FRDC
FISHERIES RESEARCH & DEVELOPMENT CORPORATION

Practicing aquatic animal welfare:
Identifying and mitigating obstacles to uptake and adoption by the Australian Seafood Industry

Dr. Nicole (Nicki) Mazur

Mr Andy Bodsworth

March 2022

FRDC Project No 2019-023

ISBN **[978-0-646-85763-3]**

Practicing aquatic animal welfare: Identifying and mitigating obstacles to uptake and adoption of aquatic animal welfare practices by the Australian Seafood Industry
FRDC 2019-023

2022

This publication (and any information sourced from it) should be attributed to; Mazur, N. & A. Bodsworth. 2022. *Practicing aquatic animal welfare: Identifying and mitigating obstacles to uptake and adoption of aquatic animal welfare practices by the Australian Seafood Industry.* Canberra. March.

Researcher Contact Details
Name: Nicole Mazur
Address: Canberra, ACT 20602
Phone: 0409 032 284
Email: nickimazur@grapevine.net.au

FRDC Contact Details
Address: 25 Geils Court
Deakin ACT 2600
Phone: 02 6122 2100
Email: frdc@frdc.com.au
Web: www.frdc.com.au

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

Contents

Tables

Figures

Acknowledgments

This research was funded by Fisheries Research and Development Corporation (FRDC) . The FRDC is a co-funded partnership between the Australian Government and the seafood industry. The FRDC plans and invests in fisheries research, development and extension activities in Australia that assists in the sustainable management of fisheries and aquaculture resources. The aim of the FRDC HDR is to inform responses to social and economic challenges facing fisheries and aquaculture by facilitating targeted and appropriate social science and economics RD&E. The research was identified as a high priority by FRDC's Human Dimensions Research (HDR) subprogram. The aim of the FRDC HDR is to inform responses to social and economic challenges facing fisheries and aquaculture by facilitating targeted and appropriate social science and economics RD&E.

The Project Team sincerely thank the following people who provided us with their invaluable support and industry insights:

- Brett McCallum
- Josiah Pitt
- Sevaly Sen
- Lowri Price
- Emily Ogier
- Carolyn Stewardson

And a hearty thanks to the fishers, business owners, industry association officers, and consulting scientists who took time out of their busy schedules to participate in this Project's interview process.

Abbreviations

AW - Animal welfare

AAW - Aquatic animal welfare

AAWS – Australian Animal Welfare Strategy

AAWWG – Aquatic animal welfare working group established under the Australian Animal Welfare Strategy (AAWS)

BRD – Bycatch reduction device

DAWE – Department of Agriculture Water & Environment

FRDC – Fisheries Research and Development Corporation

SIA – Seafood Industry Australia

TEPS - Threatened endangered and protected species

SLO – Social license to operate

Executive Summary

This FRDC funded research[1] focuses on the obstacles to, and drivers of, positive practice change relating to aquatic animal welfare (AAW) in Australia's wild-catch commercial fishing and finfish aquaculture sectors. It was conducted between December 2019 and March 2022 in response to growing societal expectations that production animals, including fish and crustaceans, be treated humanely[2]; and the need to understand how the Australian seafood industry can, and should, respond.

The Project Team used an innovative and practical framework on practice change uptake and adoption to guide a desk-top literature review, consultations with CEOs of key seafood industry associations, and qualitative interviews with commercial fishers, aquaculture operators, and fisheries experts. The Team investigated the range of current AAW practices currently being used by fishers, as well as way to improve uptake and adoption of best practice across the industry.

Background

Societal expectations that animals produced for food, including aquatic animals, are treated humanely are growing stronger. Achieving animal welfare practices that are based in science and are socially acceptable has been recognised by Australia's governments as an important objective. High profile controversies affecting market and resource access in primary industries based on terrestrial and marine animals (e.g., live export, turtle bycatch) illustrate how important it is for these industries to assess existing animal welfare (AW) practices, encourage uptake of best practices, and aim to continually improve AW performance to enhance their social acceptability.

Since the Australian Animal Welfare Strategy's (AAWS) release in 2005, the Department of Agriculture, Water and Environment and FRDC have invested in numerous research projects and other initiatives to help the seafood industry address AAW matters. Most recently, the AAWWG called for greater and more coordinated industry actions that are proactive and clearly demonstrate industry's intentions to improve AAW practices and ensure wider adoption.

This Project was funded to look at what may be constraining parts of the wild-catch commercial fishing and finfish aquaculture sectors of the broader seafood industry from taking up AAW practice change.

Project objectives

The overarching aim of this project was to improve the uptake and adoption of AAW in Australia's seafood industry by:

1. Identifying best practice in (aquatic) animal welfare
2. Identify the extent to which fishers and finfish aquaculture farms are applying best practice in Australia
3. Identify factors impeding the uptake and adoption of a selection of recommended aquatic animal welfare practices in wild-catch commercial fishing and finfish aquaculture
4. Identify appropriate strategies to mitigate obstacles to improved uptake and adoption of those recommended practices
5. Help build the Australian seafood industry's capacity to design and implement extension programs, especially those targeting increased uptake and adoption of recommended aquatic animal welfare practices

[1] The research was undertaken by Dr. Nicole (Nicki) Mazur of ENVision Environmental Consulting, with support from Andy Bodsworth of Cobalt MRM P/L; and guided by the FRDC's Human Dimensions Research Subprogram (FRDC HDR).
[2] The Project assumes that the terms 'humane' or 'humanely' are equal to current best practice aquatic animal welfare standards.

6. Contribute to increased likelihood of more widespread and enduring practice-change in the seafood industry's aquatic animal welfare practices in wild-catch commercial fishing and finfish aquaculture

The information collected will contribute to increased likelihood of more widespread and enduring practice change in wild-catch commercial fishing, and in finfish aquaculture.

Methodology

A mixed-method approach was used to collect qualitative data and information, including a desk-top review, stakeholder consultations (23), and in-depth interviews (16). The selected animal welfare topics and associated industry sectors investigated were based on extensive consultation with seafood industry leaders and experts and the final subset endorsed by FRDC. Those topics were investigated using an uptake and adoption framework that groups different influencing factors into four categories. Three of those categories can be framed as questions seafood producers might ask themselves when considering how – if at all – they might use a recommended practice:

- **Do I/we want to do it?** (*How well does it fit with what I/we believe in?/ What's in it for me/us?*);
- **Will it work?** (*What are its relative advantages?)*;
- **Can I/we do it?** (*Do I have what I/we need to use it?*).

The fourth category is **External factors**.

Results

This Project identified a range of AAW practices used by some seafood producers that they believed to be 'humane' (see Table 1). The Project also identified some factors enabling and impeding seafood producers' approaches[3] (see Table 1). Key factors supporting AAW uptake and adoption included a seafood producers' openness to change and interest in learning, the relative advantages of using recommended practices, well designed and resourced extension, and positive relationships across industry, government and interest group networks.

Table 1. Key factors influencing seafood producers' 'welfare' practices

Fishery and select AAW practices	Key enabling factors	Key obstacles
Rock Lobster (Southern, Eastern zones) *Careful handling to avoid stress, broken limbs; holding procedures that avoid crowding and use optimal water quality*	Pride in doing one's job well; strong interest in learning and willingness to embrace change; belief in animal sentience; price premiums for well-handled animals	Seeing lobsters more as commodities than live animals; resistance to change; codes/guidelines insufficient; bycatch reduction devices (BRDs) can incur additional costs; insufficient deck space on vessels; lack of regulation mandating AAW
Mud Crab (NT Fishery, some Blue Swimmer Crab NSW) *Tying claws to prevent fighting and damage*	Fishers' pride in quality product; self-taught and observational learning; less stressed crabs with longer shelf life and price premiums; flexible, inclusive extension programs and materials targeting fishers' cultural and practical needs; strong networks across supply chain; social acceptability pressures	Conservative values and resistance to change; lack of AAW skills and training; low awareness of AAW and associated support materials; outdated AAW codes/guidelines; crab leg tying time consuming
Target shark fishery and Shark by-catch (NT Offshore Net and Line, Pilbara Ocean Trawl)	Fishers' awareness of and willingness to work within rules; economic efficiencies of selective fishing gear and BRD usage; regular information exchange across stakeholder networks; highly regulated fisheries	Suppressed fisher morale from fisheries reforms; difficulty and danger of releasing shark bycatch and slaughter target shark catch; substantive knowledge gaps; reactive and frequent fisheries reforms

[3] A subset of Australian fisheries was identified by the Project Team and Stakeholder Advisory panel, and endorsed by FRDC staff. They are not necessarily representative of the broader Australian seafood industry.

Quick removal of target and non-target catch from net, humane slaughter of target catch		
Trawl *(Northern, Southern, Western Prawn)* *Bycatch reduction, maximising survivability of non-target catch*	Fishery leaders' and fishers' belief in 'rightness' of humane methods; being able to use BRDs and still meet profit goals; BRDs' ease of use, trialability, effectiveness; historical success of BRD extension approaches (e.g., pre-season skipper briefings); improved social acceptability; certification programs requiring minimal bycatch; highly managed and researched fishery	Resistance to change by some fishers; low awareness of AAW; potential catch loss; cost of equipment; some outdated or no codes of practice; difficulties running trials; lack of deck space on some vessels
Seine *(Purse, Beach, Danish)(NSW General Estuary, others)* *Ice slurry for slaughter*, careful and minimal handling of catch generally*	Fishers' belief in caring for their catch and being responsive to public concerns; fishers' enthusiasm for learning; improved fishing technologies (effective, efficient); price premiums for well-handled fish; strong extension programs; healthy social networks (intra-industry, inter-agency/industry); public interest in AAW	Conservative values and resistance to change; low awareness of AAW; high volume catches; poor relationships with conservation NGOs; time consuming governmental procedures; Co-ops' pooled pricing policies driving high volume versus high quality catches; insufficient research on fishery restructures
Hook & Line *(NSW Trap and Line)* *Iki jime/spiking** or percussion stunning for slaughter*	Fishers' belief in respecting their catch; fishers' skills in using/adjusting fishing equipment; premium prices for well-handled catch; participation in quality extension programs; access to well-trained staff and well-designed fishing vessel; active in industry networks; buyer and consumer awareness of humane handling and quality fish products	Fishers' resistance to change; cost of additional crew; high volume catches; inadequate design of extension; lack of industry discussion about AAW; poor weather and rough seas

**There is still considerable debate about how humane it is to use ice slurry to slaughter some fish and crustaceans (e.g. finfish, prawns).*
***Iki jime is spiking the fish's brain to cause immediate death, which also maximises flesh quality and storage life.*

This summarised data inadvertently hides important details needed to formulate strategies to address AAW challenges in different fisheries and regions. Figure 1 provides a 'road map' to help time-poor readers of this Report find the Project data at different topics and levels of detail – with **a hyperlink** for each of the designated tables and appendices, which are listed according to decreasing amount of detail.

Figure 1. Project report locations for data on obstacles to & enablers of best-practice AAW.

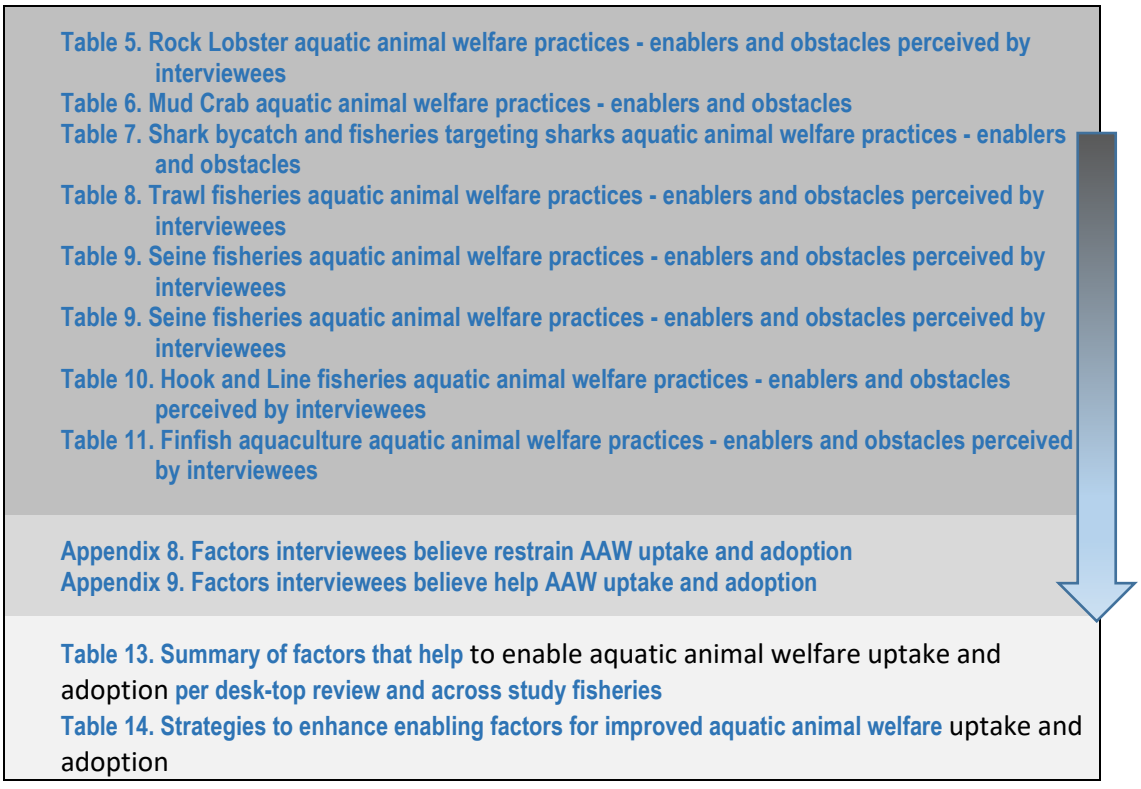


Table 12. Estimated risk levels for the social acceptability of aquatic animal welfare practices in select Australian fisheries

Implications

This project's findings support results from other recent Australian seafood industry research and policy initiatives, which have found that more appropriately designed and consistently-funded extension programs can help improve AAW uptake and adoption. However, AAW is a complex issue, and requires more than just extension. A range of carefully conceived and integrated policy instruments (e.g., market instruments, regulations) are needed to achieve substantive and lasting AAW practice change.

This Project provides highly useful insights about AAW practices used by a small sample of Australian seafood industry members, which were primarily representatives of the wild-catch commercial fishing sector with two from the finfish aquaculture sector. The findings do not fully represent the entire industry or particular sectors or specific fisheries sectors included in the study. Therefore, some care is needed when releasing the Final Report to avoid the favourable or unfavourable findings being exaggerated.

Furthermore, this Project identifies some AAW research and information gaps restraining practice change that should be considered. However, trying to fill those gaps with quantitative studies of how widely recommended AAW practices are used across Australia's seafood industry should not be prioritised over seafood industry leaders and fisheries regulators/managers improving their understanding of why recommendations from previous relevant AAW works have so far not been taken up more widely. To do so invites further scepticism from AAW advocates who may feel that the industry is making unreasonable excuses for not addressing AAW more substantially. Moreover, defensive industry responses to calls for improved AAW, such as conventional communications strategies, tends to amplify public concern and distracts members from building more trust with influential individuals and groups interested in AAW decision-making.

Recommendations

Five recommendations have been formulated to help amplify enablers of and mitigate obstacles to AAW uptake and adoption.

Recommendation 1 – Support seafood producers already answering 'yes' to the question: *Do I/we want to do it*?
Some seafood business operators will be more interested in taking up recommended AAW practices than others, and some are already doing so. These people should be supported to act (formally and/or informally) as 'change champions' in their (regional or local) fishery and provided with access to opportunities to build AAW skills (e.g., similar to the OceanWatch Master Fisherman Program). In addition, it remains important to better understand the situations of seafood operators who - despite encouragement through well-designed extension programs and peer demonstration of benefits – hold negative attitudes to AAW and consistently resist AAW practice change[4].

Recommendation 2 – Ensure seafood producers *can* answer 'yes' to the question: *Will it work*?
The fewer relative advantages of a recommended AAW practice, the lower the likelihood it will be adopted. A range of policy instruments (extension, regulation, market mechanisms) should be used to involve seafood producers in the design of AAW fishing and handling methods that effectively reduce stress of targeted and non-target catch, afford them price premiums, are safe for seafood producers and not overly difficult to use.

[4] This reflects the importance of widespread industry adoption of good AAW practices, and therefore may have a disproportionate adverse effect on the seafood industry's reputation.

Recommendation 3 - Ensure seafood producers can answer 'yes' to the question: *Can I/we do it?*
Appropriate vessel design, and seafood producers' good relationships with regulators, fisheries consultants, scientists, and NGOs can make positive contributions to AAW uptake and adoption levels. More formal and informal workshops, meetings, and conversations are needed that identify how improved AAW uptake and adoption has benefits for all stakeholders with interests in fisheries policy and management. Additionally, a comprehensive analysis is needed of what human and financial resources would be required to expand fisheries extension services (or establish new ones) to incorporate AAW uptake and adoption (e.g., Fisheries Extension Network, Master Fisherman's Program, peak industry bodies etc.) Finally, since certain vessel design features can limit AAW practice change assessment of the seafood industry's AAW capability should include consideration of predominant vessel designs in Australia's commercial fishing fleet.

Recommendation 4 – Address external factors influencing fishing practices
The fisheries policy network should identify opportunities to incorporate AAW into existing industry engagement strategies focused on building trust with influential decision makers and interest groups; assess risk level of negative public sentiment by incorporating AAW topics into existing public surveys conducted by and for the seafood industry; and engage with fisheries economists and interested NGOs in order to increase (buyers' and consumers') awareness of the link between product quality and 'best practice' AAW.

Recommendation 5 - Further development
Further work could also assess what mix of policy instruments can be used in a more integrated and coordinated fashion to help improve AAW practice change in Australia's seafood industry. This Project's findings could be synthesised with findings from FRDC Project 2020-040 to assess how well AAW government regulations and industry self-regulatory mechanisms (codes, guidelines) are or can be used better.

Similar to the analysis shown in Table 12. Estimated risk levels for the social acceptability of aquatic animal welfare practices in select Australian fisheriesa more targeted and comprehensive analysis could better estimate the risk to the industry's social acceptability given the interrelationship between public controversy over the industry's AAW practices, current and future levels of adoption of recommended AAW practices (including which of the six stages of adoption seafood producers are up to – Appendix 5), and the availability and time to implement effective extension programs. Subsequent remediation strategies could then focus on higher risk situations, where there is a combination of more controversy (contemporary or predicted) about AAW issues, low adoption levels of recommended practices, and substantive gaps in extension efforts targeting AAW.

Any further 'scans' or 'stocktakes' of AAW practices should be designed and implemented with seafood industry participants; based on AAW practices well-recognised as 'best practice'; focused on the four categories of barriers and enabling factors designated in this Project; and target higher risk fisheries. Finally, the seafood industry has had to contend with complex matters lately, such as the Covid pandemic, trade issues with China, ESD challenges, and climate change risks. Additional scans or risk analyses could be integrated with other seafood industry risk management processes to make better use of scarce resources and ensure that this project's findings are used.

Next steps:

- Workshop to draw out policy and industry-led options to enhance adoption, including feasibility of a risk assessment.
- Case studies to test risk assessment and options to improve adoption.

Keywords
Aquatic animal welfare, animal welfare, best practice, uptake, adoption, extension, fisheries, wild-catch fisheries, crustaceans, 'codes of practice', 'guidelines'

Introduction

Animal welfare is typically about preventing or reducing suffering and maximising animals' well-being. Animal welfare considerations can apply to animals used for food, research, those kept in captivity (pets, zoos), and wild species. Since animals are part of natural systems and will be affected by our use and alteration of those systems, animal welfare can be seen as part of environmental and natural resource management. However, animal welfare approaches vary and are widely debated. For example, attitudes may depend on people's fundamental values and beliefs about how much and what kind of action should be taken to: protect animals for their own sake versus their use to us; whether or not people prioritise the well-being of ecosystems and species over individual animals; and/or prioritise some species and animals' needs over others (e.g., mammals versus fish and invertebrates). [5]

Achieving animal welfare practices that are based in science and socially acceptable has been recognised by governments and the seafood industry as a key challenge. Its importance is illustrated by high-profile controversies affecting market and resource access in primary industries based on terrestrial and marine animals (e.g., live export of sheep, turtle bycatch in prawn trawl fisheries).

In 2005 the Australian Animal Welfare Strategy (AAWS) was launched to enhance welfare outcomes for all animals. Six animal sector working groups were established, including the Aquatic Animal Welfare Working Group (AAWWG), which includes commercial fishing and aquaculture. Since then, the Department of Agriculture Water and Environment (DAWE) and FRDC has funded numerous aquatic animal welfare projects that have refined the definition of 'aquatic animals'; listed all legislative and other mandates for aquatic animal welfare; identified key challenges for improving aquatic animal welfare; established overarching principles for aquatic animal welfare; benchmarked harvest methods for reducing stress on fish; identified humane practices for the killing of fish; developed fish welfare guidelines for seven commercial fishing capture methods; and road-tested fish welfare guidelines in the commercial and recreational sectors (FRDC 2012-507, 2013-049, 2017-221).

More recently, Seafood Industry Australia (SIA) formally pledged to actively care for the marine environment and aquatic animals. In addition, the AAWWG (McCallum et al 2018; pers comm) has called for more coordinated and informed approaches to helping the seafood industry better appreciate the need to credibly demonstrate their practices are both based in science and socially acceptable and to improve the uptake of best practices.

Need

Recent research shows general public support for Australia's seafood industry (Sparks 2017; Voyer et al 2016) that depends to a large extent on industry's commitment to implement best practice, and demonstration of effective environmental stewardship (Mazur et al 2014). The FRDC has recognised external pressure for the seafood industry to move beyond compliance with environmental and other regulations and improve its performance in key areas, including animal welfare. Hence, FRDC has provided support for a range of research and industry initiatives to achieve positive aquatic animal welfare outcomes, and to further improve seafood industry aquatic animal welfare practices.

Recent FRDC project investments have produced valuable insights about how multiple factors influence – positively and/or negatively – people's decisions to take up new, innovative, and/or different practices (i.e., FRDC 2017-133, FRDC 2017-046, FRDC 2017-221). These factors typically include personal values and belief systems; access to different kinds of resources required to make changes; particular features of the recommended practices; as well as a range of macro-level factors that may be outside of people's direct control but still affect their choices. For example, FRDC Project 2017-133 generated important insights about how and to what extent these kinds of factors have been keeping the seafood industry from making more substantive progress towards building greater stakeholder and community trust (Mazur & Brooks 2018).

This Project was funded to add to this knowledge by identifying the particular features of best practice care for aquatic animals; the range of factors that may be obstructing industry members' use of those practices; and provide examples of recent (extension) initiatives used to encourage better aquatic animal welfare outcomes.

[5] See Appendix 1 for a typology of attitudes to animals.

Objectives

The Project's objectives are as follows:

1. Identifying best practice in (aquatic) animal welfare.
2. Identify the extent to which fishers and finfish aquaculture farms are applying best practice in Australia
3. Identify factors impeding the uptake and adoption of a selection of recommended aquatic animal welfare practices in wild-catch commercial fishing and finfish aquaculture
4. Identify appropriate strategies to mitigate obstacles to improved uptake and adoption of those recommended practices
5. Help build the Australian seafood industry's capacity to design and implement extension programs, especially those targeting increased uptake and adoption of recommended aquatic animal welfare practices
6. Contribute to increased likelihood of more widespread and enduring practice-change in the seafood industry's aquatic animal welfare practices in wild-catch commercial fishing and finfish aquaculture

Methods

A mixed-method approach was used to collect data and information for this research. These included a desk-top review, stakeholder consultation, and a set of interviews. These are discussed further below.

