



Sharks and rays in recreational fisheries: Priority species, handling guidelines, post-release survival, and extension approaches to support cultural change in fishers

**Proceedings of the National Workshop, Adelaide, South Australia, 26th
November 2019**

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September 2020

FRDC Projects 2018-042 & 2018-055

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ISBN: 978-0-646-82728-5 doi: 10.26180/5f85004cb5782

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Preface

This preliminary report meets the FRDC reporting requirements for projects 2018-042 (Monash University) and 2018-055 (SARDI).

Acknowledgments

The authors recognise and acknowledge that the National Workshop was held on the traditional lands of the Kurna people of the Adelaide Plains. We pay our cultural respects to the Kurna people and their Elders for their spiritual relationship with the Land and Sea Country.

The joint workshop for projects 2018-055: *'Developing a positive cultural attitude towards the capture and release of sharks and rays'*, and project 2018-042: *'Improving Outcomes of Fisher Interactions with Sharks, Rays, and Chimaeras'*, were funded by the Australian Commonwealth Government and the Fisheries Research and Development Corporation (FRDC).

The editors thank all the workshop attendees for their valued contributions during the theme presentations, group discussions and for their individual responses to the pre-workshop questionnaire. We especially thank the participants that took time from their families and positions to travel from inter-state. A particular thanks to all the presenters who shared their expertise on the day and kindly allowed their presentations to be included as appendices in this report. Further thanks to Drs. Jessica Walsh and Carly Cook for help with designing the pre-workshop survey.

SARDI staff including Di Leith, Mandy Harkness and Louise Burgess provided valuable assistance with travel and accommodation logistics for the workshop participants. We thank Professor Gavin Begg for providing access to the venue and supporting the workshop.

Abbreviations

AFMA – Australian Fisheries Management Authority

AMCS – Australian Marine Conservation Society

ARFF – Australian Recreational Fishing Foundation

CITES – Convention on International Trade in Endangered Species of Wild Flora and Fauna

CSIRO – Commonwealth Scientific and Industrial Research Organisation

DEW – Department for Environment and Water (South Australian Government)

FRDC – Fisheries Research and Development Corporation

IMAS – Institute for Marine and Antarctic Studies

IUCN – International Union for Conservation of Nature

MRFAC – Minister’s Recreational Fisheries Advisory Council (South Australia)

NESP – National Environmental Science Program

NOAA – National Oceanic and Atmospheric Administration (U.S.A.)

NSW DPI – New South Wales Department of Primary Industries

PIER – Pflieger Institute of Environmental Research

PIRSA – Primary Industries and Regions South Australia

PRS – Post-release Survival

SARDI – South Australian Research and Development Institute

SBT – Southern Bluefin Tuna

UTAS – University of Tasmania

VFA – Victorian Fisheries Authority

VNPA – Victorian National Parks Association

VRFish – Victorian Recreational Fishing Peak Body

WA DPIRD – Western Australian Department of Primary Industries and Regional Development

Executive Summary

This report summarises the outcomes of the Workshop on; prioritisation of species, identification of best-practice capture and handling, design of post-release survival (PRS) studies, and development of effective communication campaigns, for developing positive behavioural change in recreational fishing of Sharks and Rays.

The workshop was delivered by two collaborative projects that were funded by the FRDC in 2019, including the South Australia-based project (2018-055) '*Developing a positive cultural attitude towards the capture and release of sharks and rays*', and the Victoria-based project (2018-042), '*Improving Outcomes of Fisher Interactions with Sharks, Rays, and Chimaeras*.' The two projects were led by SARDI Aquatic Sciences and Monash University, respectively. The one-day national workshop was held on 26th November 2019 at the South Australian Research and Development Institute (SARDI).

Recent examples have been reported widely in the media about the inhumane treatment of sharks and rays by recreational fishers. Incidents such as these reflect unethical behaviour which can lead to poor welfare outcomes for sharks and rays. Furthermore, they have the potential to impact the broader social acceptance of recreational fishing. Best-practice capture and handling guidelines for sharks and rays in recreational fishing serve as an important resource to enable positive cultural and behavioural change within recreational fisheries.

