0	0	4	5.48	1	
	West Coast Demersal Scalefish (Interim)	Dropline	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	2	0	0	0	0	0	4	5.48	1	
		Dropline and Hydraulic Gunwhale Mounted Reel	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	2	0	0	0	0	0	4	5.48	1	
		Handheld Reel and Dropline	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	2	0	0	0	0	0	4	5.48	1	
		Gunwhale Mounted Hand Operated Reel	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	2	0	0	0	0	0	4	5.48	1	
		Electric Gunwhale Mounted Reel	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	2	0	0	0	0	0	4	5.48	1	
		Hydraulic Gunwhale Mounted Reel	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	2	0	0	0	0	0	4	5.48	1	
		Handheld Reel	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	2	0	0	0	0	0	4	5.48	1	
	West Coast Deep Sea Crustacean	Crab Trap	4	2	3	3	3	2	2	2	2	3	2	2	2	2	2	2	2	3	0	4	0	2	49	67.12	3	
		Potting	4	2	3	3	3	2	2	2	2	3	2	2	2	2	2	2	2	3	0	4	0	2	49	67.12	3	
	Cockburn Sound (Crab)	Crab Trap	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	2	0	0	0	0	0	4	5.48	1	
	West Australian Sea Cucumber Fishery	Diving																										1
	Open Access in the North Coast, Gascoyne Coast and West Coast Bioregions	Beach Seine	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	2	0	0	0	0	0	4	5.48	1	
		Potting	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	2	0	0	0	0	0	4	5.48	1	
		Squid Jigging																										1
		Gillnet	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	2	0	0	0	0	0	4	5.48	1	
		Hydraulic Gunwhale Mounted Reel	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	2	0	0	0	0	0	4	5.48	1	
		Haul Net / Ring Net	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	2	0	0	0	0	0	4	5.48	1	

	Open Access in the South Coast Bioregion	Beach Seine	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	2	0	0	0	0	0	4	5.48	1			
		Haul Net / Ring Net	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	2	0	0	0	0	0	4	5.48	1			
		Handline	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	2	0	0	0	0	0	4	5.48	1			
		Trolling																												1
		Gillnet	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	2	0	0	0	0	0	4	5.48	1			
		Squid Jigging																												1
		Electric Gunwhale Mounted Reel	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	2	0	0	0	0	0	4	5.48	1			
		Gunwhale Mounted Hand Operated Reel	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	2	0	0	0	0	0	4	5.48	1			
		Handheld Reel	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	2	0	0	0	0	0	4	5.48	1			
		Hydraulic Gunwhale Mounted Reel	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	2	0	0	0	0	0	4	5.48	1			
		Dropline	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	2	0	0	0	0	0	4	5.48	1			
	South Coast Estuarine	Crab Trap	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	2	0	0	0	0	0	4	5.48	1			
		Fish Trap	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	2	0	0	0	0	0	4	5.48	1			
		Haul Net / Ring Net	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	2	0	0	0	0	0	4	5.48	1			
		Gillnet	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	2	0	0	0	0	0	4	5.48	1			
	Gascoyne Demersal Scalefish	Electric Gunwhale Mounted Reel	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	2	0	0	0	0	0	4	5.48	1			
		Gunwhale Mounted Hand Operated Reel	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	2	0	0	0	0	0	4	5.48	1			
		Handheld Reel	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	2	0	0	0	0	0	4	5.48	1			
		Hydraulic Gunwhale Mounted Reel	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	2	0	0	0	0	0	4	5.48	1			
	Pilbara Line Fishery (Condition)	Electric Gunwhale Mounted Reel	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	2	0	0	0	0	0	4	5.48	1			
		Handheld Reel	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	2	0	0	0	0	0	4	5.48	1			
		Hydraulic Gunwhale Mounted Reel	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	2	0	0	0	0	0	4	5.48	1			
	Octopus Interim	Shelter Pot	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	2	0	0	0	0	0	4	5.48	1			
		Trigger Pot	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	2	0	0	0	0	0	4	5.48	1			