Desk-top review

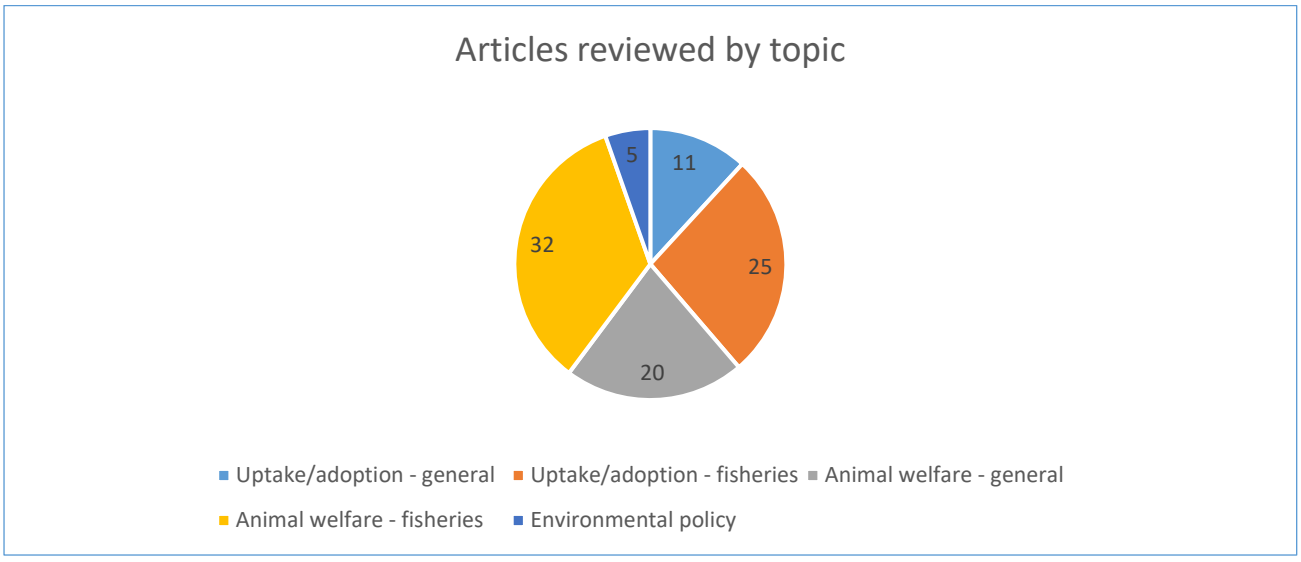
The desktop review of the scientific and grey literature covered several key subject areas:

1) Factors influencing the uptake and adoption of recommended practices for natural resource management and primary industry;
2) Factors influencing the uptake and adoption of recommended practices in wild-catch commercial fisheries and finfish aquaculture;
3) Key animal welfare principles generally, and for aquatic animal welfare in particular; and
4) International and national guidelines and/or codes of practice pertaining to aquatic animal welfare.

The main search engines used included Academic Search Premier and Google Scholar. Highly topical journals were also searched directly (e.g., Marine Policy, Fisheries Management, ICES Journal of Marine Science, Animal Welfare, etc). Key search terms included: 'aquatic animal welfare', 'animal welfare', 'fisheries', 'uptake and adoption', 'codes of practice', 'guidelines', etc. Other selection criteria for documents that had been published since 2010, although a few older references were identified and used.

A total of 93 documents were reviewed. Figure 2 shows the classification of those materials.

Figure 2. Desktop review articles by topic.



Stakeholder consultation

Early in the project the Principal Investigators (PI) consulted with a six-member Stakeholder Panel comprising professionals with strong working knowledge and experience in the Australian seafood industry, fisheries research (biological and social), aquatic animal welfare, and research extension (see Acknowledgements).

Recognising that the full range of aquatic animal welfare practices and settings is extensive and beyond the scope of this Project, FRDC's HDR specified some initial features that should inform the Project's general focus and its specific scan of contemporary aquatic animal welfare practices in Australia. Thus, a key task during the early stages of the Project was to develop the sampling strategy for a practice scan to identify which aquatic animal welfare issues would be explored further.

The PIs provided the Stakeholder Panel with a matrix synthesising various criteria for identifying welfare matters (e.g., activities/fishing methods, species, practices, industries, key issues, etc.), which was discussed in detail during a telephone meeting. This was further refined following consultation with FRDC staff. The agreed list of aquatic animal welfare topics is shown in Table 2 below. The priority settings shown in the first column were determined in the next phase of consultation (described below).

Table 2. FRDC approved aquatic animal welfare topics

Priority As per stakeholder preferences and available information	**FRDC approved aquatic animal welfare topics**
High	**Rock Lobster** Development of numerous guides and codes of practice. Questions regarding how and to what extent recommended practices are used.
	Mud Crab Relatively recent controversy regarding tying of crab claws to prevent cannibalism post capture.
	Octopus Slaughter methods are developing, and implications for growing live trade opportunities.
Medium	**Shark fisheries** To what extent does shark finning still occur. Bycatch and slaughter methods more topical with industry leaders at present.
	Trawl fisheries Impacts of conditions during net deployment/haul-in on fish/prawns.
	Purse seine *(for small pelagics)* **or Beach seine** Primary focus on slaughter methods for different catch volumes (e.g., use of Iki jime or percussion stunning, ice slurry).
Unclear	**Long line (or Hook and Line) seafood** Issues associated with length of time fish are hooked before dying or slaughter.
	Aquaculture Farmed prawns – eye stalk removal. General conditions for Barramundi, Salmon.

The Stakeholder Panel then provided the PIs with a recommendation of seafood industry association leaders to be contacted. The objective of this consultation process was to:

- Identify which of the FRDC-approved welfare topics were most relevant to their membership; and
- Obtain their recommendations for seafood industry members who could be contacted to see if they would be willing to be interviewed.

Twenty-three industry leaders from different seafood industry sectors were contacted from late January to mid-March 2020. Twelve telephone consultations were undertaken. A prioritisation of the approved list of topics was formulated based on the geographic coverage, aquatic animal welfare initiatives already in place, and industry leaders' interest and views about the relevance of those topics (see Table 1).

Due to the Project's postponement from April 2020 to January 2021 during the Covid19 outbreak, all of these consultations were repeated to ensure that the information obtained was still relevant. In addition, other industry leaders were contacted to identify seafood producers willing to participate to ensure that the desired total number of interviews was met.

Once the interview process was completed, those data and the information from the desktop review were collated, synthesised, and circulated to the Stakeholder Panel members, as well as to the Project Manager for FRDC Project *2020-040: Aquatic animal welfare - A review of guidance documents and legislation*. A Zoom workshop reviewed the research findings, provided feedback on recommended strategies to reduce impediments to aquatic animal welfare practice change, and explored additional mitigative actions that Panel Members thought relevant.

The Draft Project Report was also circulated to Stakeholder Panel members for comment.

Interviews

The findings of the desk-top review and stakeholder consultation were synthesised and used to develop a set of interview questions put to seafood industry members (see Appendix 2). As noted above, the interviewees were selected in collaboration with EOs and CEOs of key seafood industry associations.

The selection of those interviewees comprised a purposive sample. This sampling technique is a form of non-probability sampling and is based on selecting for particular characteristics of a target population and exploring issues in depth. There are limits to how much the resulting data from this technique can be statistically generalised to an entire target population. Nonetheless, the technique is very useful when the research goal is to examine issues in depth, to look at the degree of variety in responses, and when there is limited time and resources available to conduct the project across such a diverse industry.

For this Project, the target population was seafood producers whose activities were relevant to the FRDC-approved welfare topics (see Table 2 above) and included the use of various fishing methods. Sixteen interviews were completed. Given the Project delays and other (economic, social) obstacles rendered by the Covid19 outbreak and some people's refusal to participate due to their concern about the subject matter, the final sample:

- included people who were not seafood producers. However, these participants did have significant knowledge and experience working directly with the seafood industry on various management issues and uptake of new technology; and
- represented a wider variety of the aquatic animal welfare topics than originally planned for and prioritised (e.g. Table 1).

Table 3 lists the sample obtained according to participants' role in the seafood industry. Eight interviewees were fishers/owners of wild-catch commercial fishing businesses, with six of them directly involved in harvest operations. Most of these seafood businesses were relatively small by international standards. One business had over 100 employees, another had over 500 staff. The other businesses were primarily owner-operator with no more than three full time employees.

Table 3. Interviews as seafood industry roles

Role in the seafood industry	No. of interviews
Fisher/business operator	8
Fisheries consultant/scientist	3
Seafood industry association officer	2
Post-harvest (e.g., Co-op managers, exporters, etc.)	2
NGOs	1
Total	**16**

The final coverage of the original approved welfare topics (Table 2) in the interview process is shown in Table 4. The Table also shows which licensed fisheries interviewees were speaking about. Furthermore, some of the topics were not covered (e.g., shark finning, octopus) due to not being able to find fishers willing to be interviewed. Other topics changed slightly from the original descriptions of what would be investigated. For example, shark finning was not covered, however managing shark catch and bycatch was discussed.

Table 4. Interviews as per aquatic animal welfare topics

FRDC approved aquatic animal welfare topics	No. of interviews in which topic discussed
Rock Lobster ***(Southern, Eastern zones)*** Development of numerous guides and codes of practice. Questions regarding how and to what extent recommended practices are used.	3
Mud Crab ***(NT Fishery, Blue Swimmer Crab in NSW General Estuary)*** Relatively recent controversy regarding tying of crab claws to prevent cannibalism post capture	4
Octopus	0

Slaughter methods on-board for frozen market / sector is developing and may be targeting live trade opportunities	
Shark bycatch and Target shark fisheries ***(NT Offshore Net and Line, Pilbara Ocean Trawl)*** Shark finning not covered. Discussions focused on shark bycatch and/or challenges with humane release and/or slaughter methods	**2**
Trawl fisheries ***(Northern, Southern, and Western Prawn)*** Understanding if fish/prawns alive in net just prior to haul	**5**
Seine fisheries (Purse for small pelagics, Beach seine, Danish) ***(NSW General Estuary, Western Australia beach seine)*** Use of Iki jime (which might be the best welfare methods for individual fish: ice slurry more efficient for slaughter across the whole catch – but questions remain about how humane it is for certain fish and crustacean species)	**3**
Hook and Line fishing ***(NSW Trap and Line)*** Issues around how long fish are hooked on the fishing line before dying or slaughter; Iki jime or percussion stunning also covered	**3**
Finfsh aquaculture ***(Salmon)*** Issues associated with general care, slaughter methods	**2**
Total	**22**

** Includes some coverage of Blue Swimmer Crabs – NSW General Estuary Fishery*

Figure 3 illustrates what fishing and production methods were discussed by interviewees. Sometimes more than one fishing or production method was discussed by a single interviewee, and not all fishing or production methods mentioned were covered in detail. Figure 4 shows the jurisdictions that were covered by the interview process.

Figure 3. Fishing or production methods discussed in interviews.

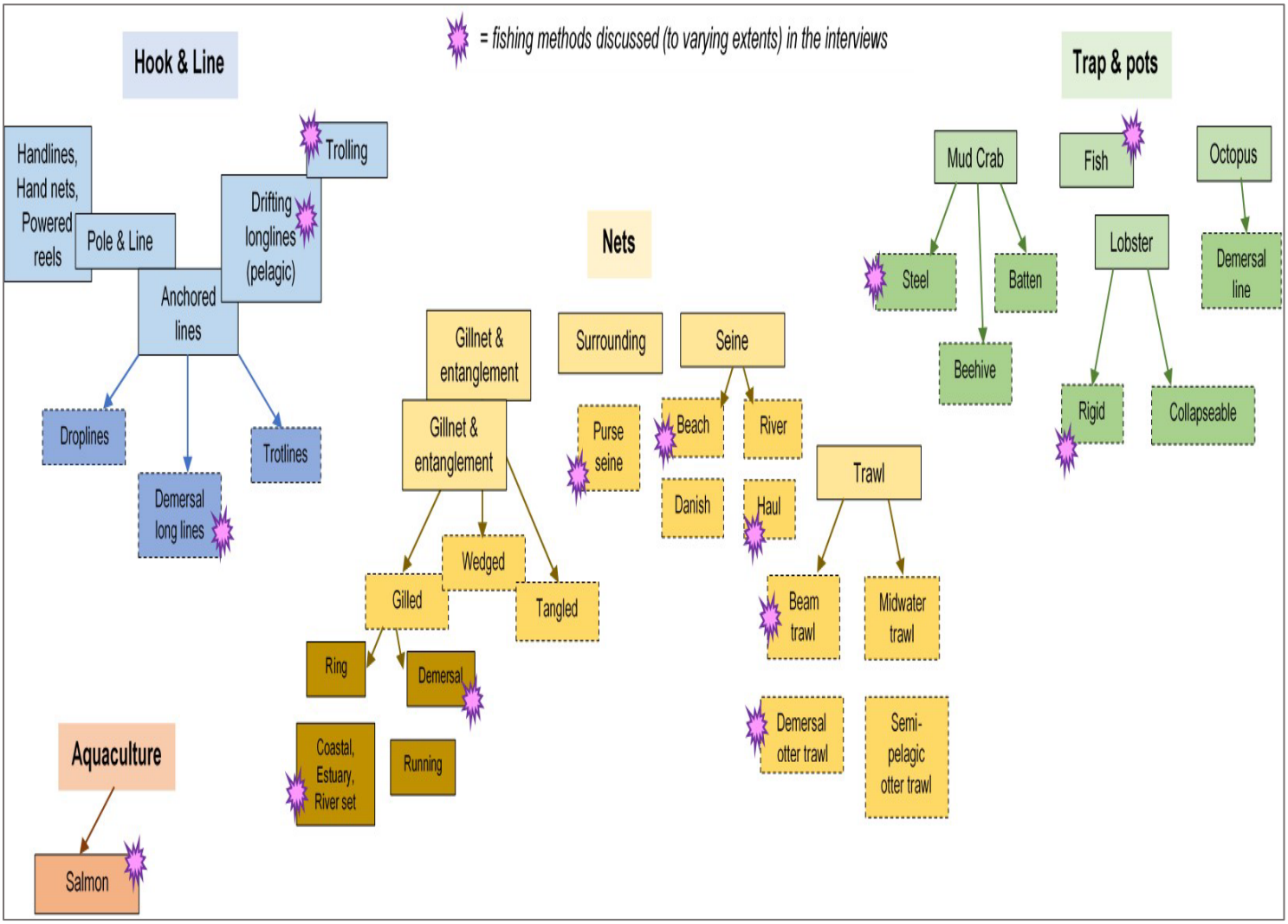
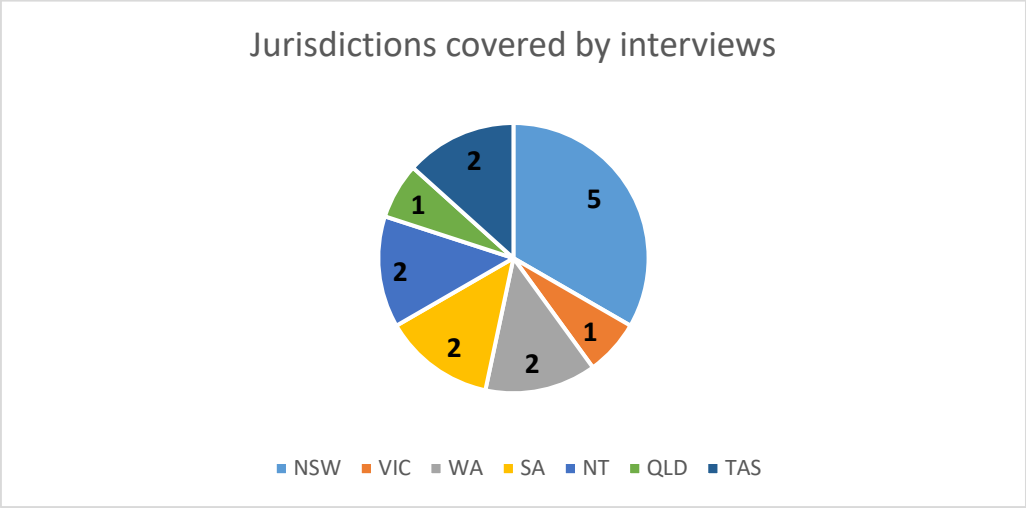


Figure 4. Jurisdictions covered by interviews



The interview questions focused on:

- Characteristics of the seafood business;
- Current aquatic animal welfare practices used; and
- Perceived factors enabling and/or impeding current practices and/or other recommended practices.

The majority of the interviews took place using Zoom Meeting Technology and took 45 – 60 minutes to complete. The meeting discussion notes were sent to all interviewees to review for accuracy and provide them with the option to add other relevant comments.

Results

Desktop review

What is 'best practice' (aquatic) animal welfare?

As noted earlier, animal welfare is typically about preventing or reducing suffering and maximising animals' well-being. Animal welfare considerations can apply to animals used for food, research, those kept in captivity (pets, zoos), and wild species. However, various definitions of welfare underpin aquatic animal research, policy and management initiatives. What makes for 'good' animal welfare or what is considered 'humane' – and particularly for aquatic animals – is difficult to define and widely contested (Conte 2010, Browman et al 2019). In this regard, it is similar to defining 'sustainability' which will also be subject to change over time (Curtis et al 2016).

The Five Freedoms Approach (FAWC 2009) is commonly used in terrestrial animal welfare settings and has also been applied to aquatic animal care. In this approach individual animals are considered to be sentient[6] beings that should not be subject to unnecessary stress and/or pain. Animals in good care should be free from:

1. Hunger and thirst;
2. Undue environmental challenges;
3. Disease and injury;
4. Behavioural restrictions, and
5. Mental suffering.

There is disagreement how appropriate the Five Freedoms Approach is for achieving 'good' welfare outcomes for aquatic animals. The Five Freedoms Approach and other approaches like it have been criticised, because it uses 'feelings-based' definitions of animal welfare (i.e., are the fish free from negative feelings) (Huntingford & Kadri 2014). Some believe that such approaches depend too heavily on 'subjective' judgements, using emotive terms like 'pain' and 'suffering' which are deemed to be difficult to scientifically measure and therefore to then mitigate or eradicate (Diggles et al 2011; Wilkinson et al 2012; Huntingford & Kadri 2014; Hardy-Smith 2015; Browman et al 2019). Furthermore, focusing on the suffering of individual animals is very difficult in wild-catch fishing or scientific surveys where large volumes of fish and crustaceans are caught at one time.

Many fisheries scientists and veterinarians define 'good' aquatic animal welfare as something that is equal to animals' 'healthy' functioning in their artificial or natural systems. Diggles et al (2011; 2019) argue that behavioural, physiological, neurological, pathological and cellular criteria are easier to observe and measure than 'pain' indicators and can therefore be used to assess welfare issues for different aquatic animal species. Similarly, Browman et al (2019) state that it is easier and more practical to measure aquatic animals' welfare using pathogen indicators (e.g., viruses, bacteria, parasite loads) or survival/growth rate indicators rather than trying to link behavioural measures to welfare. They argue that greater emphasis should be placed on the practical benefits of keeping aquatic animals 'healthy' during the stages of capture, holding, extended captivity, and slaughter.

Aquatic animal welfare Codes of Practice and Guidelines

This Project included a brief 'stocktake' of the range of international and national Codes of Practice and Guidelines that directly address aquatic animal welfare. These are listed in Appendices 3 and 4, respectively. These two lists were compiled as a snapshot of readily available information. The lists are not meant to be fully representative of all current (or planned) AAW codes or guidelines in Australia or overseas.

The international search primarily revealed resources to guide fish and crustacean handling in commercial finfish aquaculture and scientific research operations. Three resources target finfish aquaculture practices in Australia (Appendix 3), while all of the international guidelines found address finfish aquaculture (Appendix 4). In Europe more

[6] Sentience is the capacity to be aware of feelings and sensations. There is extensive debate about whether and/or how to define pain sensations in vertebrate and non-vertebrate aquatic species.

attention has historically been paid to aquatic animal welfare of species used in finfish aquaculture than in wild-catch commercial fishing (Browman et al 2019).

The list of Australian resources includes the extensive work conducted for the AAWWG as part of the Australian Animal Welfare Strategy (AAWS). Six guidelines were developed for different fishing methods: Pot/Trap, Rod/Handline, Purse Seine, Mesh Netting, Trawl, and Beach Seine. This set of guidelines are based on the work undertaken by the AAWWG, which has been to establish Overarching Principles that sub-sectors can use to base any more specific best practice guidelines or codes of practice (see Box 1). These Principles were formulated on an agreement that debating whether fish feel 'pain' or not would be counter-productive, and that concentrating on measures to "minimise stress from capture to slaughter" would be a more practical outcome to work towards (McCallum 2017: v).

Box 1. Aquatic Animal Welfare Overarching Principles

1. For fish held in captivity, the key parameters (temperature, salinity, pH, dissolved oxygen, and metabolites) of the aquatic environment in which fish are maintained should be within the species' natural range of tolerance.

2. For fish held in captivity, the holding unit in which they are normally housed should provide
   - safety from predators,
   - refuge from environmental extremes beyond their natural range of tolerance,
   - appropriate space,
   - appropriate space and/or water flow to avoid chronic degradation of water quality parameters referred to in point 1 above.

3. For fish held in captivity the feed supplied should meet known nutritional requirements, and be distributed in a manner and frequency which avoids starvation for periods longer than the species natural range of tolerance.

4. For fish held in captivity, any visibly damaged or sick fish should be assessed and either treated appropriately or promptly removed for killing by humane means suitable for the species.

5. During any handling of live fish,
   - care should be taken to avoid any damage to the fish
   - for prolonged handling of fish out of water (e.g., health checks, vet treatment, artificial reproduction, etc), an anaesthetic appropriate for the species and frequent irrigation of skin and gills is essential
   - fish intended to remain alive should be returned to the water promptly.

6. Any fish selected for harvest should be killed as rapidly as possible, by humane means suitable for the species.

7. For fish harvested from the wild timely handling from capture to death is essential to minimise suffering. (Note 5)

8. Capture methods should be designed to minimise the capture of unwanted fish.

The development of the AAW Guidelines specifies three Principles that are the most relevant to the commercial wild harvest sector of the seafood industry, which are:

1. Timely handling from capture to death is essential to minimise stress;
2. Capture methods should be designed to minimise the capture of unwanted fish; and
3. Any fish selected for harvest should be killed as rapidly as possible, by humane means suitable for the species (AAWS Guidelines 2012).

The more specific 'best practices' laid out in each of the Guidelines address key steps of harvest processes for those fishing methods. These steps vary to some extent. Some of the steps can be generalised across the different fishing methods, and include:

- setting pot/traps, lines, nets and the 'soak time';
- hauling-in of capture gear;
- bringing the capture gear onto the boat (includes handling of fish);
- removing target (and non-target) catches from capture gear (includes handling of fish);
- holding conditions for fish/crustaceans destined for live market; and
- slaughtering target-catch.

The key challenge across these steps is to allow sufficient time for the fishing gear to be in the water to catch an optimal number of targeted species. And at the same time, when the catch is brought onto the fishing vessel and slaughtered or stored live, it must be done quickly so that the animals are not overly stressed and quality is maintained.