The main objective of the national workshop was to discuss adoption of best-practice techniques by the recreational fishing sector in order to improve outcomes for fishers and animals. The specific objectives of the workshop were to:

1. Identify priority species (or groups) of chondrichthyans caught by recreational fishers for the development of best-practice capture and release guidelines and post-release survival studies.
2. Develop and identify key messaging for safe capture and handling to include in best-practice guidelines.
3. Identify key design aspects of PRS studies needed to assess, support and refine the proposed best-practice guidelines for recreational fishers.
4. Assess the best ways to communicate and extend the guidelines to recreational fishers.
5. Discuss approaches for monitoring and measuring behaviour change in recreational fisheries.

In total, there were 25 workshop participants which included the research and fisheries management agencies, fishing sectors, and non-government organisations. Prior to the workshop, a questionnaire circulated to participants aimed to pre-identify priority species, factors and requirements for handling guidelines in each state, region and fishery. This provided starting points for the discussions and aided the cross-validation and alignment of the project(s) priorities with those of the various jurisdictions.

The structure of the workshop included 12 presentations given by a range of speakers across three main sessions. Following each session there were break-out discussion groups, and at the end of the workshop there was a further summary discussion session to provide a synthesis and discuss 'next steps'. This report summarises the information presented at the workshop and collected from the pre-workshop survey of participants. The report also highlights the opinions and points made during the discussion sessions during which all participants provided input.

Workshop participants generated a list of 18 species for prioritisation for development of best-practice capture and release guidelines. It was suggested that species be grouped based on similar handling practices. Workshop participants discussed criteria for grouping species that could have similar handling practices, which were; morphology (body shape & size), respiratory mode (ram vs buccal pumping; related to activity level), feeding behaviour (relates to bait taken), reproductive mode (live bearing vs egg-laying), phylogeny (Rays vs Whalers vs Hammerheads). We recommend best-practice guidelines differentiate species into four groups; sharks < 1.5m, sharks > 1.5m, rays with or without a barb.

Workshop participants identified five species for prioritisation for PRS studies in southern Australia, including Smooth Hammerhead (*Sphyrna zygaena*), Southern Eagle Ray (*Myliobatis tenuicaudatus*), School Shark (*Galeorhinus galeus*), Bronze Whaler (*Carcharhinus brachyurus*) and Smooth Stingray (*Dasyatis brevicaudata*).

Guidelines should present simple messaging, clear graphics and diagrams. Recommended fishing and handling practices included; use of circle hooks, heavy line and gear, reduce fight time, keep animal in water where possible, no gaffing in the body (lower jaw preferred), no lifting by the tail or squeezing the gills, calm shark by covering the eyes with a smooth, wet and dark cloth. If not possible to remove the hook, cut the leader as short as possible, help recovery if needed by facing fish into the current of the water, release as soon as possible and reduce exposure to sun and air.

Further refinement of the guidelines should be informed by PRS studies of priority species within recreational fisheries. It is important to investigate factors that can both be practically and statistically assessed in PRS studies. Factors that were identified as being important to assess during PRS studies included; hook and gear type, hooking location, duration of fight, handling practices at landing, resuscitation, air exposure and temperature. However, it is important not to test too many variables at once to avoid reductions in statistical power of analyses.

Effective extension of best-practice to the recreational fishing community will enable positive behavioural and cultural change with regard to the capture and release of sharks and rays. Simple and clear messages should be developed for extension activities based off the best-practice guidelines. Extension campaigns could utilise a mixed-media (including face-to-face) approach to providing communication of the key messaging. It is recommended to produce clear animations, photos and simple videos (1-3 minutes) for creating content to extend the key messages to the community. Extension can be achieved through use of print, a central campaign website or information hub, face-to-face communication, social media (Instagram and Facebook), and by engaging celebrity ambassadors that resonate with the recreational fishing community to champion the key messaging.

Recreational fisher surveys were identified as an effective tool to assess the efficacy of extension activities in causing behavioural change. Pre-campaign and post-campaign surveys can be utilised to assess changes in attitudes, beliefs and behaviours of recreational fishers. It is important that surveys are designed properly with representative samples. It may be difficult to influence fringe behaviours, i.e. bad actors who will do the wrong thing regardless of having education about best-practice. However, by creating general behaviour change in recreational fishing towards best-practice behaviours, it is possible that these behaviours will become the 'social norm' which will potentially increase the uptake of these behaviours even by fishers who were previously acting poorly.