	Trochus Fishery	Intertidal Hand Collection																												1
	Mackerel	Trolling	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	2	0	0	0	0	0	4	5.48	1			
		Trolling and Jigging	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	2	0	0	0	0	0	4	5.48	1			
		Jigging	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	2	0	0	0	0	0	4	5.48	1			
		Handheld Reel	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	2	0	0	0	0	0	4	5.48	1			
	Mandurah to Bunbury Developing Crab Fishery	Crab Trap	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	2	0	0	0	0	0	4	5.48	1			
	South Coast Crustacean	Crab Trap	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	2	0	0	0	0	0	4	5.48	1			
		Potting	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	2	0	0	0	0	0	4	5.48	1			
	Warnbro Sound Crab	Crab Trap	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	2	0	0	0	0	0	4	5.48	1			
	Cockburn Sound (Line and Pot)	Handheld Reel	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	2	0	0	0	0	0	4	5.48	1			
		Squid Jigging																												1
		Shelter Pot	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	2	0	0	0	0	0	4	5.48	1			
		Octopus Pot	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	2	0	0	0	0	0	4	5.48	1			
		Handline	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	2	0	0	0	0	0	4	5.48	1			
	FBL condition 74 Fish Trapping	Fish Trap	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	2	0	0	0	0	0	4	5.48	1			
																								average scores:		5.47	7.49	1.06		

SA	Marine Scalefish and Miscellaneous	Lines	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	2	0	0	0	0	0	4	5.48	1		
		Nets	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	2	0	0	0	0	0	4	5.48	1		
		Traps	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	2	0	0	0	0	0	4	5.48	1		
		Other	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	2	0	0	0	0	0	4	5.48	1		
	Prawn	Trawling	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	2	0	0	0	0	0	4	5.48	1		
	Lakes and Coorong - Other	Mostly Nets	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	2	0	0	0	0	0	4	5.48	1		
	Lakes and Coorong - Pipis	Rakes etc.	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	2	0	0	0	0	0	4	5.48	1		
	Rock Lobster (South)	Pots	5	2	3	3	3	1	1	0	2	3	2	2	2	2	2	0	2	3	2	2	0	1	43	58.90	1		
	Rock Lobster (North)	Pots	5	2	3	3	3	1	1	0	2	3	2	2	2	2	2	0	2	3	2	2	0	1	43	58.90	1		
	Abalone	Diving	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	2	0	0	0	0	0	4	5.48	1		
	Blue Crab	Pots	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	2	0	0	0	0	0	4	5.48	1		
	Sardine	Purse Seine	4	3	2	2	4	2	2	2	1	1	2	2	2	2	2	2	2	5	0	3	2	2	49	67.12	3		
	Giant Crab	Pots	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	2	0	0	0	0	0	4	5.48	1		
	Totals																												
																							average scores:		13.46	18.44	1.15		
C'wealth	Coral Sea		3	2	1	1	0	1	1	1	1	3	2	2	0	2	0	0	2	2	0	0	1	0	25	34.25	1		
	East Coast Deep Water		4	3	3	3	2	2	2	1	2	4	2	2	0	2	0	0	2	2	0	0	1	0	37	50.68	2		
	Eastern Tuna and Billfish		5	3	4	4	2	2	2	2	2	5	2	2	0	2	0	2	2	6	0	0	1	3	51	69.86	3		
	Gillnet, Hook and Trap		5	3	4	4	2	2	2	2	2	5	2	2	0	2	0	2	2	6	0	0	1	3	51	69.86	3		
	Great Australian Bight		4	3	3	3	2	2	2	1	2	4	2	2	0	2	0	0	2	3	0	0	1	3	41	56.16	2		
	High Seas		3	2	1	1	0	1	1	1	1	3	2	2	0	2	0	0	2	3	0	0	1	3	29	39.73	1		
	North West Slope		3	2	1	1	0	1	1	1	1	3	2	2	0	2	0	0	2	4	0	0	1	3	30	41.10	1		
	Northern Prawn		5	3	4	4	2	2	2	2	2	5	2	2	0	2	0	0	2	6	0	0	1	3	49	67.12	3		
	Scallop		1	1	0	0	0	0	0	0	0	3	2	2	0	2	0	0	2	2	0	0	1	0	16	21.92	1		
	Small Pelagic		4	3	3	3	2	2	2	1	2	4	2	2	0	2	0	0	2	3	0	0	1	3	41	56.16	2		
	South East Trawl		5	3	4	4	2	2	2	2	2	5	2	2	0	2	0	0	2	6	0	0	1	3	49	67.12	3		
	Southern Bluefin Tuna		3	2	1	1	0	1	1	1	1	3	2	2	0	2	0	0	2	6	0	0	1	0	29	39.73	1		
	Torres Strait Prawn		4	3	3	3	2	2	2	1	2	4	2	2	0	2	0	0	2	6	0	0	1	3	44	60.27	2		
	Western Deep Water		1	1	0	0	0	0	0	0	0	3	2	2	0	2	0	0	2	2	0	0	1	0	16	21.92	1		
	Western Tuna and Billfish		3	2	1	1	0	1	1	1	1	3	2	2	0	2	0	0	2	3	0	0	1	3	29	39.73	1		
																							average scores:		35.80	49.04	1.80		
	1 - assumes zero discards and no need to quantify discards and therefore a quality metric is not applicable																												