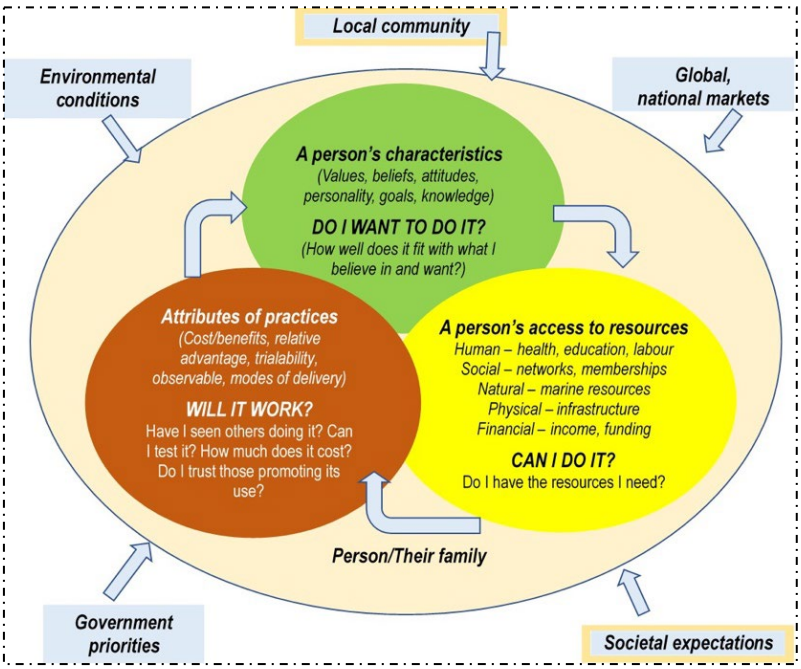
The AAWWG developed the AAW Communications Plan, which was published in 2014. The key objective of this Plan was to raise seafood industry and public awareness of the existence of the AAW guidelines and practices. The Plan identified barriers and drivers to achieving greater awareness. The Plan also identified target audiences according to their degree of influence; key messages; major communication pathways; specific media channels and activities; how to evaluate the Strategy; and ways to manage communication risks. The Plan was unable to be implemented once federal funding for the AAWS was discontinued in 2013 and no new funding has been forthcoming. The AAWWG has operated on a voluntary basis from 2013.

Uptake and adoption theory

Australia's seafood industry wishes to improve its social license to operate – and part of those efforts include utilising sound aquatic animal welfare practices. When considering the industry's capability to consider and adopt those practices, it is useful to think about the extent to which we are asking industry members to do something 'different' (e.g., more, better) from what they have been doing to date. Getting people to do something 'different' is about behaviour change. Social scientists have shown that people do not necessarily change their behaviour just because someone suggests that they do (e.g., Pannell et al 2006; Pickworth et al 2007; Stern et al 1993, 1999; Stern 2000). They have demonstrated that when people decide to change their behaviour (or not, or only a little) and take up different or new practices – it is because they are being influenced by a range of factors (personal, social, structural) that can encourage or discourage them from doing so (see Figure 5) (Pannell et al 2006; Pickworth et al 2007).

Those factors can be framed as a set of questions that a person or groups of people working together might (consciously or otherwise) ask themselves when considering whether to take up that practice/activity: *Do I/we want to do it?, Can I/we do it?, and if I/we do it Will it work?* (Figure 5). Those three questions represent personal and situational matters that people (as individuals and/or in group decision making settings) tend to have some control over – personal control being a key element in motivations to change. In addition, there are always macro-level factors affecting people's choices, that they do not necessarily have direct control over (e.g., economic conditions and pressures; government policies, legislation, programs and priorities; public pressures; and environmental conditions).

Figure 5. Factors influencing uptake of recommended practices



The uptake and adoption of new practices is also a dynamic process, wherein people initially decide to collect and evaluate information about a particular practice (or set of practices) and use a mixture of scientific information, personal experience and skills, and cultural influence to apply (to varying degrees) that practice. Pannell et al (2006) identified six stages of adoption (see Appendix 5) that essentially involves a person becoming aware of a problem (or opportunity), gathering and evaluating more information about potential actions, trialling the new practice, and depending on degrees of success over time deciding to fully or partially adopt or reject that practice.

As noted above, there are multiple influences on a person (individual and/or with other people) choosing to change their practices. Extension is an important tool among a range of policy options to encourage such practice change. It has been defined (in an agricultural context) as:

> … the process of enabling change in individuals, communities and industries involved with primary industries and natural resource management (NRM). Extension is concerned with building capacity for change through improved communication and information flow between industry, agency and community stakeholders. Extension seeks outcomes of capacity building and resilience in individuals and communities. Extension contributes to protecting, maintaining and enhancing the landscapes, livelihoods and lifestyles of all Australians (SELN, 2006, p.3 cited in Hunt et al 2011: 113).

Extension approaches vary in form and context, and there are many different ways to categorise them. Extension is typically more effective when a mix of complementary models are used (Coutts et al 2005), and there is adequate longer-term funding to support a viable extension sector (Marsh et al 2011).

Jennings & Pakula (2011) identified and evaluated five main models of extension that have been used in Australian fisheries (see Appendix 6). The most common models were technology development/problem solving, information access, and training/programmed learning models. Mentoring and group empowerment were used less often. Their interview data suggested that the mix of approaches used were achieving relatively good rates of adoption. In widely dispersed fisheries, broader models of extension are more appropriate and effective. They recommended that the industry focus on the particular characteristics of extension models that helped improve adoption and continue using those approaches; extension networks be strengthened; professional development and training in extension be provided to industry members; engagement between industry leaders and boat operators be strengthened; and regional-scale intra-industry communications be improved.

Many of those findings and recommendations are reflected in Australia's *National Fishing and Aquaculture Extension and Adoption Strategy* (2012). The Strategy was created to improve extension capacity and increase adoption of RD&E recommendations across fishing and aquaculture sectors. Its recommendations stated that extension be more highly valued, more regularly evaluated, adequately funded, and better supported by strengthening (regional) networks of providers and end-users.

Engaging directly with individual seafood producers and groups through extension programs can help build their capacity to take up recommended AAW practices. However, it is important to recognise that extension on its own cannot achieve all the change required to improve AAW uptake and adoption. AAW can be considered to be a 'wicked' policy problem. These problems are typically difficult to define; encompass conflicting goals and objectives; are continually evolving; have few clear solutions; are socially complex; do not fit within the responsibility of any one organisation; and involve changing behaviour (APSC 2007; Head et al 2016). Combinations of policy instruments are needed to address these complex problems (Gunningham & Sinclair 1998; APSC 2009; Curtis et al 2016). These instruments typically include legislation and regulation, financial instruments (grants, rebates, subsidies), market-based instruments, and persuasion (education, information, training) [7]. Extension programs can be classified as persuasion.

Uptake and adoption in the seafood industry

The desk-top review included a search of scientific and grey literature that focused on factors influencing uptake and adoption in seafood industry settings. Few of the articles focused on 'aquatic animal welfare' per se. Rather, the

[7] An optimal combination of policy instruments required to address complex problems are also referred to as The Five Ps – prescription, penalties, property rights (and markets), payment, and persuasion (Salzman 2019).

most common articles (50%) were on the development and dissemination of bycatch reduction devices and technologies. These were followed by selective fishing gear and fishery dependent data collection, best ways to create and implement fisheries policy and/or management. There were some projects undertaken in Australia on extension and adoption in the seafood industry – more in wild-catch commercial fisheries than in aquaculture. Detailed review findings are listed in Appendix 7, and are categorised according to the factors that can restrict or enable uptake and adoption of primarily wild-catch commercial fishing and to a lesser extent aquaculture practices.

The first category covered articles that focused on values, beliefs, and attitudes particularly towards aquatic animals (**Do I/we 'want' to do it?**). There were limited studies focusing strictly on seafood producers' perspectives, and the literature included examinations of veterinarians (Lloyd et al 2020), fisheries researchers and gear technologists (Message & Greenhough 2019), wild-catch commercial fishers' use of safety procedures (Brooks et al 2019), and societal attitudes more generally (see Appendix 1). The predominance in (Western) society of utilitarian attitudes towards non-human animals and preferences for warm-blooded animals will inform some seafood producers' doubts about the necessity and benefits of aquatic animal welfare practices (Glass et al 2015). Other obstacles include the power of wild-catch commercial fishers' fear of losing their independence and general resistance to change, even in the face of regulatory mandates for and relative advantages of a particular practice shift (Eayr & Pol 2018). McCallum (2017) noted that seafood producers' who believe they are already addressing 'welfare' issues and fear further 'red tape' will resist change. While not related to animal welfare, an extensive study of Australian wild-catch commercial fishers found that negative perceptions of safety requirements restricted the uptake of these measures (Brooks et al 2017).

The debate about whether fish are sentient or not can have a powerful influence on seafood producers' actions, as well as others working in the industry (e.g., scientists, veterinarians/students, technologists). Generally, the greater the doubt about sentience the more resistance there is to implementing a range of actions to improve fish welfare (Message & Greenhough 2019). Additionally, the type and extent of knowledge fishers and others have about (aquatic) animal welfare issues, or fish biology, informs their actions – with greater and current knowledge being an enabling factor for practice change (Jenkins 2010; McCallum 2017). Other enabling factors include extensive understanding and experience in commercial fishing and exposure to AAW dilemmas (Jenkins 2010). In addition, fishers who have chosen or are contemplating changing their practices want to be acknowledged for doing so (Piovano et al 2012).

The second category of articles were those that focused (specifically or incidentally) on the features of particular AAW practices (***Will it work?***). These articles also included consideration of how practices were disseminated (extension). A common focus in the literature is on what kind of financial costs fishers incur when taking up some kind of practice change, with BRDs most often discussed followed by selective fishing techniques, and fishery data collection. Generally speaking, the greater the monetary and time 'costs' of a particular practice - the higher likelihood that seafood producers will resist using that method/gear (e.g., safety gear, reduced target catch, high cost of equipment, more time needed to use it, complicated to use) (Diggles et al 2011; Condi et al 2014; Glass et al 2015; Peckham et al 2015; Sullivan et al 2017; Eayrs & Pol 2019; Brooks et al 2019). Not surprisingly, this research notes that the greater the relative advantages of a given practice the greater the likelihood of its uptake (e.g., price premiums for better handled and therefore quality fish, reduced fuel costs from shorter haul times, reduced bycatch saving sorting time, etc.).

Certain features of how recommended practices are extended to end-users can inhibit (however unintentionally) uptake and adoption. The literature identified mistrust of fisheries managers promoting the practice change (Glass et al 2015; Bradley et al 2019; Brooks et al 2019; Message & Greenhough 2019), those managers not having the necessary skills and/or time to deliver extension (Glass et al 2015; Feekings et al 2019), low end-user awareness of guidelines/Codes of Practice, and guidelines/Codes of Practice that are framed too generally to be sufficiently clear to end users (welfare indicators poorly defined) (Huntingford & Kadri 2014). However, it was also pointed out that varying physiological needs of different species and certain research gaps make it difficult to have more specific guidelines or codes that can apply to all situations (Manfrid et al 2018).

Extension features believed to encourage uptake were:

- including varied stakeholders in project design (Feekings et al 2019);

- using stakeholders' specific skills/knowledge to develop solutions (Feekings et al 2019; Peckham et al 2015);
- ensuring fishers know about where and how 'good welfare' knowledge is produced (Message & Greenhough 2019);
- using knowledge from organizational change management to help achieve/improve uptake and adoption (Eayrs & Pol 2019; Glass et al 2015); and
- building seafood producers' trust in those promoting a particular practice change (Message & Greenhough 2019; Glass et al 2015).

A person's access to resources (human, social, natural, physical, financial) will affect their uptake and adoption of new or different practices (***'Can I/we do it?'***). The literature reviewed suggests that not enough attention is paid to how significant social and cultural capital is to seafood producers' inclination to change their practices (Gustavsson 2018; Brooks et al 2019). Another study found that BRD uptake is better facilitated when fishers can readily access easily understood and credible information (Mazur et al 2007), appropriately skilled staff, and specific equipment (Jenkins 2010). A shortage of funding to trial practices will limit uptake as well.

Some of the macro-level factors that can negatively affect seafood producers' uptake and adoption, and that are not necessarily in their direct control included:

- A shortage of veterinarians specifically trained for AAW and with expertise in preventative care and medicine globally (Diggles et al 2011; Lloyd et al 2020; Browman et al 2019);
- Gaps in AAW research (e.g., specific and reliable parameters for AAW such as humane stunning methods) (Browman et al 2019; Manfrin et al 2018);
- An absence of a 'culture of care' in research organisations that hold aquatic and other animals (Brown et al 2018);
- Public views that the seafood industry is not applying AAW principles and guidelines (Browman et al 2019; McCallum 2017);
- A lack of clarity about consumers' willingness to pay more for seafood certified as 'best practice' AAW. Some assert it is a key driver (Manfrin et al 2018; Conte 2010), others note only where consumers and producers hold common views on necessary practices (HAS 2018) and are willing to pay a price premium (Ellingsen 2015);
- A shortage of legislation (globally) to enforce AAW best practice (in finfish aquaculture), accompanied by debates about how and to what degree stricter legislation would help – particularly for fisheries that have or will be undergoing restructuring (Manfrin et al 2018; WOAH 2017; Voyer et al 2016); and
- Cessation of Australia's federal funding for national AW and AAW policy and research in 2013 (McCallum 2017).

Positive influences in fisheries' broader operating environments included cross-sectoral cooperation to reconcile long-standing differences of opinion about what constitutes 'best practice' AAW and what trade-offs are socially acceptable (Friedman et al (2018); and cross-sectoral information exchange that is transparent, consistent and regularly evaluated (Soomai 2017).

Aquatic animal welfare perspectives and practices in Australia

As noted in the Methods Chapter, seafood industry association leaders were consulted to discuss how the welfare topics nominated by the Project Team were relevant to their members. Those consultations included discussions about how aquatic animal 'welfare' was being addressed.

One EO felt that AAW was a difficult topic to address relative to other reporting requirements in their industry sectors, and can become a lower priority. They also believed that given the variety of views about what constitutes 'acceptable practices' it is difficult to define 'best practice' AAW. Another EO felt that AAW was a "sleeper" issue, as it was only a matter of time before it creates substantial difficulties for their fishery. They felt challenged by various issues demanding attention and struggled to find ways to respond more proactively rather than reactively.

One EO noted that it could be hard to discern between the term 'health' and 'welfare' in relation to aquatic animals. Using the term 'welfare' when speaking with fishers and post-harvest processors did elicit some defensiveness, so this person preferred to use the term 'health'. Similarly, one EO noted that while their industry did not have a

welfare code of practice, the strong relationship between animal health, product quality and welfare resulted in the (live) species being well cared for throughout the production cycle. Another EO discussed the importance of water quality in tanks holding live catch, as it is integral to ensuring product quality.

Interviewees – what does AAW mean?

Interviewees were asked what the phrase '*aquatic animal welfare'* or *'animal welfare'* meant to them. Rather than offer a concise technical definition, most respondents talked about what they felt is expected of them (the industry, their fishery, their business) and/or what they do to address welfare issues. For example, one interviewee focused on bycatch said AAW meant, "… getting things back in the ocean alive."

The term 'humane' was used by several interviewees to describe how fish should be handled and slaughtered, primarily by minimizing stress. None of the interviewees referred directly to animal sentience. However, one interviewee believed that lobsters do feel 'pain'.

Virtually all interviewees' responses to this question focused heavily on the practical and material value of aquatic animals i.e., were *Utilitarian*[8]. Fish were often referred to as 'products', 'resource', or 'the catch'. All interviewees talked about a causal link between 'humane' catch/handling methods and a quality product. The following quote typifies this perspective:

> *"… [AAW is] looking after the resource that we are trying to harvest … in a way that you are doing the right thing by the fish … dispose of it humanely… we are continually trying to target better markets … the better we handle our fish … it comes back as encouragement in [the form of] a better price."* Interviewee 5.

Interview data revealed other attitudes. One interviewee talked about the intrinsic value of aquatic animals. Another interviewee spoke about their affection for animals generally and their preference for working in live fisheries, because doing so meant they did not have to slaughter their catch. Another interviewee referred to the Five Freedoms when defining AAW. Several interviewees talked about the important role that survivability of bycatch played in maintaining fish stocks and ecosystem health.

The responses also revealed concern about the extent to which AAW is taken seriously by the seafood industry. Two interviewees were concerned about AAW not being sufficiently "… on fishers' radar." The interview data also points to defensive attitudes towards AAW. When first discussing AAW, another two interviewees described the term as "… yet another way to get rid of the seafood industry." It is not clear how representative these views are of the rest of the seafood industry.

Interviewees – business goals

Interviewees were asked to describe their business goal(s). In the case of interviewees who were not owner-operators, they were asked what they believed were typical goals for seafood producers in their purvey.

A range of themes were evident in the interviewees' responses. These themes included: being able to provide for their families; earning a comfortable living; enjoying their work; maintaining a sustainable and viable operation; focusing on producing quality products; and providing employment for others. Some interviewees talked about changes they made to their operations to stay viable and successful (e.g., relocation, investment in infrastructure). Several of the interviewees who were owner-operators talked about being happy to operate a small-scale business.

Interviewees – perceived obstacles and enabling factors

Figure 3 in the previous Chapter showed the variety of general fishing methods used and/or discussed by the interviewees. Interviewees were also asked what practices within those methods they used to reduce the stress of target and non- target species. The following material is organized according to the key aquatic animal welfare topics for this Project (see Table 1).

[8] See Appendix 1 for typology of attitudes to animals.

Rock Lobster Fisheries (Southern, Eastern zones)

Three of the sixteen interviewees were involved in the Rock Lobster industry. They spoke about using the following methods to reduce the stress of their catch in harvest and post-harvest phases:

- Minimising handling time of lobsters, having tanks on board the vessel to swim the lobsters, and, keeping them out of the sun and wind;
- Ensuring holding tank management is of the highest standard (e.g., continuous water purification to remove nitrates and acids, minimum density of animals to ensure purging prior to transport); and
- Soak time for traps no more than 24-48 hours; setting and hauling procedures that encourage lobsters to seek out pots; use of a wet well on boat and holding tanks in port; use gloves for handling; grabbing lobsters by the horns, holding them firmly, lasso tails if facing away from pot opening; avoid returning undersized lobsters to sea when seals are present; when windy or hot avoid transferring catch from boat to port or port to buyers; limit number of lobsters in the holding tanks to avoid crowding.

One of the interviewees spoke about bycatch in the lobster pots. This fisher invested in a BRD device for all their pots (i.e., seal spikes) to avoid catching these mammals, which typically eat the lobster and can then drown if they get stuck in the pots.

Table 5 shows the topics Rock Lobster interviewees raised when talking about factors that affect their humane practices. These data are grouped according to four types of factors shown to influence uptake and adoption (see Figure 5). Interviewees tended to speak about humane practices more generally, but did identify how specific practices were encouraged or discouraged. Pride in one's work, belief in being humane focussed towards animals, and an openness to learning were mentioned as enabling factors. Obstacles included (other fishers') resistance to change and seeing animals as commodities.

Table 5. Rock Lobster aquatic animal welfare practices - enablers and obstacles perceived by interviewees

Rock Lobster (Southern, Eastern zones)	**Enabling factors and/or advantages of practices**	**Obstacles to and/or disadvantages of practices**
	Interviewees' observations	
Do I/we want to do it? *How well does it fit w/ what I/we believe in?*	General • Pride in doing it well • Strong interest in learning and willingness to embrace change	General • Too many fishers seeing lobsters as commodity vs live animals • Too many fishers being resistant to change
	• Short soak times: Belief that its more humane focussed and environmentally sustainable • BRDs: More humane not to kill wildlife • Extension: Benefits of experience – getting better at what you do over time	
Will it work? *Cost/ benefits, relative advantage, trialability, trust those promoting it?*	General • Higher prices for quality - well-handled animals	General •Codes/guidelines designed for minimum best practices - bar set too low
		• Optimal haul out speed: Codes/guidelines don't address implications for fishing in deeper waters 24-48 hr soak time: Resistance from large corporate fishing businesses seeking maximum yield • Use of BRDs (seal spikes): Take more time to set up/use, costly, may reduce catch of larger lobster
		Extension • Need to include mammal bycatch and fish handling in codes/guidelines/induction programs for new entrants • Codes/guides aim at minimum vs maximum acceptable practices; lowest common denominator • Codes/guides don't cover subtleties of BP learned from experience • Lack of education for new entrants

Can I/we do it? *Do I/we have 'resources' needed?*	• Formal education in natural resource management • Good and active relationships with variety of fisheries stakeholders Extension • Being on the fishery's management committee • Actively using networks to learn more about AAW and sustainability practices & advocating for their inclusion in fishery code/guidelines and induction programs	• Not having enough deck space (storage, tanks, etc) Extension • Low awareness of Southern Rock Lobster Pty Ltd Codes, Guidelines • Lack of inter-agency and/or inter-organisational communication
External factors *Macro-level factors beyond a seafood producers' direct control*	• Market recognition of AAW standards • Crustacean physiology (throwing legs when stressed) mandates better handling • Use of BRDs: Fisheries regulator not penalizing fishers for reporting wildlife interactions	• Larger animals more dominant and harder to handle • Large companies buying up small fishing businesses (consolidated ownership) • 24–48-hour pot soak time: Lack of regulation mandating its use • BRDs: Lack of regulation mandating their use

Views about particular features that helped encourage humane practices focused on the (potential, actual) price advantage of well-handled fish. There was more discussion about factors hindering humane-focused fishing methods, including: insufficient deck space for equipment; additional costs (equipment prices, reduced catch, time to use); and insufficient content in existing codes and guidelines. Dissemination of information about welfare practices was discussed by several interviewees. These interviewees believed that existing codes of practice or guidelines had not reached a wide audience and lacked enough AAW information, particularly for new entrants to the fishery.

Some issues were raised regarding resources needed to apply welfare methods. Enabling factors included having natural resource management education and various benefits of strong relationships across different social networks. Uptake of welfare practices was thought to be hindered by low awareness among fishers of existing AAW codes and guidelines and weaker social networks.

External factors thought to be positively influencing AAW practice uptake/adoption market responsiveness and delicate physiology of lobsters. One interviewee believed that BRDs use was encouraged by agency understanding of factors beyond fishers' control. Conversely, another interviewee felt using BRDs and short pot setting times were discouraged by an absence of legislation mandating their use. Consolidated ownership in rock lobster fisheries was cited as an obstacle. It was thought that the larger fishing business avoided practices that could reduce catch levels, such as shorter soak times for lobster pots.

Mud Crab fisheries

Three interviewees spoke about what practices they (or fishers they knew of) used to reduce the stress of crabs (primarily live Mud Crabs, but also Blue Swimmer Crabs). The following approaches were used:

- Use of rigid pots; sorting of catch at the point of capture; baskets with crabs caught placed in cool and moist place out of the sun, wind and noise; regularly checking baskets for vermin; generally trying to minimise disturbance to the crabs;
- Use of crab claw ties to minimise struggling and fighting between animals (for live trade catch); insulated box with ice slurry to slow animal's movement down for sorting, then colder water to slaughter them (non-live trade) (used to use this); and
- Trap design that enables smaller crabs and fish to escape; tying of the nippers back to the body to mimic resting position in the wild and reduce damage; storing them in cool and dark areas.