The project teams led by SARDI Aquatic Sciences and Monash University will work to develop and deliver extension materials that educate recreational fishers on best-practice and safe-handling methods during the capture and release of sharks and rays in 2020 and 2021. Specifically, the Monash project will develop a set of best-practice capture and handling guidelines for recreational fishing of sharks and rays in Victoria and will complete an extension campaign to facilitate positive behavioural change of fishers. The SARDI-led project will complete a PRS study on one of the priority species identified within this report to further inform refinement of shark and ray capture and handling guidelines.

This report summarises key messaging and techniques that can be adopted to enable behaviour change within recreational fisheries leading to positive outcomes for fishers and sharks and rays. A cross-jurisdictional and collaborative approach will enable the best-practice guidelines to be taken up by recreational fishers across Australia.

Keywords

Chondrichthyans, elasmobranchs, recreational fishing, post-release survival, capture and handling guidelines, best practice, behaviour change

1. Introduction

Australian fishery management jurisdictions share many of the same policy drivers for their recreational fisheries. Recent events related to the capture, handling and treatment of shark and ray species focused attention on fishery policy and public perception of recreational fishing across southern Australia, including in South Australia (SA) and Victoria (VIC). Consultation supporting management and policy for sharks and rays often highlights the need to improve educational outreach, and evidence-based resources to inform safe and humane capture, handling and release practices. There were multiple examples in VIC, SA and Western Australia (WA), of rays and sharks being mutilated and killed in inhumane circumstances in 2017. This garnered significant media attention and negatively impacted the social licence of recreational fishers.

Despite these instances, the majority of recreational fishers hold positive values towards sharks and rays. Furthermore, they value stewardship of the fishery and the use of humane capture and release techniques. However, values do not always align with behaviour. Some fishers, especially those with limited experience, may not be aware of what constitutes best practice despite wanting to ensure the best outcomes for released animals. This may lead to situations where their actions do not result in positive welfare outcomes, and reflect an overall lack of understanding of the best approaches to catch, handle and release sharks and rays. Therefore, the provision of information and extension to the recreational fishing community about best-practice capture and handling of sharks and rays is warranted.

Recreational fisheries are challenging to study accurately with respect to catch rates, release rates, current practice and behaviours. Most studies rely on self-reported survey responses. There is a particular lack of information about current interactions with sharks and rays in recreational fisheries. Therefore, studies that improve our understanding of current practices and behaviours by recreational fishers when catching sharks and rays would be useful.

There have been few studies conducted on the post-release survival (PRS) of sharks and rays after capture in recreational fisheries. Most studies have focused on popular game or tournament fishing species, including Thresher Sharks (*Alopias vulpinus*) or Shortfin Makos (*Isurus oxyrinchus*). There is much more known about the PRS of chondrichthyans captured in commercial fisheries. However, the gear types and practices are vastly different. There is a need for further PRS studies of sharks and rays captured in recreational fisheries in Australia. Furthermore, there needs to be careful consideration given to the correct design of such studies.

There are existing best-practice guidelines for the capture and release of sharks and rays in recreational fishing. However, they some are species-specific, such as the guides for thresher sharks in Victoria or the United States. The South Australian Government has produced some broad guidelines to suit most species caught in South Australian waters, however, there are plans for these to be refined further. There is a clear need for further development and refinement of best-practice guidelines for the capture and release of sharks and rays in recreational fisheries within Australia. Furthermore, there is a need for subsequent extension activities to enable awareness and uptake of the best-practice approaches by the recreational fishing community. When coupled with an effective extension campaign the guidelines will enable positive behavioural and cultural change within recreational fisheries that lead to improved outcomes for fishers and animals.

To address these needs, the FRDC funded two projects in 2019. One project is focused on Victoria is being led by Monash University (FRDC 2018-042) and the other is focused on South Australia and is being led by SARDI (FRDC 2018-055). The goal of both of these projects is to develop and further refine best-practice guidelines for the capture and release of sharks and rays to ensure safety of fishers and improved outcomes for animals. Guidelines and key messaging will be disseminated to recreational fishers through various extension activities. The Monash-led project will use surveys to assess current behaviour and attitudes of recreational fishers. A follow-up survey will also be undertaken to assess the

effectiveness of extension activities. The SARDI-led project will assess the guidelines by conducting a PRS study in South Australian waters on a relevant species and investigate factors that influence post-release mortality. The results of this study will then be used to further refine the guidelines. Prior to conducting this work, a workshop was jointly organised in Adelaide by investigators from both projects in order to meet the objectives of both projects.