Table 6 shows the topics Mud and Blue Swimmer crab fishery interviewees raised when talking about factors that affect their welfare practices. These data are grouped according to four types of factors shown to influence uptake and adoption (see Figure 5). Pride in one's work and an interest in learning were seen as key personal factors positively influencing fishers' choices about welfare methods. Conversely, (some) fishers' conservative values were seen as causing low awareness of AAW codes/guidelines and little interest in practice change.

Table 6. Mud Crab aquatic animal welfare practices - enablers and obstacles

Mud Crab *(Included some coverage of Blue Swimmer Crab in NSW General Estuary)*	**Enabling factors and/or advantages of practices**	**Obstacles to and/or disadvantages of practices**
	Interviewees' observations	
Do I/we want to do it? *How well does it fit w/ what I/we believe in?*	General • Fishers' pride in how good their product looks Extension • Self-taught and observational learning	General • Conservative values leading to resistance to change • Fishers' lack of sufficient skills and training • Lack of motivation/interest among some fishers to address SLO Extension • Low/no awareness of AAWWG Guidelines
Will it work? *Cost/ benefits, relative advantage, trialability, trust those promoting it?*	General • Co-ops that no longer use pooled weighting of catches and offer better prices for quality catch • Lower stressed animals have longer shelf life • Price premiums for crabs that have been well cared for • Tying crab legs: Improves quality upon presentation to market	Tying crab legs: Can take a bit more time to do
	Extension • Codes emphasise profitability and survivability/ quality of catch; currently working on welfare specific Codes • Understanding that fishers may say "too hard" – we respond w/ "find a way to make it work" • Low tech fishery makes it easier in some ways to teach people • Sydney Fish Market's fish handling workshop – Ken Hirada Making it a point to talk to fishers	Extension • Codes not updated since 1990s • Lack of information and training re: crab handling (Blues)
Can I/we do it? *Do I/we have resources needed?*	Extension • Working with an inclusive and culturally sensitive approach factoring in complications of remote location and supply chain participants • Advocacy across networks for legal minimum size increase • Being on various committees and facilitating information exchange • Working closely with fishing industry association and fishers to address issues and fishing methods	
External factors *Macro-level factors beyond a fishers' direct control*	• Increase in legal size for crab catch • Live fishery • Social license pressures for poor practices (e.g., Dumping of dead crabs)	Extension • Remote location of fishers

Interviewees also identified what features of their welfare practices positively or negatively influenced their adoption. They noted good general handling practices and tying crab claws improved crabs' quality, which could bring better prices from buyers, especially from those Co-ops not using pooled weighting of catches. One interviewee noted that tying of legs can take more time.

Positive features of processes aiming to encourage uptake of welfare practices included: information materials (codes, guidelines, courses) that emphasize financial benefits of welfare practices; and extension practitioners working directly and flexibly with fishers. Obstacles to effective extension included outdated codes of practice and gaps in information and training opportunities for handling crabs.

When discussing different kinds of resources needed to use welfare methods only social resources were discussed. Fishers and fisheries experts spoke about using their social networks to engage different stakeholders (including other fishers). Their conversations were about various ways to improve information exchange and uptake of welfare practices.

There were some external factors that interviewees believed were having a positive influencing on fishers' uptake of welfare practices. These included social pressure for better welfare practices, particularly for fisheries selling live

fish. One fisher felt that an increased size allowance in their fishery encouraged better practices. Remote fishing locations added logistical difficulties for AAW information and training, but these challenges were not seen as insurmountable.

Shark bycatch and fisheries targeting sharks (NT Offshore Net and Line, Pilbara Ocean Trawl)

Two interviewees spoke about recommended practices that to the best of their knowledge were used in fisheries either targeting sharks and/or caught them as bycatch. These practices included:

- A maximum net soak time of three hours; nets hauled at speeds enabling safe removal of catch;
- Minimal line soak times; avoiding fast winching speed; careful removal of animals from hooks; careful fish handling; quick release of non-target catch; and
- Striving to return non-target catch to sea alive; working towards continuous improvement in gear selectivity to help avoid mammal bycatch; use of iki jime or percussion stunning and then ice slurry for larger catch, smaller catch into ice slurry.

Table 7 shows the topics Shark fishery interviewees raised when talking about factors that affect their welfare practices. These data are grouped according to four types of factors shown to influence uptake and adoption (see Figure 5). Fishers' personal willingness to work within current requirements was a positive influence on uptake. Fisheries' reforms have had damaging effects on fishers' morale, which in turn was seen to reduce their motivation to embrace practice change.

Table 7. Shark bycatch and fisheries targeting sharks aquatic animal welfare practices - enablers and obstacles

Shark bycatch and fisheries targeting sharks *(NT Offshore Net and Line, Pilbara Ocean Trawl)*	**Enabling factors and/or advantages of practices**	**Obstacles to and/or disadvantages of practices**
	Interviewees' observations	
Do I/we want to do it? *How well does it fit w/ what I/we believe in?*	General Awareness of and happy to work with rules	General Suppressed fisher morale resulting from fisheries reform fatigue
Will it work? *Cost/ benefits, relative advantage, trialability, trust those promoting it?*	General Selective fishing – avoids difficulties (time, danger) of shark bycatch Economically efficient Short Net and Line soaking times effective for quality product	Careful removal/handling of shark bycatch – difficult and dangerous due to thrashing animal Careful removal/handling of shark bycatch – Boat design: vessels sit high out of water, harder to safely release and ensure survivability
	Extension Information exchange via regulatory meetings that address challenges across stakeholder groups	Extension Code and EMS unclear effectiveness since lack information on slaughtering sharks, also outdated Paper booklets not effectiveness – need shorter w/ pictures, videos to watch
Can I/we do it? *Do I/we have resources needed?*	Extension Acting as chair of a fishery committee	General Knowledge gaps on welfare focussed release and slaughter methods for large sharks and lack of discussion and info sharing across jurisdictions
External factors *Macro-level factors beyond a seafood producers' direct control*	Highly contentious and therefore highly regulated fishery Warm waters – need to get catch out of water quickly Extension Skippers' requirement to be interviewed by Dept if new to the fishery	General High volume of TEPs in fishery Reactive, quick, frequent changes to fisheries management w/o sufficient involvement of fishers Physiological features of sharks – movement when first slaughtered Lack of research funding on welfare focussed release and slaughter of large sharks Extension Skippers' requirement to be interviewed by Dept if new – but not clear how effectively addresses AAW

The benefits of selective fishing to avoid shark bycatch included saving time, avoiding dangerous deck procedures and generally being more economically efficient. Short net and line soaking times helped achieve better quality catch. Obstacles to 'best practice' for dealing with shark bycatch included its inherent danger – removing animals

from hooks and returning them to the water safely is very difficult, and can be made more so depending on a boat's design (e.g., vessels that sit high out of the water).

Interviewees noted that the lack of information on handling, release, and slaughtering (larger) sharks is a significant obstacle for extension of best practice AAW. Communication products like paper booklets were seen as less effective than video demonstrations. Regulatory meetings have been used well to address challenges like improved uptake of AAW practices.

Social resources encouraging the uptake of AAW practices include fisheries expert representation on key shark committees. However, it was believed that there has not been sufficient inter-jurisdictional discussions or information exchange on addressing AAW for sharks.

There were several external factors interviewees believed have either a positive or negative influence on AAW uptake. Public controversy, strong fishery regulations, and warmer water temperatures increased pressure to find ways to get target shark catches out of the water (and slaughtered) as quickly as possible. Obstacles to best practice included: reactive fisheries reform with insufficient consultation with fishers; little to no research funding on AAW for sharks; and high volumes of TEPs in some areas. It was not clear how effective a requirement for interviewing new fishery entrants could be for encouraging AAW practice change.

Trawl fisheries (Northern, Southern, and Western Prawn)

Several interviewees discussed what they believed were good welfare practices in trawl fisheries. Practices to avoid bycatch and maximizing survivability of bycatch was a prominent topic:

- Reducing bycatch and maximising the survival of non-targets returned to the water, primarily using BRDs;
- Selective fishing to reduce bycatch, using excluder devices;
- Short trawl times (50 minutes), use of Wet Hopper systems for sorting catch – enabling quick release of non-targets and efficient Hopper, ice slurry to slaughter target catch;
- Return non-targets to water alive, Iki jime or percussion stunning to slaughter larger fish, ice slurry to slaughter smaller target species caught in higher volumes, continuous improvement of gear selectivity to reduce/avoid bycatch; and
- Use of various methods including Iki jime/percussion stunning, BRDs, floats on trawl nets to avoid seabird bycatch, ice slurry to slaughter fish/catch quickly.

Table 8 shows the topics the Trawl interviewees raised when talking about factors that affect their welfare practices. These data are grouped according to four types of factors shown to influence uptake and adoption (see Figure 5). Interviewees talked about how fishers' personal beliefs and goals were very relevant. Those fishers who believed there was some moral imperative to use humane approaches and/or had business goals that reflect sustainable catch levels were more inclined to take up and keep using AAW practices. Those practices include using BRDs. Conversely, fishers holding a 'fishing is my right' mindset, some older fishers, and/or those with no or low awareness of AAW were seen as less likely to embrace practice change.

Table 8. Trawl fisheries aquatic animal welfare practices - enablers and obstacles perceived by interviewees

Trawl *(Northern, Southern, and Western Prawn)*	**Enabling factors and/or advantages of practices**	**Obstacles to and/or disadvantages of practices**
	Interviewees' observations	
Do I/we want to do it? *How well does it fit w/ what I/we believe in?*	General Belief that humane methods are the 'right' thing to do Being able to meet goals of profitability via catching tonnes at lowest input costs while maximizing quality/size of target species BRDs Fishers' desire to participate in trials – due to getting quality products	General (Some) older fishers and/or family-dominated businesses' resistance to change/public pressure Fishing = a rights-based mindset Low awareness of AAW
Will it work? *Cost/ benefits, relative advantage, trialability, trust those promoting it?*	General Industry leadership – proactive and considered responses to SLO Industry leadership – trust in industry association Crew recruitment practices targeting skills, motivation Existing widespread use of AAW practices across region	
	BRDs	BRDs

	Contemporary devices easy to use (e.g., hydraulic lifts) Fishers seeing success of trials and regular use by other fishers Effectiveness of devices reducing bycatch and sorting/processing times, etc. 20 years of devices being effective helps fishers' acceptance	Belief among fishers that bycatch rates sufficiently low so reduced relative advantage of using BRDs Early difficulties with safety of heavy equipment in bad weather Potential loss of catch, purchasing equipment Some difficulties with clogged device (seagrass, algae) FishEye not always showing significant reduction of bycatch
	Ice slurry - Shortens time that fish not being cooled	Ice slurry Sometimes insufficient deck space, crew Increased time to prepare and use Iki jime or percussion stunning – not practical for use with high volume catches
	Extension Skipper briefings at beginning of each season – can raise questions, discuss issues, includes 1st mates and skippers Working directly w/ fishers to address issues AFMA port visits to help set up equipment Having a CoP Industry wide adoption of wet hoppers and BRDs in early 2000 People trialling, experiments with BRDs before mandated so benefits clear to them Utility of having Codes w/ AAW component (modules) that gets covered during induction Trialling other BRDs via industry association, encouraging fishers to do trials and keep those broad and simple Dedicated role for bycatch manager in fishery w/ expertise in gear tech, fishing, skippering	Extension Fishery's codes need updating Insufficient shark handling guides Website needs updating No formal codes, guidelines Can be challenging to find the right 'window' for running trials (e.g., Fishers wanting to see trials during high prawn catches) No welfare-specific Codes
Can I/we do it? *Do I/we have resources needed?*	General Available quality scientific expertise BRDs Industry leadership advocating for their use and encouraging participation in trials Extension Dedicated role for bycatch manager who works with/across fishers, science agencies, regulators Several fishers working together to help 'set up observer program to collect info Association working across fishers (persistently, earning their trust) and reaching out to science agency to set up trials	BRDs Vessel size can limit ease and efficiency (time) of sorting
External factors *Macro-level factors beyond a seafood producers' direct control*	General Improvements in SLO for trawl fisheries Highly managed and well researched fishery	General Lag time between legislation and what happens on the water
	BRDs Improved SLO from reduced catch of charismatic fauna Regulations mandating use of BRDs Regulations maintaining resource access MSC certification requiring <5% bycatch Use of crab bags Opening up of crab markets Increased quota for crabs Extension Participation in MSC program	General Limited number of days to fish and/or incident of bycatch limits ability to trial devices Extension Confidentiality/privacy issues minimize opportunities to learn from video surveillance in Observer programs

The particular features of AAW practices in trawl fisheries were discussed extensively. Interviewees believed that the historic and widespread use of BRDs, their extensive trials – with high fisher participation rates, their relative ease of use, and effectiveness in reducing bycatch and improving catch sorting/processing times have helped make them largely standard practice. Features impeding uptake included initial crew safety issues, some loss/reduction of target

catch, cost of purchasing equipment, and some devices not working as well as others (e.g., FishEye). Ice slurry was thought to be beneficial, because it improved product quality (fish kept cool longer). Conversely, insufficient deck space and/or crew and time needed to prepare ice was seen as a disadvantage or deterrent to its use.

The positive features of how the benefits of BRD methods have been disseminated included participation in MSC, well-designed trials, industry association working closely with its members to identify and discuss issues (e.g., pre-season skipper briefings), some technical support from regulatory authorities (e.g., port visits) and bycatch officers, and having bycatch policies and Codes of Practice. Conversely, the lack of welfare-specific Codes of Practice or outdated Codes and websites, and difficulties with designing and implementing appropriate BRD trials can inhibit best practice uptake.

Interviewees discussed some social resources encouraging the uptake of AAW practices in trawl fisheries. A significant positive influence was thought to be industry leaders proactively and consistently engaging varied stakeholders – including industry association members - to advocate for practice change. These leaders have worked across networks to build trust, assigned multi-skilled staff to bycatch management programs that involve industry, government and research organisations. One interviewee noted that some fishers' smaller vessels can reduce the ease and efficiency of more humane sorting procedures.

There were several external factors interviewees believed have positively or negatively influenced AAW uptake. The ongoing refinement and use of BRDs in trawl fisheries had been helped by improved social license to operation (SLO) (reduced catch of charismatic fauna), extensive research on BRDs, regulations mandating BRD usage, regulations maintaining fishery resource access, and MSC certification requiring limited bycatch. The use of crab bags was seen to be helped by an increased quota and opening up of markets for this product. Negative influences cited by interviewees included lengthy delays to change regulations (e.g., Mesh sizes of nets), limited legal fishing days restricting ability to run trials, and privacy laws restricting learning opportunities of Observer Program surveillance videos.

Seine fisheries (Purse, Beach, Danish) (NSW General Estuary - Danish, Western Australia - Beach)

Three interviewees talked about humane practices in purse and beach seine fisheries. Two of the interviewees were owner operators. One interviewee managed a fishing cooperative. The practices discussed included:

- (Purse seine) Short soak times, net configuration that allows fish to swim while in net, quick slaughter via ice slurry; fishing early morning to avoid seabird bycatch
- (Beach seine) Short soak times, sorting catch in shallow water, quick slaughtering of catch via ice slurry
- Use of various methods to slaughter catch – iki jime or percussion stunning and ice slurry
- Nets set in shallow water drawn in slowly; speed of haul and net design enables fish to keep swimming, catch transferred to floating baskets for sorting; direct transfer from baskets to ice slurry; use of false nets to prohibit predation of released catch by pelicans

Table 9 shows the topics Seine fishery interviewees raised when talking about factors that affect their welfare practices. These data are grouped according to four types of factors shown to influence uptake and adoption (see Figure 5). Fishers' personal beliefs that it's important to address SLO and to keep fish stocks sustainable encouraged them to fish early mornings to avoid seabird bycatch and using false nets to deter pelican predation on release of non-target catch, respectively. Interviewees looking to ensure better quality product said they were happy to use quick net soaks and haul-ins, and ice slurry to slaughter and store their catch. Other positive factors discussed included family tradition of fish dinners and understanding fishing methods that influence product taste and being motivated to learn. Personal factors thought to inhibit practice change included conservative values that encourage people being "set in their ways" and low to no awareness of existing AAW guidelines.

Table 9. Seine fisheries aquatic animal welfare practices - enablers and obstacles perceived by interviewees

Seine fisheries (Purse, beach, Danish) *(NSW General Estuary, Western Australia)*	**Enabling factors and/or advantages of practices**	**Obstacles to and/or disadvantages of practices**
	Interviewees' observations	
Do I/we want to do it? *How well does it fit w/ what I/we believe in?*	General Family tradition of fish dinners, knowing why taste varies Purse seine – quick soak, haul ins, ice slurry Fishers' motivation for better quality product Purse/beach seine – early morning fishing to avoid seabird bycatch Fishers' belief that social licenses 'costs' higher than cost of not acting to address AAW Purse/seine – false nets to deter pelican predation Fishers believe that its best to look after the resource (sustainable stocks) Extension Self-taught/observational learning	General Conservative values, people set in their ways No awareness among fishers of AAWWG Short net soaks, sorting, ice slurry - Resistance to changing tradition
Will it work? *Cost/ benefits, relative advantage, trialability, trust those promoting it?*	General Improved technology and fishing methods over last decade 20-25% price increase for quality catch since cessation of 'price pooling' by Co-Op	
	Quick haul-in-shallow water, ice slurry – avoidance of double handling Fish pump – potential time saving device, reducing damage to catch Changed net features (mesh size) – effectively reduces bycatch (rivers, estuaries) amd less sorting time	Ice slurry Very high-volume catches make it impractical Costs of electricity for making ice Fish Pump - very expensive and damages fish, limited deck space for equipment Changed net features (mesh size) – Costly, some information gaps on effectiveness
	Extension Sea net officers, annual Dept meetings, Dept scientist's w/ seabird expertise and in Observer program Sydney Fish Market fish handling workshop	Extension Lack of info/training on handling Blue Swimmer Crabs
Can I/we do it? *Do I/we have resources needed?*	General and practice of fishing early mornings Strong intra-industry and inter-agency/industry networks	General Damaged relations w/ NGOs who wanted more change than achieved to date (Int 2)
External factors *Macro-level factors beyond a seafood producers' direct control*	General Public pressure to reduce (seabird) bycatch	General Fisheries Dept 'red tape' and resistance to fishers seeking to change their fishing methods Covid19 initially reducing number of Observers NSW fisheries reform to open access and lack of kilogram quotas Co-op policies of pooled pricing – drive high catch volumes versus value-adding Low prices for fish Beach seine: short soaks, shallow water sorting, ice slurry Loss of bait fish market (Int 8) Insufficient research on fishery restructure options

Interviewees discussed features of AAW practices for purse and beach seine fishing. Generally, improved technology and fishing methods in the last decade, the cessation of price pooling by some fishing cooperatives leading to price increases for quality catch, and increased fishing efficiencies have encouraged practice change. In estuarine settings, these included quicker haul-in times, sorting catch in shallow water to avoid double handling and ice-slurry for slaughtering target catch. However, ice slurry use was seen as impractical for high volume catches and can be expensive (increased electricity costs). Fish pumps that do not damage fish can save time, although they can be

expensive and some vessels have limited deck space for them. Changes to nets' mesh size can reduce bycatch and therefore sorting times, but (new) nets can be costly and more information is needed on their effectiveness.

Interviewees did not identify many of the possible resources that can influence uptake of AAW practices. One interviewee discussed the positive and negative influence that social networks can have. This person believed that their strong relationships in industry and government networks helped identify improved AAW for their fishery. It was also noted that when there is dissatisfaction within these networks with the type and degree of practice change achieved, the resulting tension and conflict can escalate.

Interviewees were primarily focused on some external factors that they felt inhibit general AAW practice change. One interviewee felt that public pressure to reduce seabird bycatch was a valuable driver for improved practices. Other factors included government 'red tape', temporary cessation of Observer Programs due to the Covid pandemic, open access fisheries and the absence of kilogram quotas, Co-op policies of pooled pricing, and low prices for fish generally. The loss of a bait fish market and insufficient research on fishery restructuring options were thought to inhibit implementing more welfare practices in beach seine fisheries (e.g., short soaks, shallow water sorting, ice slurry).

Hook and Line fisheries (NSW Trap and Line)

Three interviewees talked about practices they/others used in Hook and Line fisheries.

- Short line soak times (1-2 minutes), lines hauled in quickly (30-60 seconds) work to minimise handling (no doubling handling) as soon as fish caught; legal sized fish spiked (on foam mattress) to slaughter them, fish early morning to avoid bycatch;
- Transferring catch into ice slurry as quickly as possible, undersized catch back into the water as quickly as possible; and
- Short net soak times, haul in lines at speeds enabling safe removal of catch, minimal line soak times, remove from hooks carefully, careful fish handling, quick release of non-targets.

Table 10 shows the topics the Hook and Line interviewees raised when talking about factors that affect their welfare practices. These data are grouped according to four types of factors shown to influence uptake and adoption (see Figure 5). One fisher believed it was important to respect your catch and be responsive to public concerns, and so used careful handling techniques. Two interviewees (fishers) motivated to learn actively sought information (from family and other sources) about welfare methods like Iki jime or percussion stunning and refined them over time. Personal characteristics seen as inhibiting AAW practice change were (older) fishers who seemed "stuck in their ways".

Table 10. Hook and Line fisheries aquatic animal welfare practices - enablers and obstacles perceived by interviewees

Hook and Line *(NSW Trap and Line)*	**Enabling factors and/or advantages of practices**	**Obstacles to and/or disadvantages of practices**
	Interviewees' observations	
Do I/we want to do it? *How well does it fit w/ what I/we believe in?*	General Belief that careful handling is being respectful to catch Having a plan to respond to public Iki jime or percussion stunning Having sufficient skills to make/adjust own equipment Extension Family tradition and knowledge exchange Practice changes from experience (getting better over time) and pursuing info Making own tools partly by talking to others	General Older fishers stuck in their ways
Will it work? *Cost/ benefits, relative advantage, trialability, trust those promoting it?*	Iki jime or percussion stunning Improved quality and therefore price of fish Easier to do with line fishing (handling one fish at a time)	General Not always able to get price premium for well handled (higher quality) fish Iki jime or percussion stunning – additional costs of having more crew
	Extension	Extension

	Sydney Fish Market workshop on fish handling Participating in the OW Master Fisherman's Program	Codes, EMS – not clear how effective they are (e.g., lacking information on slaughtering sharks) Unclear effectiveness of requirement for new entrant interviews with Dept Paper booklets too long, need pictures, better to use videos
Can I/we do it? *Do I/we have resources needed?*	General Boat configuration (e.g., steering controls at stern close to lines) Good relationships between fishers and buyers Iki-jime – having enough well-trained deck hands Extension Watching other blokes – a melting pot of experience Being on Co-op board, Lobster committee Spiking – learned from deckhand	Iki jime or percussion stunning Not having sufficient crew Extension Lacking explicit conversation about slaughtering sharks Small fleet size limits knowledge exchange via people moving up the ranks
External factors *Macro-level factors beyond a seafood producers' direct control*	General Buyer and consumer awareness of (causal) link between good handling and quality of fish Individual weigh-ins and pricing at Co-ops	General Bad weather and resulting rough seas All new fishers required to interview with Dept – not clear how effective that is for AAW

Iki jime (or spiking, and sometimes percussion stunning) was the main technique used and discussed by these interviewees. Its advantages were that it was easier to use with line fishing (removing fish from hooks one at a time) than other fishing methods and that it can improve product quality and therefore its price. The disadvantages of Iki jime were additional costs of opting for/needing more crew and selling to buyers who do not pay price premiums.

The uptake and adoption of Iki jime and other methods of this fishery has been helped by initiatives such as a Sydney Fish Market workshop on careful fish handling and OceanWatch's Master Fishermen's Program. Some of the extension weaknesses identified for the Shark fisheries also apply here (e.g., Codes of Practices, EMSs lacking information on slaughtering sharks, unclear on extent that new entrant inductions cover AAW, need greater use of instruction videos).

Fishers' access to various social, human and physical resources were discussed. The use of Iki jime was enabled by certain vessel configurations, learning about techniques from positive relationships in fisher networks, and having well-trained staff. Conversely, lacking sufficient crew and/or small fleet size limited knowledge exchange about AAW practices.

External factors positively influencing AAW practice change were seen to be buyer and consumer awareness of improved fish quality from careful handling and individual weigh-ins at fishermen cooperatives. Potential deterrents to practice change included bad weather and a lack of clarity about the effectiveness requiring new entrants to be interviewed by fisheries departments.

Finfish aquaculture (Salmon)

Two interviews covered practices in salmon aquaculture. The practices discussed were those required by the RSPCA Approved Farming Scheme Standard (Farmed Atlantic Salmon) (RSPCA 2020). Those practices generally specify that for good fish welfare, fish have space to swim normally in oxygen-rich water and can school with other fish, they are handled in a low stress manner and slaughtered using recommended welfare methods. One interviewee provided only very general information about their operation and mostly stated that they are applying recommended AAW practices. This interviewee did not discuss any factors that might be getting in the way of AAW 'best practice' in their business. Their reluctance to provide more detail could be related to the recent controversy over salmon farming in Tasmania.

Table 11 shows the topics the finfish aquaculture interviewees raised when talking about factors that affect their welfare practices. These data are grouped according to four types of factors shown to influence uptake and adoption (see Figure 5). Fishing business motivation to be good corporate citizens, well designed stakeholder engagement processes, and sufficient market demand for welfare-certified seafood were listed as enabling recommended fish

welfare practices. Factors restricting uptake of best practice included unresolved differences of opinion about the relative (cost) advantages of certification requirements (e.g., stocking density parameters, seal management) and sentience not recognized in animal welfare legislation.

Table 11. Finfish aquaculture aquatic animal welfare practices - enablers and obstacles perceived by interviewees

Finfish aquaculture *(Salmon)*	**Enabling factors and/or advantages of practices**	**Obstacles to and/or disadvantages of practices**
	Interviewees' observations	
Do I/we want to do it? *How well does it fit w/ what I/we believe in?*	Company interest and values steeped in environmental and corporate responsibility	Unresolved differences of opinion
Will it work *Cost/ benefits, relative advantage, trialability, trust those promoting it?*	Well-planned and implemented stakeholder consultation	
External factors *Macro-level factors beyond a seafood producers' direct control*	Sufficient market demand for welfare certified seafood	Unresolved differences over appropriate management strategies to reduce fish predation by seals Lack of recognition of fish sentience in animal welfare legislation

Discussion

Discussion: *Identifying best practice in aquatic animal welfare (Project objective1).*

The Practicing Aquatic Animal Welfare Project has confirmed that 'good' animal welfare, particularly for aquatic animals, is challenging to define, widely contested (Conte 2010, Huntingford & Kadri 2014) and similar to concepts like 'sustainability' can change over time (Curtis et al 2016). A key part of those discussions is whether and how to define 'sentience', pain sensations in vertebrate and non-vertebrate aquatic species, and then how to apply those principles to fishing practices. Many fisheries scientists and veterinarians focus less on 'pain' per se and see 'good' aquatic animal welfare as something more pragmatic (Diggles et al 2011; Browman et al 2019; Huntingford & Kadri 2014). That is, keeping animals healthy during the stages of capture, holding, extended captivity, and slaughter benefits the industry.

This pragmatic view was evident in the Project consultations with key seafood industry leaders. Industry leaders talked about feeling challenged by aquatic animal welfare issues, partly because 'best practice' is hard to define. Furthermore, some of them believed words like 'welfare' can elicit defensiveness among industry members. Terms like aquatic animal 'health' seemed less provocative and more easily linked by fishers to improved quality of fish products. When defining 'aquatic animal welfare', most interviewees focused on the utilitarian link (see Appendix 1) between 'humane' practices that minimise stress and therefore help get them a higher quality product. A few interviewees spoke about aquatic animals' intrinsic value and were concerned about some seafood producers' defensive attitudes towards animal welfare and the negative implications those attitudes held for the overall industry.

This Project has produced a snapshot of some international and Australian Codes of Practice and Guidelines that specify to varying degrees what 'best practice' aquatic animal welfare should look like (see Appendices 3 and 4). These materials have a strong utilitarian focus – identifying the practical and material value of aquatic animals and their habitats, which good welfare practices can protect. Most of the international works identified focus on finfish aquaculture, which could indicate that this seafood industry sector in Scandinavia and Europe is larger and has been responding longer to interest group and public pressure for improved AAW longer than is the case in Australia. In Australia there have been guidelines and codes produced by the AAWWG (for six commercial wild-catch fishing sectors), the Southern Rock Lobster industry, the Northern Territory (two wild-catch fisheries), the Northern Prawn Fishery (to address bycatch reduction), and the RSPCA (salmon aquaculture, slaughter of crustaceans).

The format and level of detail in these materials vary. They typically set out broad welfare principles, as well as identify specific steps in harvest and processing for end users to follow. The AAW Guidelines stress timely handling from capture to death to reduce stress, capture methods that minimise non-target catch, and provide more specific information for broad fisheries sectors (i.e., quick removal of fish from seine nets, optimal pot soak times to avoid bycatch and/or enable escape of juvenile fish/crustaceans, etc.)

Discussion: *Identifying extent that seafood producers are applying best practice in Australia (Project objective 2).*

There is limited information available about the extent of implementation of international and national AAW practices. Rather, most of the information identifies the need for improved AAW, debates about how best to measure AAW, and lists existing public and private initiatives (e.g., Bayel & Mellor 2014). The Project was not designed and resourced to reach a definitive conclusion about the extent that best practice AAW is being used across Australia's seafood industry or those industry sectors included in this study.

Using the desktop review, consultation with seafood industry leaders, and 16 interviews, the Project Team has been able to generate information about the *nature* of AAW practices by a subset of seafood producers. As well as the drivers and/or barriers to improved AAW practices. This information is needed to address how and to what extent AAW practices in Australia's seafood industry can be improved. It may be appropriate to extrapolate this information to the wider Australian commercial seafood industry where the circumstances of these respective groups are similar.

As noted earlier, AAW is interpreted differently for a range of reasons. Understanding those varied views helps answer the question about the extent to which recommended welfare practices are being used in the Australian seafood industry. The interview and industry consultation data suggests there are:

- Seafood producers who have some awareness and understanding of AAW benefits and are therefore proactively changing their practices;
- Seafood producers who do not see what they do daily as practicing good 'welfare' per se. Rather, it may simply be part and parcel of being a 'good' fisher that has practical benefits; and
- Seafood producers who do not understand and/or have hostile attitudes towards AAW and continue to use methods that have negative welfare impacts.

AAW in Australia's seafood industry is a complex topic. In addition to the varied and sometime conflicting definitions of 'good' AAW, Australian fisheries are diverse with numerous forms of best-practice. Furthermore, there are many potential social, economic, and environmental influences on adoption of those practices. As this Project cannot definitively answer the quantitative question of 'how widely used are recommended AAW practices' in Australian fisheries, it is helpful to analyse potential risks that may arise if 'good' welfare practices are not widely practiced.

Table 12 shows a selection of AAW practices and a qualitative estimate of uptake/adoption, possible controversy, and extension services associated with the fisheries assessed in this project. The more controversy associated with a fishery's welfare practices and the lower the levels adoption and extension of those recommended practices, the greater the risk posed to that fishery's social acceptability. For example, this analysis suggests that fisheries targeting sharks and/or grapple with shark by-catch issues could be designated as in need of priority attention.

Table 12. Estimated risk levels for the social acceptability of aquatic animal welfare practices in select Australian fisheries

		Ratings**		
AAW topic and relevant fisheries approved by FRDC	**A selection of key AAW best practices***	**Levels of adoption**	**Degree of controversy**	**Degree of effective extension**
Rock Lobster (Southern, Eastern zones)	Careful handling – avoidance of stress and broken limbs	Low	Medium	Low
	Holding procedures – crowding, optimal water quality	Low	Medium	Low
Mud Crab *(NT Fishery, Some Blue Swimmer Crab in NSW General Estuary)*	Tying claws to prevent fighting and damage	Medium	High	Medium
Shark by-catch, Target shark fishery *(NT Offshore Net and Line, Pilbara Ocean Trawl***)*	Removal of target and non-target catch from nets	Low	High	Low
	Slaughtering target catch	Low	High	Low
Trawl *(Northern, Southern, and Western Prawn)*	Bycatch reduction and maximising survivability of non-target catch	High	High	High
Seine (Purse, Beach, Danish) *(NSW General Estuary)*	Ice slurry****	Medium	Medium	Medium
	Careful and minimal handling of catch generally	Medium	Medium	Medium
Hook & Line *(NSW Trap and Line)*	Iki jime (spiking)	Low	Uncertain	Medium

** These practices were selected for analysis, because they were frequently discussed in stakeholder consultations, interviews, and the desk-top review. Some fisheries and practices do not appear in the table (e.g., members of the Octopus fishery were not available to be interviewed; insufficient data collected on aquaculture industry to designate key practices or ratings).*
***The qualitative ratings are based on data from stakeholder consultations, 16 interviews, and the desk-top review.*
****The Pilbara Ocean Trawl does not target shark species. There may be occasional incidences of bycatch of larger sharks and/or sawfish – which is not a shark species, but presents similar challenges for safe release as do sharks.*
*****As noted earlier, there is considerable debate about how 'humane' this technique is for the slaughter of some fish and crustacean species (e.g., Finfish, prawns).*

Lessons can be learned from those fisheries where there are higher levels of adoption and extension. The Northern Prawn Trawl Fisheries' relatively long history of addressing bycatch reduction challenges can provide insights for how to increase uptake and adoption, including the design and implementation of extension initiatives. Medium to high

levels of effective extension (*Mud Crab, Trawl, Seine, Hook and Line*) appear to be contributing to higher adoption levels and better management of potential and/or current social acceptability issues.

In *Hook and Line* fisheries if there are low adoption levels of Iki jime/spiking, clearer information about any controversy associated with fishery and its practices would help stakeholders decided how to prioritise improving extension efforts. For the *Rock Lobster* fisheries, greater investment in extension and other supporting policy instruments maybe be called for.

Discussion: *Identifying factors impeding the uptake and adoption of a selection of recommended aquatic animal welfare practices in wild-catch commercial fishing and finfish aquaculture* (Project objective 3).

The Practicing Aquatic Animal Welfare Project has generated information about a range of negative influences on seafood producers' uptake and adoption of recommended welfare methods. The Project desk-top review identifies that strongly utilitarian attitudes towards (aquatic) animals (Message and Greenhough 2019), general resistance to change (Eayr & Pol 2018), and low knowledge and skills can inhibit seafood producers' practice change (Jenkins 2010). These desk-top review findings were reflected in the interview data (see Table 5,

Table 6, Table 7, Table 8, Table 9, 10,

Table 11, Appendix 7. Review of uptake and adoption literature When identifying personal obstacles to welfare practices (***'Do I/we want to do it')***, interviewees across all the fisheries talked about a fisher's general resistance to change due to a seafood producers' older age, conservative values, and/or seeing social license issues as less important (*Rock Lobster, Mud Crab, Trawl, Seine, Hook and Line, finfish aquaculture)*. Interviewees also believed that a fisher's low awareness, knowledge, and skills relating to AAW restricted their ability to take up recommended practices (*Rock Lobster, Mud Crab, Trawl, Seine*).

The greater the relative advantages of certain (fishing) practices the more likely it is to be trialled and adopted (Pannell et al 2006; Condi et al 2014; Glass et al 2015; Peckham et al 2015; Sullivan et al 2017; Eayrs & Pol 2019). Some factors limiting the effectiveness and practicality of recommended welfare practices (***'Will it work?'***) arose more often in the interviews than others (see Appendix 8. Factors interviewees believe restrain AAW uptake and adoption). Interviewees from the *Mud Crab, Shark, and Seine fisheries* discussed how it can be difficult to bring capture gear onto a vessel and remove and sort (target and/or non-target) catch quickly, safely and/or efficiently. Interviewees from *Shark, Trawl, and Seine fisheries* identified that welfare focussed slaughter of target catch can be physically difficult/dangerous with large animals and/or high-volume catches.

Seafood industry practice change can also be limited by inadequate extension program design and delivery (***'Will it work?'***) (Glass et al 2015; Bradley et al 2019; Message & Greenhough 2019; Feeking et al 2019). For example, interviewees from the *Rock Lobster, Seine, and Hook and Line fisheries* believed there was a general lack of information and training – particularly for new entrants – on AAW. Interviewees across most of the fisheries reported that there was low fisher awareness of existing Codes or Guidelines, and/or those materials were out of date and/or missing subtle yet very important details about fishing with more welfare focus (e.g., *Mud Crab* codes produced in the 1990s, knowing optimal soaking times for lobster pots to avoid bycatch but ensure good target catch volumes, etc.)

Limited resources (human resources, financial, social capital, physical infrastructure) can restrict the uptake and adoption of recommended practices ***('Can I/we do it'***) (Gustavsson 2018; Mazur et al 2007; Jenkins 2010). Sub-optimal fishing vessel design features, such as insufficient deck space and/or a vessel height from the water were mentioned by interviewees in three fisheries (*Rock Lobster, Mud Crab, Trawl*) (see Appendix 8). Inadequate communication and information sharing among and between fisheries agencies and seafood industry sectors about aquatic animal welfare was seen as an issue by interviewees from three fisheries (*Rock Lobster, Mud Crab, Hook and Line*) (see Appendix 8).

The desk-top review and interviews revealed a range of **External factors** that may obstruct AAW uptake and adoption (see Tables 5-11 and Appendix 7). There is certainly debate about how and to what extent welfare legislation can improve uptake and adoption of AAW. Some cite a shortage of strong regulatory mandates for best-

practice AAW (*Rock Lobster, finfish aquaculture*). Others caution against introducing highly prescriptive regulatory regimes for AAW, particularly where controversial fisheries restructures have or will take place, and there has been insufficient consultation with affected fishers (*Sharks*). The negative impacts of fisheries reforms that lack well designed fisheries engagement measures has been well documented (Voyer et al 2016).

Other **External factors** inhibiting uptake and adoption include research, funding, and skills gaps. There are gaps in AAW research, particularly for finding reliable parameters of fish and crustacean health (Diggles et al 2011; Manfrin et al 2018); shortages of vets with qualifications in AAW (Diggles et al 2011); and in Australia insufficient funding for animal welfare generally and AAW policy, research, and extension, in particular (McCallum 2017). Interviewees cited a lack of research funding for fishery-specific AAW practices and for restructure options in fisheries with AAW controversies (*Sharks, Beach seine*). Economic obstacles to AAW can be a lack of clarity about consumers' interest in and willingness to pay for well-handled fish (Manfrin et al 2018; Conte 2010; Ellingsen et al 2014). Many interviewees were concerned about reliable and sufficient market recognition of 'welfare-friendly' fish products.

Organisations lacking a culture of 'care' are less likely to embrace best-practice welfare approaches for the animals in their short or long-term care (Brown et al 2018). The interview data included concern that large corporate seafood businesses with maximum yield as a key goal were less interested in some recommended AAW practices (e.g., *Rock Lobster*). Finally, interviewees felt that the delicate physiological features of crustaceans or large size of some fish made applying recommended practices challenging (*Rock Lobster, Sharks*).

Some obstacles mentioned by interviewees were more specific to particular fisheries than across multiple fisheries in this Project. ***Rock Lobster*** fisheries interviewees talked about negative influences on practice change such as: fishers viewing animals purely as commodities; difficulties deploying bycatch reduction devices; no regulatory mandate for aquatic animal welfare practices (e.g., BRD use, short soak times for traps); corporate mandates for maximum yield catches which may allow less time for more careful harvest and processing of catch; and crustaceans' delicate physiology. Interviewees from the ***Shark fisheries*** identified low fisher morale from non-consultative fisheries reforms; an overreliance of printed booklets as extension tools; and a lack of funding for research on humane slaughter methods for sharks. Interviewees from various ***Seine fisheries*** identified failed relationships between the seafood industry and NGOs as potential and actual obstacles. A lack of funding for research on fishery restructure options was mentioned in relation to Beach seine fisheries, as well as not being able to obtain price premiums for well-handled (and therefore higher quality) fish products.

Discussion: *Identify appropriate strategies to mitigate obstacles to improved uptake and adoption of those recommended practices* (Project objective 4).

If the nature of good practice is clear, and we have identified barriers, then strategies to reduce those obstacles and regularly monitor and evaluate progress toward good practice are needed (McKenzie-Mohr & Schulz 2014). In addition to identifying obstacles to uptake and adoption of AAW, this Project has highlighted factors that are likely to *encourage* practice change. Table 13 provides a summary of those key enabling factors, and this also reflects strong consistency between the desk-top review and interview data. Not surprisingly, in cases where obstacles were minimal and a range of these and other enabling factors were present, there were reports of greater use of 'best practice' AAW (see Table 5,

Table 6, Table 7, Table 8, Table 9, Table 10,

Table 11, Appendix 7. Review of uptake and adoption literature

Table 13. Summary of factors that help to enable aquatic animal welfare uptake and adoption

Categories	Enabling factors	Literature	Interviewee mentions
Do I/we want to do it? *How well does it fit w/ what I/we believe in?*	Seeing aquatic animals as 'sentient' beings with intrinsic value	Message & Greenhough (2019), Ellingsen et al 2015	*Rock Lobster, Mud Crab, Seine, Hook and Line*
	Interest in learning, greater skills and knowledge, willingness to embrace change	Eayrs & Pol (2019), Gustavsson (2018), Sullivan et al (2017), Jenkins 2010	*Rock Lobster, Mud Crab, Seine, Hook and Line*

Will it work? *Cost/ benefits, relative advantage, trialability, trust those promoting it?*	Being able to obtain price premiums for well-handled catch	Hardy-Smith (2015), Diggles (2011), Glass et al 2015, Feekings et al 2019	*All*
	Welfare practices that are relatively easy to use, effective, and safe	Feekings et al (2019), Eayrs & Pol 2019, Hardy-Smith 2015	*All*
	Extension: regular occurrence, emphasis on open discussions with and involvement of fishers about AAW challenges and practical solutions and trials	Jennings & Pakula 2011, FAEAWG 2012, Glass et al 2015	*All*
	Extension: Dedicated resources to enable qualified (government, industry, NGO) staff to deliver training	Jenkins & Pakula 2011, FAEAWG 2012, FRDC 2020	*Trawl, Seine*
Can I/we do it? *Do I/we have resources needed?*	Social capital: positive relationship within and across seafood industry, government, research, and NGO networks which helps foster mutual learning	Pannell et al (2006), Brooks et al 2019, Jenkins 2010, Voyer et al 2017	*All*
	Access to formal education/training (e.g., AAW, natural resource management)	Bradley et al 2019, Jenkins 2010, Gustavsson 2018	*Rock Lobster, Mud Crab*
External factors *Macro-level factors beyond a seafood producers' direct control*	Public acknowledgement of seafood producers' efforts to address AAW	Piovano et al 2012, Jenkins 2010, Diggles et al 2011	
	Market recognition of standards/certification for AAW and the link to product quality (e.g., wholesale and retail buyers, consumers)	Conte 2016, Browman et al 2019	*Rock Lobster, Mud Crab, Hook and Line, Aquaculture*
	Public pressure to address AAW (e.g., reduce bycatch, humane holding of live catch, etc)	McCallum 2017, Mazur et al 2014,	*Mud Crab, Shark, Trawl, Seine*
	Regulatory mandates that (appropriately) address AAW as well as sustainability (e.g., bycatch reduction, wildlife-fishing interaction reporting w/o penalties, etc)	Browman et al 2019, Salzman 2019,	*Rock Lobster, Shark, Trawl*
	Environmental conditions and particular physiological characteristics of fish/crustaceans (e.g., warm waters mandating fast removal of catch from sea, crustaceans' delicate limbs, etc)	Message & Greenhough 2019, Huntingford & Kadri 2014	*Rock Lobster, Mud Crab, Shark*

The Project's desk-top review also demonstrates that over the last 5-7 years a wide range of resources have been developed that already include ***strategies for improving practice change*** in Australia's commercial fisheries and aquaculture. These resources address ways to improve uptake and adoption in fisheries more generally (Jennings & Pakula 2011; FAEAWG 2012; RIRDC 2017). They also address ways to encourage practice change relating to more specific topics such as OH&S (Brooks et al 2019), stakeholder and community engagement (Mazur & Brooks 2018; Mazur et al 2014), and AAW practices - including bycatch reduction (Mazur et al 2007; Hardy-Smith 2015; McCallum 2017; Boulton & McCallum 2018).

This Project value-adds to that body of work by providing a way to categorise the vast range of influences on seafood producers' AAW (and general) practices, and provide qualitative data and information about the nature of those influences (see Table 13). Recommendations for enhancing the enabling factors and mitigating obstacles are also provided (Table 14 below and addressed in more detail in the Recommendations Chapter).

Table 14. Strategies to enhance enabling factors for improved aquatic animal welfare uptake and adoption

Categories	Enabling factors	Strategies to enhance enabling factors and reduce obstacles
Do I/we want to do it? *How well does it fit w/ what I/we believe in?*	Seeing aquatic animals as 'sentient' beings with intrinsic value	• Provide support to seafood industry members whose core values and beliefs are more sympathetic to not just the material but also the moral benefits of AAW to become 'change champions' • Identify those seafood industry members with a strong interest in learning and provide opportunities for them to build skills in AAW
	Interest in learning, greater skills and knowledge, willingness to embrace change	

Will it work? *Cost/ benefits, relative advantage, trialability, trust those promoting it?*	Fishers being able to obtain price premiums for well handled-catch Welfare practices that are relatively easy to use, effective, and safe	• Work with fish wholesalers/processors to create price premiums for well-handled and therefore higher quality fish, to encourage fishers to see the relative advantages • Examine more closely how and to what degree relative advantages of particular recommended welfare practices are present (e.g., ease of use, trialability, etc.) • Ensure fisher participation in the design and implementation of research on and trials of recommended AAW practices.
	Extension: Regular occurrence, emphasis on open discussions, fishers involved in identifying AAW challenges and practical solutions, fishers involved in designing and implementing and evaluating trials of best practices Extension: Dedicated resources to enable qualified (government, industry, NGO) staff to deliver training	• Consider ways to manage funding gaps for AAW, extension generally, and extension for AAW recommended practices in particular • Identify type and extent of resources (human, financial) required to deliver extension programs or projects that include a focus on AAW • Investigate feasibility of reviving the Fisheries Extension Network
Can I/we do it? *Do I have resources needed?*	Social capital: positive relationship within and across seafood industry, government, research, and NGO networks which helps foster mutual learning about AAW	• Increase and strengthen favourable relationships within and across seafood industry and fisheries policy networks by encouraging reciprocity (mutual benefits for participants)
	Access to formal education/training (e.g., AAW, natural resource management)	• Ensure extension programs featuring AAW can be readily accessed by interested fishers
External factors *Macro-level factors beyond a seafood producers' direct control*	Public pressure to address AAW (e.g., reduce bycatch, humane holding of live catch, etc) Public acknowledgement of existing welfare practices undertaken by fishers	• Identify opportunities to incorporate AAW into existing industry engagement strategies that focus on improving trust with influential decision makers and interest groups • Assess risk level of negative public sentiment by incorporating AAW topics into existing public surveys conducted by and for the seafood industry
	Market recognition of standards/certification for AAW and the link to product quality	• Engage with fisheries economics and marketing experts and NGOs to determine what 'levers' can be pulled to improve the visibility of product quality and good AAW practices
	Regulatory mandates that appropriately address AAW as well as sustainability (e.g., bycatch reduction, wildlife-fishing interaction reporting w/o penalties, etc)	• Synthesise findings from this Project and FRDC Project 2020-020 to identify the extent that current and proposed AAW legislation can account for factors influencing practice change.