This Report:

The report highlights research gaps that exist for sharks and rays in Australian recreational fisheries. There is a summary of tag-recapture and survey information for sharks and rays captured in recreational fisheries. It summarises the results of a species vulnerability assessment for sharks and rays taken in recreational fisheries in southern Australia. Critically, the report presents information on those species and species groups that should be prioritised for development of best-practice capture and handling guidelines and future post-release survival (PRS) studies. The report reviews existing guidelines for sharks and rays and provides information on what the key messaging should be for the development of future guidelines. Finally, the report summarises the best ways to communicate and extend fishing guidelines to recreational fishers and appropriate techniques to measure uptake of best-practices and levels of behaviour change by recreational fishers.

The goal of this report is to; provide a summary of best-practice capture and handling techniques for sharks and rays, highlight appropriate methods to assess and refine the guidelines through post-release survival studies, and summarise optimal extension methods and methods for monitoring behaviour change.

2. Objectives

The objectives of the Workshop on Sharks and Rays in Recreational Fisheries held at SARDI on the 26th of November 2019 were to:

1. Identify priority species (or groups) of Chondrichthyans caught by recreational fishers for the development of best-practice capture and release guidelines and post-release survival studies.
2. Develop and identify key messaging for safe capture and handling to include in best-practice guidelines.
3. Identify key design aspects of post-release survival studies needed to assess, support and refine the proposed best-practice guidelines for recreational fishers.
4. Assess the best ways to communicate and extend the guidelines to recreational fishers.
5. Discuss approaches for monitoring and measuring behaviour change in recreational fisheries.

3. Method

A workshop was held at The South Australian Research and Development Institute (SARDI), West Beach (SA), on the 26th of November 2019. The workshop was titled “Sharks and rays in recreational fishing: priority species, handling guidelines, post-release survival, and extension approaches to support cultural change in fishers”. The workshop was jointly organised and delivered by the investigators of two FRDC-funded projects; project 2018-042 led by Dr. Richard Reina (Monash University) and project 2018-055 led by Dr. Paul Rogers (SARDI). Workshop participants included representatives from recreational fisheries peak bodies, fisheries scientists, conservation NGO scientists, government fisheries and natural resource managers and policy officers, social scientists, and representatives from the recreational fishing sector. A full list of all workshop attendees is provided in Appendix 2 and the agenda for the workshop is provided in Appendix 3. The workshop was broken into four sessions:

- 1) prioritising species (groups of species)
- 2) handling guidelines and post-release survival studies to inform guidelines
- 3) communication, engagement and cultural change
- 4) a general discussion session

Each session was chaired by either Dr. Richard Reina, Dr. Paul Rogers or Dr. Sean Williamson. A total of 12 presentations were given in the first three sessions and these presentations have been provided in Appendices 4 – 15.

Prior to the workshop, attendees were asked to complete an online survey. Respondents provided answers to questions about; which species should be prioritised for development of best-practice capture and release guidelines, which species and practices should be investigated in future post-release survival studies, and what capture and release techniques should be considered best-practice and worst-practice. Respondents were also asked to provide justification for their answers which helped underscore risk and research gaps for particular species.

At the workshop, following each of the four sessions listed above attendees were broken into three separate discussion groups. The groups then discussed key points relevant to each session topic. Groups were tasked with discussing and taking notes on; how they would prioritise different species or groups for development of safe-handling guidelines, which species or groups they would prioritise, key techniques for best-practice guidelines, the most important variables to assess and species to prioritise for PRS studies, and the optimal methods for extension of guidelines to the recreational fishing community. Following each of these discussion sessions, the notes of each group were transcribed in order to record the key points for translation into this report.

Attendees provided justification for their answers in both the pre-workshop survey and in the discussions throughout the workshop. This information underscored reasons particular species are more vulnerable and highlighted research gaps that currently exist for sharks and rays in recreational fisheries. This report summarises the information, opinions and discussions that were presented at the workshop and collected from the pre-workshop survey.