Discussion: ***Help build the Australian seafood industry's capacity to design and implement extension programs, especially those targeting increased uptake and adoption of recommended aquatic animal welfare practices*** (Project objective 5).

Extension programs are one of several policy tools that help address complex policy problems and build capacity for change (Curtis et al 2019; Salzman 2019). This Project has re-iterated the widespread calls to improve Australian fisheries extension capacity and increase the adoption of fisheries research findings through better funding, other kinds of support, and more frequent evaluation (e.g., ANFAEAS 2012; Jennings & Pakula 2011; Williams et al 2018). Ideally, fisheries extension should facilitate improved communication and information exchange among industry, agency, and community stakeholders.

This Project has identified key obstacles to AAW uptake and adoption that are related to extension design and implementation (see Table 5,

Table 6, Table 7, Table 8, Table 9, Table 10,

Table 11, Appendix 7). As noted above in the discussion about Objective 3, these extension weaknesses include codes and guidelines that are believed to be out of date, missing subtle but important elements, and/or not widely disseminated (hence low awareness of them among fishers). There is also an alleged overreliance on printed

materials to provide information about AAW and little evaluation of the effectiveness of those and other extension initiatives.

Identifying these weaknesses can help the seafood industry, governments and NGOs formulate strategies to reduce these barriers. Conversely, the more effective extension features identified by this Project can be used to create strategies to enhance those efforts (see Table 5,

Table 6, Table 7, Table 8, Table 9, Table 10,

Table 11, Appendix 7 & 9). As noted earlier, those features include, but are not limited to, regular and flexible modes of delivery and content focused on practical problem solving, trialling new practices, and securing dedicated (human, financial) resources for design and delivery of extension programs.

Discussion: *Contribute to increased likelihood of more widespread and enduring practice-change in the seafood industry's aquatic animal welfare practices in wild-catch commercial fishing and finfish aquaculture* (Project objective 6).

This Project has framed the question about practice change in the Australian seafood industry as primarily a matter of behaviour change. People's choices – in this case seafood producers' decisions about how and to what extent they will use recommended AAW methods – are influenced by far more factors than someone or some organisation simply making a request for them to do so (Mazur et al 2007; Mazur & Brooks 2018; Pickworth et al 2007; Stern et al 1993, 1999; Stern 2000).

Grouping those influencing factors into four categories, *'Do I/we want* to', *'Will it work?*', *'Can I/we do* it', and '*External factors'*, provides a type of 'short cut' or checklist. It can operate as a logical framework to help enable the necessary changes. Seafood industry members, fisheries managers, researchers, extension providers and others can use the list to consider what might be influencing practice change in various fisheries. In turn, they can then make more informed and earlier decisions about designing, implementing, and monitoring and evaluating best practices.

There is another important benefit from using a change framework to help improve AAW uptake and adoption. That is the question of shared responsibility. Society is calling for the seafood industry to clearly demonstrate its 'duty of care' to aquatic animals using (more) welfare focused methods. Where that 'duty of care' requires 'step changes' in fishing practices, considerable costs may be imposed on some fishers. This may be a considerable barrier for some businesses, particularly those operating on slim profit margins. The fisheries policy community could investigate ways to ensure the procedural fairness of current and future decision-making when wider societal expectations impose large financial costs on the industry.

The Practicing Aquatic Animal Welfare Project's participative methods will also contribute to more extensive practice change. A subset of industry participants has helped define 'the problem' to be investigated as well as identify possible solutions. The Project Advisory Panel consisted of professionals with strong working knowledge and experience in the Australian seafood industry, fisheries research (biological and social), aquatic animal welfare, and research extension. Panel members were consulted as a group and individually throughout the various stages of the Project. They had several opportunities to share their opinions about priority welfare topics for investigation, key stakeholders to consult, the significance and implications of preliminary Project findings, and draft report preparation. Industry association leaders were also consulted on the relevance of selected welfare topics for their fisheries, challenges of addressing aquatic animal welfare, and people for the PIs to contact for the interview process. Finally, during the interviews participants learned about the Project's aims and objectives and shared their views about AAW issues and methods.

Conclusion

Animal welfare proponents seek to prevent or reduce animals' suffering and maximise their well-being. This goal is far from simple. Like environmental and natural resource management, approaches to animal welfare vary according to people's fundamental beliefs about how much and what kind of action we should take to protect animals. A key challenge for Australia's seafood industry and governments is to implement AAW policies and management measures that have optimal levels of scientific rigor and social acceptability in a practical and cost-effective way. Insufficient and inappropriate action can generate intense levels of public scrutiny that in turn can further compromise fisheries' market and resource access. Recent controversy associated with salmon farming in Tasmania or the 'super trawler' are examples of this type of negative outcome.

Since the launch of the AAWS in 2005, numerous projects under the guise of the AAWWG and FRDC have been implemented to help address AAW challenges in Australia's seafood industry sectors. More recently, the FRDC has recognised that public controversies about animal welfare practices in other primary industries held comparable risks for the seafood industry. Consequently, this Project was funded in order to generate further information about how AAW is understood, what factors influence industry members ability to use recommended practices, and what strategies can help improve the uptake and adoption of those practices.

Best practice

Since 'animal welfare' can be understood in varying and sometimes conflicting ways, it follows that what constitutes 'good' or 'best-practice' *aquatic* animal welfare is difficult to pin down. A key point of disagreement has been and remains whether fish and crustaceans should be considered sentient beings and therefore feel 'pain'. There has been some consensus in the international and Australian scientific and seafood industry communities that taking a pragmatic view is the best way to move forward. That is, broader society expects at a minimum some consideration be given to the welfare of fish and crustaceans and that preference should be accommodated by the seafood industry. Secondly, in addition to the moral imperative for AAW, minimising stress of target (and non-target) aquatic animals from capture to slaughter also has a range of practical benefits.

The range of international and Australian guidelines and codes of practice for 'best practice' identified by this Project (Appendix 4) heavily emphasise the practical benefits of AAW. Harvested aquatic animals that have been handled and slaughtered with more care will yield a higher quality product; and international literature suggests more work has been done specifying recommended welfare practices for finfish aquaculture than for wild-catch fisheries. In the Australian context, there are a range of guidelines and codes that directly and indirectly set out welfare practices for both finfish aquaculture and wild-catch fisheries. They identify the different stages of fishing and recommend ways to handle animals from capture to slaughter that reduces stress, capture methods that minimise non-target catch, and humane-focused, timely slaughter methods of target catch.

Extent of 'best practice'

There is considerable information available about the need for (improved) AAW, debates about how best to measure 'good' AAW, and existing public and private initiatives addressing AAW. This Project did not find as much information about levels of international and Australian adoption of these recommended practices; however, there is evidence that seafood industry members' values, beliefs, attitudes, and practices relating to AAW occur along a spectrum. At one end are fishers with greater awareness, understanding and support for AAW's moral and material benefits and, as such, are proactively changing their practices. At the other end of the spectrum are fishers who are highly sceptical about AAW and continually use methods that have negative welfare impacts. In the middle are those with varying degrees of awareness, knowledge, support, and operational use of 'best practice' AAW.

This Project has also generated practical information about what type of welfare methods are being used in parts of some fisheries and what factors hinder or help fishers to adopt recommended practices (see Tables 5-11, Appendix 7). This kind of information may in the short term be more important than trying to obtain a precise quantitative stocktake of recommended AAW practices being used in Australia's seafood industry. Such a measure would be logistically challenging, and expensive, given the current lack of consensus on what constitutes 'best practice', the size and variation of the industry and fishing methods, and limited (human and financial) resources. Furthermore, our qualitative data may be applicable to the wider Australian seafood industry where their circumstances are similar with those fishers participating in this Project.

What gets in the way of 'best practice'?

A range of factors are likely to inhibit seafood producers' capacity to adopt recommended AAW practices (see Table 5,

Table 6, Table 7, Table 8, Table 9, Table 10,

Table 11, Appendix 7). This Project has categorised these factors as: ***Do I/we want to do it?*** (How well does it fit with what I/we want and believe in?); ***Will it work?*** (What are the relative advantages of using it); ***Can I/we do it?*** (Do I/we have the resources I need?); and ***External factors*** (market conditions, government policy, environmental conditions, public opinion).

Some seafood producers' personal characteristics (*Do I/we want to do it?*) such as strongly conservative values and negative attitudes towards (aquatic) animals were linked to their resistance to using recommended welfare methods. Some features of recommended AAW practices (*Will it work?*) can reduce uptake and adoption, such as Iki jime/spiking or percussion stunning for high volume catches. Recommended AAW methods were used less when seen by fishers as difficult, dangerous, and/or expensive to use.

Extension projects that lacked any or sufficient on-going funding, extensive and appropriate fisher participation in design and implementation, trusted staff, or easily accessible information were not seen as contributing to improved AAW. Where fishers had limited social and physical resources (*Can I/we do it?*), such as convivial relationships within and across different parts of Australia's fisheries policy networks or boats designed to accommodate recommended welfare methods, uptake and adoption was more limited.

A range of influences beyond the direct control of fishers (*External factors*) are believed to inhibit AAW uptake and adoption. These obstacles include gaps in research, funding, and skills (veterinary specialists); unclear market signals for welfare-friendly seafood harvesting; and industry organisational cultures that are resistant to change.

Strategies to help

Not surprisingly, in cases where these obstacles were minimal and a range of enabling factors were present, there were reports of greater use of 'best practice' AAW (see Table 5-14, Appendix 7). A key strategy for continual improvements in AAW will be to amplify the positive influences on adoption by using a range of policy measures, such as:

- Support seafood industry members with more positive attitudes to AAW and stronger interests in learning and who are trusted by other fishers to act as 'change agents';
- Continue development of effective and highly useable AAW methods and ensure that fishers participate in that development and in trials of those methods;
- Increase the use of price premiums for fish and crustaceans caught using welfare-focused harvesting and holding methods;
- Secure dedicated and stable funding for fisheries extension generally and AAW in particular;
- Build social capital within and across different government, industry, and NGO sectors in Australia's fisheries policy networks; and
- Incorporate AAW into existing seafood industry projects/initiatives focused on engaging with decision makers, interest groups, and the wider public.

In addition to amplifying enabling factors, another strategy would be to undertake some risk analyses (see Table 122). The seafood industry's social acceptability will be influenced by levels of public controversy about AAW practices, and how actively, and effectively, good practices are currently used. This also depends on whether or not there are effective extension options available (see Table 122). Risk assessment is widely used to anticipate problems and to target often scarce resources at higher risk issues. In this AAW context, risk remediation strategies can focus on those higher risk situations, likely to arise from a combination of more controversy (contemporary or predicted) about AAW issues, low adoption levels of recommended practices, and substantive gaps in extension efforts targeting AAW.

Opportunities should also be sought and taken to identify lessons from examples where fisheries have dealt successfully with public controversy over AAW by widely implementing recommended welfare practices through

well-designed and funded extension programs, such as OceanWatch's Master Fisherman's Program and the Northern Prawn Fishery BRD campaign.

Building industry capacity for practice change

This Project has generated information that, where sufficient funding and industry motivation are present, could help Australia's seafood industry build its capacity to create extension programs targeting AAW practices and therefore to facilitate more extensive and lasting practice change. To do this we have utilised secondary data from numerous (international and national) projects that were commissioned to identify seafood industry capacity for change generally, and particularly for improved aquatic animal welfare, extension, OH&S, and community engagement. These Projects also identified a range of barriers and enabling factors influencing desired outcomes.

This Project has valued added to that substantive body of knowledge by:

- Repeating the call to view uptake and adoption as a key element of behaviour change;
- Providing a framework to readily categorise different types of influences on seafood producers' choices to use and eventually adopt recommended AAW practices;
- Synthesising existing knowledge about factors influencing uptake and adoption with current data about some Australian seafood producers' use of key recommended welfare practices; and
- Engaging with interested industry members and fisheries experts who hold (formal and informal) 'leadership' roles in the seafood industry, which ensures the research findings are more relevant and therefore likely to be more influential.

Implications

The following outlines the potential impacts of the Practicing Aquatic Animal Welfare Project's outcomes on key end users. The primary target audience is the FRDC staff. The secondary target audience is current and former members of the Aquatic Animal Welfare Working Group (AAWWG); OceanWatch directors, staff, and key stakeholders; seafood industry leaders (e.g., CEOs of the national and state industry associations); and members of the FRDC Research Advisory Committees across the jurisdictions. While not specified in the original Project proposal, other important potential end users include government fisheries policy makers and managers, and fisheries (social, biological) researchers and extension providers.

Table 15 shows the primary outcomes flowing from the Project's major outputs, which is this final report containing:

- Lists of AAW 'best practices' applied in Australia and obstacles to uptake of those recommended practices in an agreed subset of wild-catch commercial fisheries and finfish aquaculture contexts; and
- Strategies to improve AAW management outcomes in wild-catch fisheries and finfish aquaculture.

Table 15. Practicing aquatic animal welfare outcomes

Practicing Aquatic Animal Welfare Project stated outcomes
Improved understanding about how the type of best (aquatic animal welfare) practices, their development, the degree of practice change required by them, and target audiences' situations influence uptake and adoption.
Improved understanding of the relationship between type of aquatic animal care recommended practice and type of barrier to adoption.
Increased seafood industry capacity to implement strategies to help strengthen positive aquatic animal welfare outcomes.
Increased likelihood of more widespread and enduring practice-change in seafood industry practices relating to positive aquatic animal welfare outcomes.

A key positive impact of this Project is providing interested members of the fisheries policy community (or 'network') with a constructive framework about adoption of best practice that has been widely used in other primary industry settings, as well as fisheries. This is a tool to support earlier and more informed decisions about the design, finalisation, and implementation of 'best practice' AAW; as well as how to monitor and evaluate those practices.

This Project and other related FRDC projects have provided valuable information about the need for better supported and designed seafood industry extension programs. Extension approaches are more effective when there are gaps in seafood producers' awareness, knowledge, and skills; the recommended practice have relative advantages for fishers; and mutual learning is needed to address uncertainty about how to achieve improved AAW. However, this finding could also increase the expectation that NGOs like OceanWatch should (and can) 'fill the gaps' in extension services. This expectation may not be realistic given systemic shortages of (human and financial) resources for these organisations that often have to make tough decisions about how they will prioritise a range of resource management issues that need attention.

Therefore, extension should not be thought of as the single or 'default' policy response. A range of policy instruments are needed to address complex policy issues, such as AAW practices in Australia's seafood industry. For example, where a recommended AAW practice involves significant cost impositions on fishers, it will be necessary to consider additional policy instruments to support uptake (e.g., financial or market instruments, regulations).

As noted earlier, this Project has not been designed or resourced to provide a comprehensive scan of all AAW practices being used across a statistically representative sample of Australia's seafood industry. The Project does provide information about some AAW practices being used, many of which are not necessarily seen as 'animal welfare' per se, rather just 'part and parcel' of good fishing and production methods. There is a risk that seafood industry members and/or others may assume that the findings fully represent the entirety of each fishery included in this research. Some sensitivity will be needed when releasing the results to avoid amplification of the favourable or less positive findings about those fisheries.

Where data and information from this Project are not used to best effect, the industry's social acceptability levels are at risk of further erosion. AAW advocates may be sceptical if government and industry claim that substantive change cannot happen yet, because not enough is known about how to improve AAW practices. This Project has highlighted that a substantive body of AAW (biological and social) research and other initiatives have been undertaken. Some knowledge gaps remain; however, they do not fully explain why Australia's seafood industry has not made further progress on improved AAW. The seafood industry and fisheries regulators need to consider why recommendations in previous works have not been taken up more widely.

Finally, when members of the seafood industry respond defensively to calls for improved AAW, risks to its social acceptability are also amplified. Reactive actions or withdrawing altogether inhibits learning and the potential to improve relationships across networks and AAW practices. One example of defensive industry behaviour is to see others (e.g., 'the' public) as 'the problem'. This perspective tends to lead to actions like trying to secure funds for a comprehensive and quantitative stocktake of AAW practices across Australia's seafood industry and then to incorporate those data into conventional communications strategies that tell the public how well the industry is performing. This kind of action can distract industry members from focusing on the more effective response, such as patiently building more trusting and transparent relationships with influential individual and groups interested in AAW decision-making.

Recommendations

The five key recommendations described below are designed to amplify the enablers of good AAW practice, and mitigate the obstacles hampering AAW uptake and adoption. They reflect the analysis and findings from the desk-top review, consultations with twenty-three seafood industry leaders, and the in-depth interviews with sixteen fisheries experts, and individual fishers. They should form part of a revitalised and carefully targeted response by FRDC and the appropriate sectors of the Australian seafood industry to further improve AAW outcomes, and strengthen industry's social capital to the greatest extent possible.

Recommendation 1 – Support seafood producers answering 'yes' to the question: *Do I/we want to do it?*

One of the most powerful influences on seafood producers' decisions to use and adopt recommended AAW practices relate to their personal characteristics (values, beliefs, goals, knowledge). They will typically consider how well a particular welfare practice aligns with their own outlook. For some seafood producers' their reluctance to see aquatic animals as sentient beings, and/or a resistance to change generally, reduces the likelihood they will embrace positive AAW practices.

Conversely, those seafood business operators/fishers/producers who believe in treating (aquatic) animals with a welfare focus, and have strong interests in lifelong learning, are more likely to use and adopt recommended AAW methods. Hence, the seafood industry should consider:

- Identifying those seafood industry members who have core values and beliefs that are more sympathetic to the material and moral benefits of AAW; and supporting them to become industry 'change champions' at a range of scales (regional, local, individual businesses);
- Identifying other more progressive seafood industry members that are more open to change, and providing opportunities for them to build skills in AAW, similar to the OceanWatch Master Fisherman Program; and
- Encouraging current and future compliance with those 'best-practice' AAW methods for which there is a high degree of consensus on by actively discouraging poor welfare harvesting and processing practices.

Recommendation 2 – Ensure seafood producers *can* answer 'yes' to the question: *Will it work?*

Seafood producers will ask '*Will it work*' when considering whether to use a particular AAW approach or method. Not surprisingly we found that practices with fewer relative advantages (low efficiency, effectiveness) lower the likelihood of use and eventual adoption. Less complicated practices with low usage costs (time, financial), reduced bycatch but not targeted catch, and clearly reduced fish/crustaceans' stress were more appealing. Flexible and targeted extension services that were delivered by trusted providers are seen to be more effective at encouraging AAW uptake and adoption. Therefore, the seafood industry should consider ways to:

- Work with fish wholesalers/processors to create price premiums for well-handled and therefore higher quality fish, to help seafood producers' see the relative material advantages of AAW;
- Examine more closely how and to what degree relative advantages of particular recommended welfare practices are present (e.g., ease of use, trialability, etc.);
- Ensure fisher participation in the design and implementation of research on and trials of recommended AAW practices;
- Better manage funding gaps for AAW, extension generally, and extension for AAW recommended practices in particular;
- Identify the type and extent of resources (human, financial) required to deliver extension programs or projects that include a focus on AAW; and
- Investigate feasibility of reviving the Fisheries Extension Network to assist with improving AAW uptake and adoption.

Recommendation 3 - Ensure seafood producers can answer 'yes' to the question: *Can I/we do it?*

When fishers consider taking up a new or different practice, they will also be asking themselves whether they can access the human, social, financial, and physical resources required to use a recommended AAW practice (*Can I/we do it?*). Some wild-catch commercial fishers are limited by sub-optimal vessel design features, such as insufficient deck space and/or a vessel height from the water. Inadequate communication and information sharing among and between fisheries agencies and seafood industry sectors about aquatic animal welfare also act as barriers: Therefore:

- Formal and informal initiatives are needed that increase and strengthen favourable relationships within and across seafood industry and fisheries policy networks by encouraging reciprocity (mutual benefits for participants)
- Ensure extension programs featuring AAW can be readily accessed by interested fishers, for example by providing sufficient and appropriate resourcing (human and financial) for design and implementation according to recognised contemporary best-practices.

Recommendation 4 – Address external factors influencing fishing or production practices

There will always be a range of macro-level factors that may be outside seafood producers' direct control, but still affect their choices about how and to what extent they will adopt recommended AAW practices (e.g., economic conditions and pressures; government policies, legislation, programs and priorities; public pressures; and environmental conditions). This Project suggests that poorly designed fisheries and/or animal welfare legislation and regulations, chronic funding shortages for AAW initiatives, a lack of clear market signals in support of seafood production that reflects good AAW practice, and negative public opinion can dampen seafood producers' interest in and ability to adopt recommended practices. Therefore, the seafood industry should:

- Identify opportunities to incorporate AAW into existing industry engagement strategies that focus on improving trust with influential decision makers and interest groups;
- Assess risk level of negative public sentiment by incorporating AAW topics into existing public surveys conducted by and for the seafood industry;
- Engage with fisheries economics experts and NGOs to determine what 'levers' can be pulled to improve the visibility of product quality and good AAW practices; and
- Synthesise findings from this Project and FRDC Project 2020-020 to identify the extent that current and proposed AAW legislation can account for factors influencing practice change.

Recommendation 5 - Further development

There are also several important AAW issues or factors that were outside the agreed scope of this project. Some of these would also benefit from further progress or development.

Firstly, it has been noted that complex policy issues, such as how to improve adoption of best practice AAW in Australia's seafood industry, require a range of policy instruments (regulatory to non-regulatory) to influence behaviour. The seafood industry and fisheries regulators cannot rely simply on 'persuasion' (i.e., extension) to improve uptake and adoption, especially given the lack of support and investment for that policy tool. Greater consideration is needed on how a selection of carefully designed policy instruments can be used in a more integrated and coordinated fashion to help improve AAW practice change in the seafood industry. FRDC Project 2020-020 will produce important information about AAW regulations and self-regulatory mechanisms, which can be synthesised with this Project's findings as an important starting point.

Secondly, there remains the long-standing difficulties of getting more seafood industry members to seriously engage with AAW issues in their fisheries, regions, and nationally. There are also a range of financial and resource shortages that complicate substantive action. Consequently, there is a need to be selective about which AAW issues to address and at what scales. Similar to the analysis in Table 11, a more comprehensive and in-depth risk analysis could estimate how much public controversy about AAW practices has or is likely to occur, current and future levels of

adoption of recommended AAW practices (including which of the six stages of adoption seafood producers are up to – see Appendix 5), and effective extension available. As is done for ESD risk assessment processes in many Australian and international fisheries, remediation strategies can focus on higher risk situations, where there is a combination of more controversy (contemporary or predicted) about AAW issues, low adoption levels of recommended practices, and substantive gaps in extension efforts targeting AAW.