4. Results

4.1. Presentations

4.1.1. Introduction

Presentation 1: Summary of the alignment of goals between FRDC 2018-042 & 2018-055 projects – Drs. Paul Rogers & Richard Reina ([Appendix 4](#)).

The principal investigators of each project provided the participants an overview of the need and background for the workshop. They discussed the objectives of the workshop.

The goals of both projects were clearly articulated and this highlighted that the workshop addressed the top goals for each project (Table 1). Paul and Richard emphasised the synergies and differences between the two SARDI- and Monash University-based projects. One key difference being that the latter project aims to measure fisher behavioural changes through surveys, both prior to, and following an education campaign based on best-practice capture, handling and release guidelines. Another difference is that the SARDI project will prioritise species for PRS studies and conduct a study to collect survival data using telemetry technology.

Table 1. Project goals of the SARDI- and Monash-led projects.

Project Goals	FRDC 2018-042: Monash <i>et al.</i>	FRDC 2018-055: SARDI <i>et al.</i>
Identify species captured within recreational fisheries at a state and national level for prioritisation for improving capture, handling and release practices	✓	✓
Establish best-practice capture, handling and release guidelines for priority species	✓	✓
Identify species captured within recreational fisheries and operational factors for prioritisation for Post-Release Survival (PRS) Studies		✓
Collect PRS data on some of the priority species in collaboration with recreational fishers using telemetry technology		✓
Produce evidence-based educational material about the guidelines to inform sustainable rec. fishing practices	✓	✓
Support behavioural change through extension of educational materials	✓	✓
Measure behavioural change through fisher surveys prior to and following extension / education campaign	✓	

4.1.2. Session 1: Priority Species (*Chair: Richard Reina*)

Presentation 2: Delegate questionnaire responses on priority species of sharks and rays that require development of capture, handling and release guidelines for recreational fisheries – Dr. Sean Williamson ([Appendix 5](#))

Prior to the workshop, Monash University investigators provided a short questionnaire to confirmed participants to reflect on background information relevant to expert elicitation processes planned for

the workshop. As part of this survey, participants were asked for their perspectives on: species most at risk of poor handling and post-release outcomes, the fishing practices considered most risky for animals in terms of injury and survival, important inclusions in best practice guidelines, and how best to educate fishers about safe handling practices. A total of 19 participants responded to the questionnaire of which 47.4% identified as non-recreational fishers and 52.6% were fishers. Totals of 42.1% of participants were from SA, 26% from VIC, 10.5% from QLD, and 10.5 from NSW, and 5.3% from WA.

In terms of the priority species identified as needing handling and release guidelines and based on the number of times they were listed, the Bronze Whaler and Smooth Stingray were equal first, Shortfin Mako and Southern Eagle Ray (*Myliobatis australis*) were second, Gummy Shark (*Mustelus antarcticus*) and School Shark (*Galeorhinus galeus*) were third and Hammerheads (*Sphyrna spp.*) and Southern Fiddler Ray (*Trygonorrhina dumerilii*) were fourth. In terms of prioritisation based on a weighted ranking of importance, Hammerhead spp. were first, Gummy Shark was second, School Shark was third and Shortfin Mako was fourth. At the State level and for states where there was reasonable sample size of respondents: In SA, the Southern Eagle Ray, School Shark, Bronze Whaler and Smooth Stingray rated highest and Gummy Shark, School Shark, Southern Fiddler Ray and Shortfin Mako rated highest in VIC in terms of needing guidelines. At the National level, there were only four responses identifying Hammerhead spp., Grey Nurse Shark (*Carcharias taurus*), Tiger Shark (*Galeocerdo cuvier*), Blue Shark (*Prionace glauca*) and Sandbar Shark (*Carcharhinus plumbeus*) as priorities for requiring handling guidelines. Common reasons for prioritisation of species include sensitivity to handling, frequency of release and PRS, catch rates and frequency as bycatch, cross-jurisdictional mixing, difficulty and potential danger of handling, depredation 'pests', lack of handling knowledge and education, conservation concern, frequency of pregnancy, community concern (rays and sharks encountered during diving and snorkelling) and reporting of bad practices and animal mistreatment.

With regard to priority species for studies of PRS, four participants prioritised the same species they listed as priorities for guidelines. Others were Hammerhead spp., Rays, Whaler Shark spp., Southern Fiddler Ray, Gummy Shark, School Shark and Shortfin Mako. Overall, there was no clear consensus on any one particular species being the highest priority for guidelines. Operational factors that participants considered needed to be tested included handling methods, fishing gear/bait soak times, gear and hook types, breaking strain of line, reel type and amount of drag set, fishers' perceptions towards sharks, air exposure time and air temperature during handling.

Factors and practices considered to have the highest impacts on shark and ray species included deliberate harm and mutilations, depth, exposure time, extended gear soak and fight times on lines, damage inflicted during removal of hooks, hooking location and hook type. In contrast, factors and practices considered to have the greatest positive impacts on species and should be considered to be part of guidelines were the use of circle hooks, limiting air exposure, short soak and fight times, use of hooks that rust out and the practice of flattening of barbs. Use of heavy gear to reduce fight times was also an agreed best practice.

Presentation 3. Summary of outcomes of previous workshops and reviews that support prioritisation of research gaps for shark and rays in Australian recreational fisheries – Dr. Charlie Huvaneers ([Appendix 6](#))

Charlie provided participants with a broad information summary on the Convention on International Trade in Endangered Species (CITES) statistics including the numbers of elasmobranch species listed in the past two decades. He also spoke briefly about workshops funded by the IUCN Shark Specialist Group (feeding into Red List assessment processes), Western and Central Pacific Fisheries Commission (WCPF) and Areas Beyond National Jurisdictions workshops on post release survival data from commercial pelagic fisheries in 2017 and 2019. Notably, the workshop funded through FRDC Shark Futures and led by CSIRO provided a synthesis of available data on Mako Sharks (*Isurus spp.*) and Porbeagle (*Lamna nasus*) in Australian waters. The project provided information on the status of the species and future directions for research.

Post-release survival estimates for Shortfin Makos were one of the priorities identified by the researchers and managers that took part in this workshop. The Mako and Porbeagle workshop

highlighted that there was a need for further information on the Australian recreational catches of these species. Subsequent to the Mako and Porbeagle workshop, IMAS assessed the impacts of catch and release off Shortfin Makos in the Australian recreational and game fishery and found survival rates were relatively high with short fight times, and that physical and hooking injuries explained survival rates estimated using survival pop-up satellite tags.

Other key initiatives raised were those funded by the NESP Marine Biodiversity Hub, including the prioritisation of research and management needs for Australian elasmobranch species, the Shark Action Plan Policy Report and the Report Card for Australia's Sharks. The later report card showed that of 194 species/stocks studied, 124 were assessed as sustainable (e.g. Gummy Shark and Bronze Whaler; SAFS), 42 were undefined, 9 were recovering (e.g. Dusky Whaler (*Carcharhinus obscurus*) and Sandbar Shark; SAFS and IUCN), 6 were depleting (e.g. Shortfin Mako, Tiger Shark, Bigeye Thresher (*Alopias superciliosus*) and Pelagic Thresher (*Alopias pelagicus*); IUCN Red lists), and 18 were overfished/depleted (e.g. School Shark, Grey Nurse Shark and two Hammerhead spp.). The School Shark (Conservation Dependent), Shortfin Mako and Porbeagle (Migratory) are listed under the Commonwealth Government Environmental Protection Biodiversity and Conservation Act (1999) with the latter two species listed under CITES and the Convention on Migratory Species.

Charlie introduced the utility of the concept and approach taken by Dulvy *et al.* (2017) for prioritisation of species and issues to focus for PRS in recreational fisheries. These researchers analysed global landings and conservation status of sharks, rays, skates and chimaeras in Kobe plots assessment charts (as in SAFS). Participants agreed that the future application of this approach had significant merit. It will require a) updated National recreational fishing survey data on sharks, rays, skates and chimaeras, b) species identification and species resolute catch data, and c) population assessments be completed for key recreationally caught species.