Thirdly, FRDC Project 2019-023 does not provide a definitive conclusion on the extent that best-practice AAW is being used across Australia's seafood industry. The Project does provide a taste of some of the practices being used, many of which are not necessarily seen as 'animal welfare' per se, rather just 'part and parcel' of good fishing or production methods. Any further research, or future scanning for AAW practices in Australia's seafood industry, should be:

- Designed and implemented with the participation of interested seafood industry members;
- Based on a more specific list of AAW practices where there is a relatively high degree of consensus that those methods qualify as 'best practice';
- Consistently examining the four categories of barriers and enabling factors used in this Project; and
- Targeting fisheries and sectors not covered by this Project (e.g., aquarium industry, etc).

Next steps:

- Workshop to draw out policy and industry-led options to enhance adoption, including feasibility of a risk assessment.
- Case studies to test risk assessment and options to improve adoption.

Extension and Adoption

The aim of the extension component of this Project is to:

- Deliver findings to the target audiences that directly address the identified need for this research; and
- Prepare and disseminate findings in ways that are readily accessible to a diverse target audience, so that the information provided is more likely to:
    - Be understood and therefore increase people's understanding of how to increase uptake and adoption of recommended aquatic animal welfare practices; and
    - To have discernible and positive impacts on the broader seafood industry culture.

Target Audiences

The primary target audience for this Project has been officers of the FRDC, namely the FRDC's Human Dimensions Research Coordination Program (HDR). The secondary target audience is OceanWatch directors, staff, and key stakeholders; current and former members of the Aquatic Animal Welfare Working Group (AAWWG); seafood industry leaders (e.g., CEOs of the national and state industry associations); and members of the FRDC Research Advisory Committees across the jurisdictions who would be interested in improving uptake and adoption of recommended aquatic animal welfare practices.

Key messages

1. Good animal welfare practices generally result in better product quality and higher prices.
2. Seafood industry members who can demonstrate improved aquatic animal welfare, fish-handling/discards, and bycatch practices are more likely to retain their social license to operate.
3. There are different types of factors that make it difficult for the seafood industry to implement AAW 'best practices'.
4. Designing strategies that reduce and/or eliminate constraints to uptake/adoption can improve aquatic animal welfare outcomes.

Extension methods – during the Project

This Project entailed substantive consultation with FRDC and FRDC HDR staff. We communicated regularly and extensively with Drs Carolyn Stewardson and Emily Ogier throughout the life of the Project. These discussions focused on key design and implementation features, including animal welfare topics for investigation, engagement of key stakeholders, and reporting requirements.

The Project's extension and adoption strategy has also included extensive engagement with key members of our secondary target audience. The six member Project Advisory Panel included professionals with strong working knowledge and experience in the Australian seafood industry, fisheries research (biological and social), aquatic animal welfare, and fisheries extension. The Panel helped identify the key welfare topics for investigation, which seafood industry leaders to consult with, and how best to prioritise and present findings to ensure their accessibility to a diverse audience. In addition, over twenty seafood industry leaders were contacted – often more than once – to provide them with information about the identified need for the Project, and to identify how and to what extent the welfare topics nominated and approved by the Project Team and Advisory Panel were relevant to their industry members. These stakeholders also provided the Project Team with information about which of their members might be willing to participate in our interview process.

Extension and adoption methods – after Project

Further extension of the Project's findings to members of the Research Advisory Committees and other seafood industry leaders will primarily be the responsibility of the FRDC and the FRDC HDR. We are unable to report on Adoption of Project findings at this stage, because further development and extension of the Project's Final Report is

to be determined by the FRDC HDR, and such activities were not incorporated into this Project's objectives or budget. The Project Team could present the Project findings at key fisheries meetings or conferences.

We do recommend that upon completion of the Project, with further consultation with FRDC and OceanWatch and support from FRDC, OceanWatch could:

- Integrate key Project recommendations into their operating procedures;
- Notify OceanWatch staff and Directors, OceanWatch and seafood industry stakeholders about the Project's completion and provide them with a Project brochure and access to the final report;
- Notify its wider stakeholder audience about key Project findings via a range of social media platforms;
- Conduct a workshop for SIA and the seafood industry's state peak bodies, as well as a selection of seafood industry associations across the jurisdictions. The Workshop would focus on the Project's key findings, recommendations and implications for implementation; and
- Present key Project findings to (DAWR) and to members of NRM Regions Australia.

Appendix 1. Typology of and discussion about attitudes to animals

Animal welfare approaches vary and are widely debated, depending on peoples' fundamental values and beliefs. These views can be organized along a spectrum of environmental values. At one end of that spectrum is the view that human interests are central and paramount, so people are entitled to use animals for any purpose deemed 'legitimate' (instrumental value). At the other end of the spectrum humans are seen as one of many species that are part of- not above - nature. Animals are considered to have value in their own right (intrinsic value[9]), therefore they have 'interests' that should be weighed against human interests when particular uses are being considered. In between these ends of the spectrum are a range of positions.

Other researchers have developed typologies of attitudes to animals. One of the most prominent of those was formulated by Stephen Kellert (see Table 16). Kellert (1993) found that out of nine different kinds of attitudes. Some of the more common ones in Western society are *humanistic* (strong affection for individual animals), *moralistic* (concern about right and wrong ways to treat animals), *utilitarian* (animals' practical value to humans most important), and *negativistic* (avoiding animals due to dislike or fear). While those attitudes remain dominant, there has been an increase in compassionate, protective and empathetic attitudes towards animals (reference).

Table 16. Typology of attitudes to animals

Naturalistic	Primary interest and affection for wildlife and the outdoors.
Ecologistic	Primary concern for the environment as a system, for interrelationship between wildlife species and natural habitats.
Humanistic	Primary interest and strong affection for individual animals, principally pets.
Moralistic	Primary concern for the right and wrong treatment of animals, with strong opposition to exploitation or cruelty towards animals.
Scientistic	Primary interest in the physical attributes and biological functioning of animals.
Aesthetic	Primary interest in the artistic and symbolic characteristics of animals.
Utilitarian	Primary concern for the practical and material value of animals or the animal's habitat.
Doministic	Primary interest in the mastery and control of animals typically in sporting situations
Negativistic	Primary orientation an active avoidance of animals due to indifference, dislike or fear.

In addition to the varying attitudes to animals described above, some animal species receive greater consideration than others. People often find it easier to consider the well-being of 'charismatic species' than lesser-known species (Spencer 2018, others). Charismatic species include terrestrial and marine mammals that are large; behave and have features that seem 'human-like'; may be rare or endangered; and/or have particular cultural features attributed to them (McGinley et al 2017). Their symbolic value or extensive public appeal are often used successfully to help achieve conservation and welfare outcomes. Non-charismatic species (e.g., insects, fish, molluscs) can are harder for humans to relate to, so it can be harder to convince people to care about their well-being.

People's varying attitudes to non-human nature in general and certain species in particular means that animal welfare – including aquatic animal welfare - will always be subject to a range of interpretations. Therefore, what constitutes 'good' animal welfare practices can be controversial and contested. It is important to recognize that these diverse perspectives inform stakeholders' interests in and responses to the need for aquatic animal welfare in particular and support for and engagement with various initiatives designed to improve seafood industry practices.

[9] Reference here about intrinsic value of non human nature

Appendix 2. Project interview questions.

The material below is a verbatim extract of the interview guidance sheet and questions that were sent to research participants.

This Project is building on findings from a workshop that the Fisheries Research and Development Corporation (FRDC) held back in September 2018 that looked at the economic and social benefits for the seafood industry of catching and/or producing seafood in the most humane way possible. At that workshop it was agreed that the fishing and finfish aquaculture industry sectors needed to prepare for any (aquatic) animal welfare issues that might arise – given some of the controversies the livestock sector has experienced recently.

FRDC 2019-023 involves a selective scan of aquatic animal welfare practices that have been recommended for use by Australia's seafood industry (e.g., Aquatic Animal Welfare Guidelines – Trawl sector). The Project will collect data and information on best practice through a desktop review and up to 20 stakeholder interviews across a range of fishing and finfish aquaculture sectors.

The purpose of the interviews is to hear your insights about and experiences with fishing and production practices that influence aquatic animal welfare (AAW). Each interview will be conducted keeping in mind particular recommended AAW practice(s) that are relevant to your fishery and particular operations (e.g., use of Iki jime, tow times of nets, etc.).

The interview should take about 45-60 minutes, depending on your availability. I would like to make an audio recording of the interview to help me document your reflections accurately. We would use this information as data that could be included in our report to the HDR/FRDC. If we do decide to use information you provide in this interview, we will ensure your anonymity. The audio recordings will not be shared with FRDC. Furthermore, if we use any quotes, they will be presented without any identification (i.e., "A research participant noted that..."), unless you wish to be identified as an individual or by your organisation (i.e., "… the X Seafood Industry Association noted that")

Interview questions

Introduction

1. Please describe your business/operation (e.g. size/scale, how long in operation, goals for your business/operation)
2. What does the phrase *'aquatic animal welfare'* or *'animal welfare'* mean to you?

Fishing/production methods

3. Can you please describe what method(s) you use?
4. Can you please describe where and how in those methods you take action to reduce stress of target and non-target species?

Features of AAW practice(s) and access to resources needed to use those practices

5. How long have you been using the practices discussed in Questions 3 and 4?
6. How did they hear/learn about it/them?
    - (e.g., sources/types of information (e.g., existing Codes/guidelines), any training provided, etc.)
7. Were you able to test/trial the practice before using it regularly? (If yes, please describe that process)
    - (e.g., seen others using it, saw results, degree of trust in those taking part/initiating the trial)
8. What have been the disadvantages of using the practice(s)?
    - (e.g., 'costs' (input costs, output prices, effects on profits), production risks, incompatibility with existing practices, complex to use, etc.)
9. What have been the benefits of using the practice(s)?
10. How and to what extent do you feel you have what you need to continue using existing AAW practices?
    - (e.g., kinds of 'resources' you might need more of – data, info, funding, training, other)

Closing

Do you have any other comments about the topics discussed in this interview?

Appendix 3. Aquatic animal welfare guidelines and similar instruments (Australian)

Title	Type	Description	Sector	Method
AquaPlan 2014-2019 (Dept of Agriculture 2014)	Policy document	Strategic plan for aquatic animal health – improving biosecurity capabilities (issues associated w/ infectious diseases of finfish, molluscs, crustaceans). Does not specifically address aquatic animal welfare. Does mention its importance for biosecurity planning activities and refers to the Australian Animal Welfare Strategy (AAWS)	Commercial wild-catch Finfish aquaculture	All
Department of Agriculture and Water Resources (2018) Guidelines for the Implementation of the Commonwealth Fisheries Bycatch Policy.	Guidelines	Designed to assist Australian Fisheries Management Authority deliver the Bycatch Policy and assist in developing the bycatch chapter of the Fisheries Management Strategy for each Commonwealth fishery. Requires that fisheries avoid bycatch and minimise bycatch mortality.	Commercial wild-catch	All
Johnston & Jungalwalla (2005) Aquatic Animal Welfare Guidelines: guidelines on fish and crustaceans in finfish aquaculture and/or live holding systems for human consumption. National Aquaculture Council.	Guidelines	Rationale for guidelines development, nociception/pain sensation, stress in fish and crustaceans. Welfare parameters for finfish in aquaculture (water quality and temperature, food/feeding, stock densities, equipment, husbandry practices, health, humane slaughter); welfare of crustacea in aquaculture (water quality, pond preparation/management/habitat, health monitoring and disease risk, population management, equipment use, humane harvesting); and welfare for aquatic animals in live holding systems (general and specific information on in and out of water)	Aquaculture	n/a
Benchmarking harvest methodologies in the Australian barramundi aquaculture industry – impacts on stress, product quality and fish welfare (2012)	Technical report	Commercial barramundi farms – study of harvest methods and identify best practice approaches for optimal product quality	Aquaculture	n/a
RSPCA Approved Farming Scheme Standard: Farmed Atlantic Salmon (RSPCA 2020)	Standard		Aquaculture	n/a
Aquatic Animal Welfare Guideline – Pot/ trap (AAWWG 2012)	Guidelines	Background to AAW; General aims and principles – to minimize stress; Lists all principles and cites three most relevant of overarching principles (timely handling capture to death; minimize bycatch; quick and humane slaughter of target catch); general steps in fishing method for the sector; specific practices per steps in harvest process (setting pots/traps, set time for pots/traps, hauling pots/traps, release of catch into live holding tanks, release of bycatch, killing of fish (Iki jime, ice slurry for smaller catch)	Commercial wild-catch	Pot & trap
Humane killing and processing of crustaceans for human consumption (RSPCA – ND)	Information sheet/ guidelines	Crustacean physiology and cognition, notion of loss of sensibility prior to killing, signs of stress, legal status of crustaceans in Australia, skills and experience needed to administer humane treatment, acceptable stunning and killing methods for particular species – crabs, lobster (electrical, chilling, splitting, spiking), unacceptable killing methods	Commercial wild-catch & finfish aquaculture	Pot & trap
Southern Rock Lobster Clean Green Standard – Part 1 (Southern Rock Lobster Ltd 2019)	Standard	Fishing Operations (Harvest). Background to Standard incl. governance and compliance; use of trademark, seal protection, whale/turtle protection, environmental protection, sustainable bait, vessel waste management, refuelling, training and qualifications, maximising product quality, water quality, live holding system, on-board maintenance and cleaning schedule, landing and transferring product to buyers; Appendices – catch limits, voluntary catch data, bait specifications, approved chemicals. 22pp.	Commercial wild-catch - harvest	Pot & trap
Southern Rock Lobster Clean Green Standard – Part 2 (Southern Rock Lobster Ltd 2019)	Standard	Processing and Exporting Operations (Post Harvest). Background to Standard incl. governance and compliance; staff training, transfer to receivers/consolidator, reception/grading/purging, product handling, water quality standard, licensing/regulatory requirements, identification and traceability, food safety, live export packing, humane killing.	Commercial wild-catch – Post harvest	Pot & trap

Clean Green Southern Rock Lobster Integrated Fishing Operations Standard – Vessel Food Safety Plan (2018)	Standard	All activities, procedures and hygienic controls used in the capture and supply. List of 18 best practices procedures to maximise product quality and ensure animal welfare.12-page document.	Commercial wild-catch - harvest	Pot & trap
Recommended Guidelines: Managing Live Imported Australian Southern Rock Lobster (SRL Ltd 2018)	Guidelines	2-page information sheet for supply chain actors importing and/or prepare SRL. For receivers (Stage 1): food safety parameters, transit times, reception and grading, holding tanks – water quality; Packaging and distribution (Stage 2): checking animals, transport to food service sector, slaughter procedures; Food services sector (Stage 3): parameters on receiving/storage/handling, live holding conditions (water temperature, density). Appendix 1 – humane killing procedures (insensibility rendered by freezing, then splitting or spiking)	Commercial wild-catch – Post harvest	Pot & trap
(Day & Fitzgibbon 2016) Best Practice Guide for SRL Post-Harvest Holding and Processors Industry Operations FRDC Project 2016-235.	Guidelines	General handling (care, limb loss, tail flapping, drops/shocks/impacts) emersion (physiology, metabolic stress, stress recovery), receiving stock (transport and grading, careful handling, road transport, purging, traceability), holding stock in facilities (emersion, careful handling, vitality, recirculation systems, waste removal, other water quality parameters/systems), outbound stock/exporting (chilling, anaesthetic, packing, handling) 20 pp.	Commercial wild-catch	Pot & trap
Northern Territory Code of Practice (Mud Crabs)	CoP	General code for maximising sustainability, including value and quality. Covers handling, storing, transporting, recovery and tanking procedures from capture to wholesale operation (handling, bycatch). Aim of post-harvest survival. Includes separate Fact Sheets for: Consumers, Harvesters, Retailers, Recovery procedures, and Tanking recommendations	Commercial wild-catch	Pot & trap
Aquatic Animal Welfare Guideline – Rod/ Handline (AAWG 2012)	Guidelines	Background to AAW; General aims and principles – to minimize stress; Lists all principles and cites three most relevant of overarching principles (timely handling capture to death; minimize bycatch; quick and humane slaughter of target catch); general steps in fishing method for the sector; specific practices per steps in harvest process (line soak time, retrieving line, removal of fish from line, release of fish into live holding tanks, processing of fish (Iki jime).	Commercial wild-catch	Rod & line
Northern Territory Offshore Net & Line Fishery	CoP	To assist operators to maximise the quality and value of product, minimise wastage and contribute to the ongoing ecological and economic health. Recommendations for net soak time, hauling, line soak time, line retrieval, fish handling, bycatch (incl list of TEPs)	Commercial wild-catch	Hook & line; Demersal gillnets
Northern Territory Offshore Net & Line Fishery (2016)	EMS	Includes guide to rescuing and resuscitating turtles, avoiding/minimising bycatch interactions, handling and release of sawfish, risk analysis of wildlife interactions, bycatch, external risks to fishery	Commercial wild-catch	Hook & line; Demersal gillnets
Aquatic Animal Welfare Guideline – Trawl (AAWWG 2012)	Guidelines	Background to AAW; General aims and principles – to minimize stress; Lists all principles and cites three most relevant of overarching principles (timely handling capture to death; minimize bycatch; quick and humane slaughter of target catch); general steps in fishing method for the sector; specific practices per steps in harvest process (shooting net, length of trawl shot, hauling/winching net, release of fish/sorting/discards of non-targets, killing of fish (hopper systems)	Commercial wild-catch	Trawl
Kon's Covered Fisheyes BRD Trial report – NPF (2016)	Technical report	Single vessel trial of BRD to determine effectiveness relative to legislated device	Commercial wild-catch	Trawl
NPF (2004) - NPF Industry Code of Practice for Responsible Fishing	CoP	Sets out principles and standards of behavior for responsible fishing and continuous improvement. Includes bycatch management specifications.	Commercial wild-catch	Trawl
NPF (2021) - NPF Industry Code of Conduct: Use of Bycatch Reduction Devices	Code of Conduct	Factsheet	Commercial wild-catch	Trawl
Pilbara Fish Trawl Fishery – Bycatch Code of Practice	CoP	General information (2 pg. factsheet format) about how to avoid and release bycatch of dolphins and sawfish.	Commercial wild-catch	Trawl
Aquatic Animal Welfare Guideline – Purse seine (AAWWG 2012)	Guidelines	Background to AAW; General aims and principles – to minimize stress; Lists all principles and cites three most relevant of overarching principles (timely handling capture to death; minimize bycatch; quick and humane slaughter of target catch); general steps in fishing method for the sector; specific practices per steps in harvest process (shooting the net, initial drawing of net, final net closing, removing fish from net, handling of non-target species, killing of target fish).	Commercial wild-catch	Purse seine

Aquatic Animal Welfare Guideline – Mesh netting (AAWWG 2012)	Guidelines	Background to AAW; General aims & principles – to minimize stress; Lists all principles and cites three most relevant of overarching principles (timely handling capture to death; minimize bycatch; quick & humane slaughter of target catch); general steps in fishing method for the sector; specific practices per steps in harvest process (setting the net, set time, removing fish from net, handling of non-target species, killing of target fish – spiking or Iki jime).	Commercial wild-catch	Mesh netting

Appendix 4. Aquatic animal welfare guidelines and similar instruments (international)

	Type	Description	Sector	Method
Factsheet on Animal welfare for farmed fish production (World Veterinary Associationn, ND)	Factsheet	Information about farmed fish conditions and need to promote development and enforcement of appropriate national welfare standards and regulations for farmed fish and veterinary training	Aquaculture, animals in research	n/a
OIE Aquatic Animal Health Code OIE Aquatic Animal Health Code – Chapter 7 (Welfare of Farmed Fish)	Standards	Provides standards for the improvement of aquatic animal health worldwide. It also includes standards for the welfare of farmed fish and use of antimicrobial agents in aquatic animals	Aquaculture, animals in research	n/a
OIE Manual of diagnostic tests for aquatic animals	Tech report	Outlines standardised approach for diagnosing diseases listed in OIE Aquatic Code, to facilitate health certification for aquatic animal trade	Aquaculture	n/a
Farmed fish welfare – salmon farming as a case study	Tech report	Guidance and standards on finfish welfare; list of stressors; welfare indicators used in some common Salmon Certification Schemes; list of 5 certification schemes	Aquaculture	n/a
Hhumane slaughter of finfish farmed around the world (Humane Slaughter Association 2018)	Technical report	Info on current slaughter methods, research gaps on humane stunning and priority species, known preferred practices, utility of assurance schemes, guidance required for industry	Aquaculture	n/a
Guidelines for care and welfare of cephalopods in research (2015)	Scientific paper Guidelines	Re: inclusion of class in EU Directive; implications of that; project applicant' requirements; use of 3 Rs. Advice on capture/transport, holding facilities, handling, feeding, sedation, euthanising	Animals in research	n/a

Appendix 5. Six stages of adoption

Stage of adoption	Description
Awareness of the problem or opportunity	An end-user's awareness not just of a new practice, but of its relevance/useful to them Transition from awareness to recognition of utility can vary considerably.
Non-trial evaluation	After awareness a potential end-user collects information about the new practice to help decide if they will trial it, as trialing will cost time, energy, finances Perceptions must be positive to go further
Trial evaluation	If unable to trial on a small-scale, adoption become much less likely given risk of full-scale failure and its attendant costs Untrialable practices can be adopted but require considerable information-seeking, discussion and analysis, and reflection.
Adoption	After trial results, use of practice may increase in scale Use can occur gradually and may end as partial adoption End users may adapt the recommended practice to suit their situations
Review and modification	Trialing and adjustments often continue as end-user always evaluating effectiveness
Non-adoption or dis-adoption	When external information or trial results fail to demonstrate benefits (mismatch of practice to end-users' goals, economic circumstances change, technology changes)

Adapted from Pannell et al (2006)

Appendix 6. Extension models used in Australian fisheries

Type of Extension Model	Description
Group Facilitation/Empowerment	Typically used for: • Groups of people • With an agreed agenda for what is to be learned about • Participants are committed long term to the group • Focus on increasing participants' planning/decision making and identifying their own learning needs • Group facilitator provided to assist
Technology Development/ Problem Solving	Typically used with: • Individuals (and groups) to develop specific technologies, management practices or decision systems that will eventually be used by rest of industry • Trials, demonstrations, field days, on-site visits • Individuals committed to project versus a group • Groups disband after project is finished
Programmed learning/Training	Typically used for: • Delivering a designed training program/workshop that target individuals, groups • Increasing their skills, knowledge in specific topics • A variety of teaching and learning approaches*
Information access	• Provides a range of information individuals and groups access when suitable to them (E.g., libraries, websites, other centralized locations)
Individual consultant/ Mentor	• Individualised one-on-one support • Can be technical expert visits w/ advice provided • Can be on-going mentor relationship providing sounding board for decision-making
Multi-stakeholder negotiation	• Supports collective decision-making in complex situations (e.g., Resource access, social license) • Facilitation methods seeking to build participants' enthusiasm, creativity, innovation
Institution development	Facilitating development of networks and learning and negotiation processes among stakeholders, programs

(Adapted from Jennings & Pakula 2011)

Appendix 7. Review of uptake and adoption literature (seafood production)

Factors influencing uptake and adoption	Enablers and obstacles to uptake and adoption in fisheries
Do I/we want to do it? *How well does it fit w/ what I/we believe in?*	Brooks et al (2019) • Negative perceptions of 'managers' and/or 'management' (industry, government) reduce seafood producers' motivations to follow safety procedures McCallum (2017) • Obstacles to change include some seafood producers' belief that they are already in compliance with welfare requirements and therefore do not need to attend to principles and guidelines • Enabling factors include awareness of AAW principles and belief that applying those principle is good for seafood producers' businesses. • Enabling factor: seafood producers' awareness of legislative requirements, so that they can avoid prosecution and penalties Diggles et al (2011) • Given weak evidence for fish sentience, personal values and ethics need to be distinguished from scientific processes (when determining appropriate AAW practices) World Veterinary Association (2018) • Warm-blooded vertebrates receive far more compassion than do fish, despite there being evidence for sentience in fish Eayr & Pol (2018) • Obstacles: Seafood producers' resistance to change is very powerful, and in some instances even when practice change is mandated by regulation and carries several relative advantages (e.g., reduced fuel consumption, habitat protection, etc.) Piovano et al (2012) • Proven effectiveness of BRDs does not guarantee adoption – fishers significantly influenced by socio-economic and emotional factors, such as economic incentives but also public acknowledgement of their efforts Glass et al (2015) • Complex factors underpin lack of adoption of BRDs, including seafood producers' fear of change and conservatism, perceived loss of independence if they comply with fisheries changes Eduardo et al (2014) - Study in Brazil of researcher and finfish aquaculture producers' beliefs about 'animal welfare': • Majority (76%) of respondents believe fish are sensitive to pain • Slaughter methods rated differentially (e.g., 33% 'percussive stunning' and 'removal from water' = 'Very cruel'; 55% 'thermal shock' = 'Less cruel') • Most common rationale for welfare – improved meat quality (59%), fish mortality (36%), and animal rights (34%); however, 37% of producers chose better meat quality, while researchers (43%) chose avoid fish suffering • Welfare area most in need of improvement - efforts to manage pain, injury and disease (65%). Message & Greenhough (2019) Study of scientists' and technologists' beliefs influencing implementation of fish welfare initiatives • disagreements about fish ability to feel pain and suffering can inhibit refinement of practices (e.g., analgesic protocols) even where regulatory mandates exist • attitudes ranking fish below other vertebrates an obstacle of better welfare • lack of awareness of what constitutes 'good welfare', as well as where and how that knowledge is produced Jenkins (2010)

	• Successful conservation technology inventors in fisheries have extensive understanding, knowledge and skills related to bycatch problems in commercial fishing, are adept at using mental and/or physical models, fabrication, and assembling and refining inventions Lloyd et al (2020) • Veterinarians' and veterinary students' attitudes to animal welfare vary according to background, gender, stage of study. Students in Australia, New Zealand, ranked five topics according to their importance for their study. Aquatic animals' health and welfare issues, husbandry techniques of farmed fish, and the use of antibiotics were ranked highest. Females and starting students had higher concern than males, and senior students.
Will it work? *Cost/ benefits, relative advantage, trialability, trust those promoting it?*	Brooks et al (2019) • Obstacles include seafood producers' not seeing the relative advantages of closely following safety procedures on fishing vessels • Extension that is primarily based on printed materials (booklets, pamphlets, filling out forms) was found to be ineffective in improving uptake and adoption of safety procedures • Lack of trust between fishers and safety regulators has declined in recent years and is blocking improved uptake and adoption Diggles et al (2011) • Obstacles to uptake include finfish aquaculture operators striving to reduce operational costs while maximising profits. Condi et al (2014) • Proposed policy to ban discards in European fisheries will be constrained without management measures that have economic incentives for fishers. Glass et al (2015) • Complex factors underpin lack of adoption of BRDs, including seafood producers' refusal to accept loss of target catch, fear of change and conservatism, mistrust of managers and other authorities (including their ability and motives), perceived loss of independence if they comply with fisheries changes • Scientists and managers not necessarily equipped to deliver extension given time demands and skills/experience • Extension lacks insights from change management settings/initiatives McCallum (2017) • Obstacles: Difficulties finding and understanding lengthy and complex guidelines/Codes of practice. Peckham et al (2015) • Obstacles: BRDs can reduce target catch; more selective fishing practices can be less profitable and flexible • Enablers: Participatory design of buoyless net trials that included outreach events, workshops and empowering leadership roles for fishers • Enablers: greater profits from gaining access to premium markets by catching higher quality fish in better condition Sullivan et al (2017) • Seabird BRDs need to be simple to use and cost effective; trials of Hookpod demonstrated reduced bycatch without negative impacts on catch rates Bradley et al (2019) – global review of high-tech data systems in multiple fisheries • Modernizing fisheries data systems is restricted by a lack of trust between fishers and fisheries managers. Eayrs & Pol (2019) • Fishers tend to rely on informal, ad hoc approaches to inspire uptake of proven fishing gear • Uptake typically happens over long time periods if at all • Financial benefits increase likelihood of uptake but not sufficient on its own Feekings et al (2019) • Enablers: Project design for development of new and modified fishing gears that was more inclusive of all stakeholders (fishing industry - fishermen, net makers and fisheries

	representatives), scientists and managers. Objective to value and use stakeholders' specific skills/knowledge to develop technical solutions to landing obligations reforms. Message & Greenhough (2019) • Awareness of where knowledge about what constitutes "good welfare" is produced and who it is promoted by can be as important as the knowledge itself in shaping its reception and the consequent implementation (or not) of refinements.
Can I/we do it? *Do I/we have 'resources' needed?*	Mazur et al (2007) • Seafood producers' uptake of BRDs - encouraged by access to easily understood and credible information and skilled labour; restricted access acts as obstacles • Other obstacles: shortages of information on scale of bycatch problems; restricted funding for innovation and program delivery Jenkins (2010) • Invention of BRDs is enabled by inventors with extensive experience in commercial fishing working across their networks to involve other fishers in design, trials, implementation; also access to divers and appropriate camera equipment • Adoption of technology tends to be much higher (600%) when located near inventors' home Gustavsson (2018) • Limited success of policies targeting fishing practice change result from insufficient attention to seafood producers' social and cultural capital (e.g., assuming that economic aspects of long-term uptake is more important than social resources) • Seafood producers' value demonstrating their skills; their social networks are significant for information exchange and affirmation; learning from previous generations but also important to experiment and continuously learn new knowledge from experiences at sea.
External factors	Conte (2010) • Uptake encouraged by market advantages: public perceptions favouring welfare practices then informing their choices as consumers more so than seafood producers' personal beliefs about and feelings towards aquatic animals. Hardy-Smith (2015) • Common for seafood industry members to be concerned about aquatic animal welfare policies and regulatory instruments having negative (financial) impacts Glass et al (2012) • Fisheries managers reticence to change status quo or concerns regarding suitable enforcement measures limit promotion, institutionalisation of BRD adoption Friedman et al (2018) • Enablers: Cross-sectoral cooperation key requirement for resolving historical disagreement among fishing industries and environmental interests; more open and transparent discussions about trade-offs • Obstacles: parallel but uncoordinated and independent efforts to integrate fisheries management and biodiversity McCallum (2017) • Public perceptions that the seafood industry is not applying welfare principles and guidelines Soomai (2017) • Well defined and regularly evaluated processes for information exchange across and within fisheries management organisation, seafood industry associations, NGOs improve use of science in decision-making Ellingsen et al (2015) • Study of (Norwegian) public concern about fish welfare informs their subsequent willingness to pay a price premium for products made from fish certified for best practice welfare. Public also see industry and governments holding key responsibility for fish welfare.

Appendix 8. Factors interviewees believe restrain AAW uptake and adoption

Categories As per Pannell	**Obstacles** to uptake of recommended AAW practices	**Rock Lobster** (Southern, Eastern zones)	**Mud Crab*** (NT Fishery, NSW General Estuary)	**Shark bycatch, target Shark fishery** (NT Offshore Net & Line, Pilbara Ocean Trawl***)	**Trawl** (Northern, Southern, & Western Prawn)	**Seine (Purse, Beach, Danish)** (NSW General Estuary, Western Australia)	**Hook & Line** (NSW Trap & Line)	**Finfish aquaculture** (Salmon)
		'X' indicates mentioned by interviewee(s)						
Do I/we want to do it? *How well does it fit w/ what I/we believe in?*	Seeing animals purely as commodities	X						
	Individuals' resistance to changing practices (age, conservative values, SLO issues low importance)	X	X		X	X	X	X
	Fishers' low awareness, knowledge, skills in AAW	X	X		X	X		
	Low fisher morale from fisheries reforms			X				
Will it work? *Cost/ benefits, relative advantage, trialability, trust those promoting it?*	Difficulties setting pot/traps, lines and/or nets for an optimal time**	X						
	Difficulty bringing capture gear onto vessel and removing & sorting target (and/or non-target) catch (e.g., quickly, safely, costly gear, etc) **		X	X		X		
	Difficulties using recommended slaughter methods (e.g., costs time and/or money, high volume catches) **			X	X	X		
	Bycatch reduction device use – time consuming, costly, can reduce catch, ineffective, too few times to trial**	X			X			
	Extension: Codes/ Guidelines set bar too low, missing subtle but important AAW practices, and/or out of date	X	X	X	X		X	
	Extension: general lack of AAW information, training (including for new entrants to fisheries)	X				X	X	

	Extension: overreliance on paper booklets versus other forms of media (e.g., videos)			X			X	
Can I/we do it? *Do I/we have resources needed?*	Sub-optimal fishing vessel design features (e.g., insufficient space, high out of water, etc.)	X	X		X			
	Low inter-agency and/or inter-fishing industry sector communication on aspects of AAW	X	X				X	
	Negative communications between NGOs and seafood industry					X		
External factors *Macro-level factors beyond a seafood producers' direct control*	Lack of regulatory mandate for general and particular AAW practices (e.g., sentience in fish, short soak times, BRDs)	X						X
	Corporate mandate for maximum yield can underpin resistance to AAW practices (e.g., incurs costs, reduced catch volume, etc)	X						
	Fish/ crustacean physiological features – very delicate, difficult to handle live, and/or movement after death	X		X				
	Insufficient engagement of fishers in fisheries reform process			X				
	Lack of research funding for fishery-specific AAW, fishery restructure options			X		X		
	Market conditions: Not being able to get price premium for higher quality fish (e.g., buyers, consumers)					X		

**includes some coverage of Blue Swimmer Crabs (NSW General Estuary Fishery)*
***as specified key stages of fishing in the AAWWG Guidelines*
****The Pilbara Ocean Trawl does not target shark species. There may be occasional incidences of bycatch of larger sharks and/or sawfish – which is not a shark species, but presents similar challenges for safe release as do sharks.*

Appendix 9. Factors interviewees believe help AAW uptake and adoption

Categories As per Pannell	**Enablers** that help encourage uptake/adoption of recommended AAW practices	**Rock Lobster** (Southern, Eastern zones)	**Mud Crab*** (NT Fishery, NSW General Estuary)	**Shark bycatch, target Shark fishery** (NT Offshore Net & Line, Pilbara Ocean Trawl***)	**Trawl** (Northern, Southern, & Western Prawn)	**Seine (Purse, Beach, Danish)** (NSW General Estuary, Western Australia)	**Hook & Line** (NSW Trap & Line)	**Finfish aquaculture** (Salmon)
		'X' indicates mentioned by interviewees						
Do I/we want to do it? *How well does it fit w/ what I/we believe in?*	Pride in doing (all aspects of) fishing job well	X	X			X		
	Strong interest in learning and/or willing to embrace change	X	X			X	X	
	Aware of and willing to work with fisheries rules			X				
	Belief in a moral imperative to fish sustainably and humanely	X			X	X	X	
	Family tradition					X	X	
	Strong awareness and knowledge of, skills in using AAW practices						X	
Will it work? *Cost/ benefits, relative advantage, trialability, trust those promoting it?*	Higher prices for well-handled catch (flesh quality, shelf life)	X	X	X		X	X	X
	Extension: Effective printed materials/documents (e.g., welfare specific CoPs or CoP components)		X		X			
	Extension: emphasis on flexible outreach tailored to fishers' needs		X		X			
	Extension: Regular industry and/or government workshops/ training initiatives offering issues discussions and practical solutions		X	X	X	X	X	
	Extension: Extensive, inclusive, simple trials of recommended practice(s)				X			
	Extension: Dedicated resources to enable qualified (government, NGO, industry) staff to deliver training				X	X		
Can I do it? *Do I have resources needed?*	Formal education and training in NRM	X	X					
	Positive relationships within and across seafood industry, government, research, and NGO networks that enables	X	X	X	X	X	X	X

	learning about and advocacy for AAW's inclusion							
External factors *Macro-level factors beyond a fishers' direct control*	Market recognition of standards and certification that address AAW and link with product quality (buyers, consumers)	X	X				X	X
	Social license pressure to address AAW (e.g., bycatch reduction, humane holding of live catch)		X	X	X	X		
	Regulatory mandates to address sustainability and AAW (e.g., bycatch reduction, reporting wildlife interactions w/o being penalised,	X		X	X			
	Environmental conditions and particular fish physiology (e.g., warm water, crustacean's delicate limbs)	X	X	X				
	Extensive research on fishery				X			
	Increased quota and catch size, market demand		X					

**includes some coverage of Blue Swimmer Crabs (NSW General Estuary Fishery)*

References

Boutler, M. Dodd, M. & B. McCallum. 2018. Findings from the Animal Welfare Workshop: Raising awareness of the guidelines developed by the Aquatic Animal Welfare Group (AAWWG) with industry and review their adoption, uptake rates and utility. FRDC Project 2017-221. Fisheries Research & Development Corporation: Canberra.

Bradley, D., Merrifield, M., Miller, K., Lomonico, S., Wilson, J. & M. Gleason. 2019. Opportunities to improve fisheries management through innovative technology and advanced data systems. *Fish and Fisheries* **20**: 564-583.

Brooks, K., Thomas, A., Drake, M. & T. Beatty. 2019. What's stopping you from protecting your mates? Identifying the barriers to the adoption of workplace health and safety, management systems, and equipment in the commercial fishing industry. FRDC 2017-046. Fisheries Research & Development Corporation: Canberra.

Browman, H. I., Cooke, S. J., Cowx, I. G., Derbyshire, S. W. G., Kasumyan, A., Key, B., Rose, J. D., Schwab, A., Skiftesvik, A. B., Stevens, E. D., Watson, C. A and Arlinghaus, R. 2019. Welfare of aquatic animals: where things are, where they are going, and what it means for research, aquaculture, recreational angling, and commercial fishing. *ICES Journal of Marine Science* **76:** 82–92.

Condie, H.M., Grant, A. & T.L. Catchpole. 2014. Incentivising selective fishing under a policy to ban discards: lessons from European and global fisheries. *Marine Policy* **45:** 287-292.

Conte, F. 2016. Animal welfare: Growing factor in international aquaculture. Global Aquaculture Advocate.

Coutts J, Roberts K, Frost F, and Coutts A. 2005, *Extension for Capacity Building: What Works and Why?* Rural Industries Research and Development Corporation, ACT. http://rirdc.infoservices.com.au/collections/cvcb.

Diggles, B.K., Cooke, S.J., Rose, J.D. & W. Sawynok. 2011. Ecology and welfare of aquatic animals in wild capture fisheries. *Reviews in Fish Biology and Fisheries* **21:** 739-765.

Eayrs, S. & M. Pol. 2017. Application of change management in the fishing industry. FAO/ICES Fishing Technology and Fishing Behaviour Working Group Topic Group Final Report.

Eayrs, S. & M. Pol 2019. The myth of voluntary uptake of proven fishing gear: investigations into the challenges inspiring change in fisheries. *ICES Journal of Marine Science* **76:** 392–401.

Ellingsen, K., Grimsrud, H., Nielsen, H.M., Mejdell, C., Olesen, I., Honkanen, P., Navrud, S., Gamborg, C. & Sandoe, P. 2015. Who cares about fish welfare? A Norwegian study. *British Food Journal* **117:** 257-273.

Fisheries and Aquaculture Extension and Adoption Working Group (FAEAWG) 2012. Australia's National Fishing and Aquaculture Extension and Adoption Strategy.

Farm Animal Welfare Council (FAWC) 2009. Farm animal welfare in Great Britain: Past, present and future. London. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/319292/Farm_Animal_Welfare_in_Great_Britain_-_Past__Present_and_Future.pdf

Feekings, J.P., Frandsen, R.P., Krag, L., Lund, H., Veiga-Malta, T., Eliasen, S.Q., Jacobsen, R.B., Bohnstedt, H., Melli, V., Nalon, M., Mortensen, L.O., Ulrich, C. & M. Brooks. 2019. *Fast Track: Sustainable, cost effective and responsive gear solutions under the landing obligation.* Technical University of Denmark, DTU Aqua Report No. 342-2019.

FRDC 2020. The Fisheries Research & Development Corporation research, development and extension plan 2015-20. FRDC: Canberra.

Glass, C.W., S. Eayrs, and J.M. Cournane. 2015. Bycatch reduction devices: Development, adoption and implementation? In: G.H. Kruse, H.C. An, J. DiCosimo, C.A. Eischens, G.S. Gislason, D.N. McBride, C.S. Rose, and C.E. Siddon (eds.), *Fisheries Bycatch: Global Issues and Creative Solutions*. Alaska Sea Grant, University of Alaska Fairbanks. http://doi.org/10.4027/fbgics.2015.05

Gustavsson, M. 2018. Examining the 'cultural sustainability' of two different ways of governing fishing practices. *Marine Policy*: doi: https://doi.org/10.1016/j.marpol.2018.03.017

Hardy-Smith 2020. Aquatic animal welfare – a review of guidance documents and legislation. FRDC Project 2020-040. Fisheries Research & Development Corporation: Canberra.

Hardy-Smith, P. 2015. The Australian Animal Welfare Strategy (AAWS) – The development of specific operator (Boat) level fish welfare guidelines in the commercial capture fishing sector. FRDC Project 2012-507. Fisheries Research & Development Corporation: Canberra.

HAS (Humane Slaughter Association) 2020. Humane harvesting of salmon and trout. https://www.hsa.org.uk/shop/publications-1/product/humane-harvesting-of-salmon-trout Accesed 20 Feburary 2020.

Huntingford, F.A. & S. Kadri. 2014. Defining, assessing, and promoting the welfare of farmed fish. *Rev. Sci. Tech. Off. Int. Epiz*. 33 (1):233-244.

Jenkins, L.D. 2010. Profile and influence of the successful fisher-inventor of marine conservation technology. *Conservation and Society* **8(1):** 44-54.

Jennings, J. & B. Pakula. 2011. Understanding extension and adoption in the fishing industry. Fisheries Research & Development Corporation: Canberra.

Lloyd, J.K., Collins, T., Cornish, A.R., Degeling, C., Fawcett, A., Fisher, A.D., Freire, R., Hazel, S.J., Hood, J., Johnson, J., Phillips, C., Stafford, K.J., Tzioumis V. & P.D. McGreevy. 2020. Australian and New Zealand veterinary students' ranking of issues in aquatic animal welfare and ethics. *Anthrozoös* **33(3):** 325-337. DOI: 10.1080/08927936.2020.1746522

Manfrin, A., Messori, S. & G. Arcangeli. 2018. Strengthening fish welfare research through a gap analysis study. Health Authority for Control Research and Services for Animal Health and Food Safety. Venice, Italy.

Marsh, S., Pannell, D. and R. Llewellyn. 2011. Economics and extension. In *Shaping Change: Natural Resource Management, Agriculture and the Role of Extension* Eds J. Jennings, R. Packham and D. Woodside*.,* APEN, pp 182 – 189.

Mazur, N. & K. Brooks. 2018. The right conversations: Building industry engagement capacity for socially-supported fisheries and aquaculture. FRDC Project 2017-133. Fisheries Research & Development Corporation: Canberra.

Mazur, N., Curtis, A., & A. Bodsworth (2014). *Let's talk fish: Assisting industry to understand and inform conversations about the sustainability of wild-catch fishing*. FRDC Report 2012/301.

MCallum, B. 2017. Aquatic animal welfare in perspective: An initiative of the Aquatic Animal Welfar Working Group of the Australian Animal Welfare Strategy. FRDC Project 2013-049. Fisheries Research & Development Corporation: Canberra.

Message, R. & B. Greenhough 2019. But it's just a fish: Understanding the challenges of applying the 3Rs in laboratory aquariums in the UK. *Animals* Vol. 9. doi:10.3390/ani9121075

Pannell, D.J., Marshall, G.R., Barr, N., Curtis, A., Vanclay, F. & R. Wilkinson (2006). Understanding and promoting adoption of conservation practices by rural landholders. *Australian Journal of Experimental Agriculture* **46**(11): 1407-1424.
Peckham et al 2015;

Pickworth, J., Casey, A. M., Maller, C. & Stenekes, N. (2007) *Adapting to change in fisheries: Report to the seafood industry partnership project*. Bureau of Rural Sciences, Canberra.

Piovano, S., Basciano, G., Swimmer, Y. & C. Giacoma. 2012. Evaluation of a bycatch reduction technology by fishermen: A case study from Scicily. *Marine Policy* **36:** 272-277.

Salzman J. (2019) The "Five Ps": Policy Instrument Choice for Inclusive Green Growth. In: Mandle L., Ouyang Z., Salzman J.E., Daily G. (eds) Green Growth That Works. Island Press, Washington, DC. https://doi.org/10.5822/978-1-64283-004-0_5

Sparks, M. 2011. Community perceptions of the sustainability of the fishing industry in Australia. Intuitive Solutions.

Stern, P., Dietz, T., Abel, T., Guagnano, G., & Kalof, L. (1999). A value-belief-norm theory of support for social movements: the case of environmentalism. *Human Ecology Review* 6(2): 81-95.
Stern, P., Dietz, T., Kalof, L. (1993). Value orientations, gender and environmental concern. *Environmental Behaviour* 25: 322-348.

Stern, P.C. (2000). Towards a coherent theory of environmentally significant behaviour. *Journal of Social Issues 56*(3): 407-424.

Sullivan, B.J., Kibel, B., Kibel, P., Yates, O., Potts, J.M., Ingham, B., Domingo, A., Gianuca, D., Jimenez, S., Lebepe, B., Maree, B.A., Neves, T., Peppes, F., Raseh, T., Silva-Costa, A. & R.M. Wanless. 2017. At-sea trialling of the Hookpod: a 'one stop' mitigation solution for seabird bycatch in pelagic longline fisheries. *Animal Conservation* **21:** 159-167.

Voyer, M., Barclay, K., McIlgorm, A. & N. Mazur (2017). Connections or conflict? A social and economic analysis of the interconnections between the professional fishing industry, recreational fishing and marine tourism in coastal communities in NSW, Australia. *Marine Policy* **76**: 114-121.

Williams, S., Wilcox, C., Pattinson, R. & S. McCluskey. 2018. FRDC independent performance review: Final report. Creswick, Victoria: Australia.

Wilkinson, R., Adams, M., Hulse, T., Smullen, R., Howeison, J., Partridge, G., Musgrove, R., Paton, N. 2012. *Benchmarking harvest methodologies in the Australian barramundi aquaculture industry – impacts on stress, product quality and fish welfare*. Australian Government Department of Agriculture, Fisheries, Forestry: Canberra.