Presentation 4. Species vulnerability assessment of chondrichthyans taken in recreational fisheries – Dr. Terry Walker ([Appendix 7](#))

Terry Walker presented a summary of a recent assessment of the vulnerability of 132 chondrichthyan species in the Australian Exclusive Economic Zone. The species were assigned to six ecological groups and included shelf-inshore, shelf-reef, shelf-sand, bathyal-upper, bathyal-lower and pelagic. During the process, species impacts were assessed in response to seven climate change stressors and seven anthropogenic stressors, each of which are detailed in Appendix 7. The ecological groups were exposed to five types of fishing and anthropogenic stressors. The shelf inshore group was exposed to non-commercial fisheries and other inshore stressors; the shelf-sand group was exposed to commercial shark gillnet and demersal fisheries, the bathyal-upper and -lower groups were exposed to commercial demersal trawl, and the pelagic group was exposed to the commercial and pelagic game fisheries. Vulnerability to fishing was calculated by multiplying the components of exposure, productivity and susceptibility for each species. Likewise, vulnerability to climate change was calculated by multiplying the components of exposure, sensitivity and adaptability for each species. Data used included fisheries data based on presence-absence of species in ten subregions between the NW shelf and the SW Pacific off eastern Australia, annual catches, shark gillnet survey data, size at maturity, max age and trophic level. Species considered to be at high risk of impacts from fishing included School Shark and Gummy Shark, Elephantfish (*Callorhynchus milii*), whereas Bronze Whaler and Dusky Whaler were considered high risk to climate change impacts.

Presentation 5. Stress and patterns of biological and ecological sensitivity to capture of chondrichthyan groups – Dr. Richard Reina ([Appendix 8](#))

Richard explained that the chondrichthyans are high risk due to their general characteristics of high trophic position, low reproductive capacity, longevity, slow maturity and high natural annual survivorship. He explained the consequences of capture, and what they stem from, including the capture method, exposure to air, live discarding as well as their outcomes. Some of the primary, secondary and tertiary responses can be described by analysing the catecholamines and glucocorticoids, lactates, glucose, blood Ph impacts and electrolytes, and finally the impacts on growth, immunity and

reproduction. Richard made the point that rays and sharks can be grouped based on sensitivity to handling.

In the higher sensitivity group, Richard included the ram ventilating, pelagic, and/or live-bearers (viviparous species). These sharks typically have high metabolic rates, large body sizes and they are relatively sensitive to air exposure. Species in the lower sensitivity grouping were stationary respiring, benthic, egg layers with low metabolic rates. These species are generally smaller body sized and more tolerant to air exposure.

Gear type was also described as a predictor of mortality for obligate ram ventilators and stationary respiring benthic species, with stationary respiring species having lower immediate mortalities on longlines, gillnets and in trawls. In the context of capture handling and release practices, those that minimise stress lead to improved outcomes for captured animals by reduction of physical damage, energetic costs, immune and reproductive consequences and impaired swimming behaviours. Ricard listed some survey results that outlined the commonly listed criteria used for grouping species that could be assigned similar handling practices, including morphology, respiratory mode, feeding behaviour, reproductive mode and phylogeny.

Presentation 6. A summary of tag-recapture and survey information for sharks and rays in recreational fisheries – Mr. Phil Bolton and Dr. Julian Pepperell ([Appendix 9](#))

Phil outlined that in southern Australian states, fishers taking part in the NSW DPI Game Fish Tagging Program have tagged 30,614 sharks (15 spp.) and rays (only Southern Eagle Ray) in the past 47 years. The most commonly caught, tagged and release species are Shortfin Mako (8,191), Hammerheads (5,340) and Whaler Shark species (5,323), Blue Sharks (5,089), Bronze Whalers (2,502), Tigers Sharks (1,296), Southern Eagle Rays (815) Gummy Sharks (726) and School Sharks (601). In the last decade, Shortfin Makos have mostly been tagged in NSW, TAS and VIC; Whaler spp. in NSW, SA and QLD; Bronze Whalers in VIC, SA and NSW; Hammerheads in NSW; Blue Sharks in NSW, TAS and SA; Tiger Sharks in NSW and WA; Southern Eagle Rays in SA and VIC.

Julian presented the National Recreational Fishing Survey results for 2000/01 on sharks and rays, which indicated 1.25M were caught of which 1M (82%) were released, and the rest retained. Key points highlighted from the recreational survey in NSW in 2013/14 were that numerically the Shovelnose Rays (*Aptychotrema & Rhinobatos spp.*) were the most frequently captured (35,627) and released (95%), undifferentiated 'Ray species' were the second most frequently caught (34,506) and released (99%), followed by another common species complex, the Whaler Sharks (13,488 caught and 88% released). Wobbegong spp. (*Orectolobidae*), Gummy Shark, Hammerheads and Port Jackson Shark (*Heterodontus portusjacksoni*) were also commonly caught (nominal: 9,510 - 3,240) and released (88 - 100%). Gummy Shark (4,000; 75%), School Shark (386; 0%), and Shortfin Mako (297; 100%) were caught at comparatively low levels and with the exception of School Sharks, the release rates were high.

During the most recent South Australian Recreational Fishery survey (2013/14), the Gummy Shark (11,597; 24%), School Shark (7,749; 7%), Port Jackson Shark (4,313; 99%) and Greeneye Dogfishes (*Squalus spp.*) (2,772; 100%) were the most commonly caught and released species, with a further 9,489 undifferentiated Rays and Skates captured of which 100% were released. The Queensland Recreational Fishing Survey (2013/14) indicated undifferentiated Whaler Shark and Weasel Sharks (*Hemigaleidae spp.*) (24,000; 100%) and Shovelnose Rays and Guitarfishes (*Rhinobatidae & Rhinidae spp.*) (28,000; 93%) were important numerically, with 66,000 Rays and Skates caught, comprising the largest group, of which all were released.

The 2015/16 Western Australian recreational fishing survey found Blacktip Reef Shark (*Carcharhinus melanopterus*) (1,419 caught; 85% released), Dusky Whaler (1,467 caught; 84% released), Bronze Whaler (1,235 caught; 71% released), and Port Jackson Shark (1,047; 97% released) were most commonly caught and released, along with unidentified species; "Other Shark" (2,739; 86%) and "Other Rays/Skates" (2,241; 98%). The 2009/10 Northern Territory survey found "Sharks & Rays" were

commonly caught and released (27,738 caught and 95% released). There was a higher rate of retention of “Sharks & Rays” reported in the 2012/13 Tasmanian survey (38,641 caught and 76% released).

Key points from the group discussion session following Session 1 were:

- Attendees were asked to discuss prioritisation of species, or groups of species, for the development of handling guidelines. Attendees were split amongst three separate groups and a representative from each group reported back to all the attendees about their key discussion points at the end of the discussion session.
- Attendees were generally in agreement with results from the pre-workshop questionnaire that suggested the following species should be prioritised for handling and release guidelines: Bronze Whaler, Smooth Stingray, Shortfin Mako, Southern Eagle Ray, Gummy Shark, School Shark, Hammerheads and Southern Fiddler Ray.
- Attendees discussed that prioritisation of species for development of guidelines is complicated due to the multifactorial considerations of each species’ sensitivity to handling, frequency of release and PRS, catch rates and frequency as bycatch, difficulty and potential danger of handling, lack of handling knowledge and education.
- The concept of using Kobe plots and approaches similar to those utilised by Dulvy *et al.* (2017) for prioritisation of species, and operational and ecological factors to focus on for PRS studies in recreational fisheries, was discussed as having considerable potential. Future application of this approach has significant merit and will require better data resolution for recreational shark and ray catches and species compositions.
- Various methods for grouping species were proposed and discussed. One group thought that species could be group based on the fishing location that they were likely to be caught. For example, beaches and jetties (Eagle Ray, Smooth Stingray, Southern Fiddler Ray, Port Jackson Shark), or inshore boat fishing (Broadnose Shark (*Notorynchus cepedianus*), Bronze Whaler, Dusky Whaler, Gummy Shark, School Shark), or offshore boat fishing (Shortfin Mako, Thresher Shark, Blue Shark). Another group similarly thought that species could be group based on the fishing location likely to be caught; jetty vs boat vs shore. The final group thought that it would be best to group species based on the difficulty and danger of handling. For example, group the following: a) all rays with a potentially dangerous barb; b) all sharks of a large size and with potentially dangerous teeth; c) non-dangerous rays; and d) small sharks. They suggested this because they thought that the practices for handling would be more similar for these types of groups.

4.1.3. Session 2: Handling guidelines for priority-species (groups) – Design principles and considerations when developing post-release survival studies to inform best practice guides in recreational fisheries (Chair: Paul Rogers)

Presentation 7. Review of existing handling guidelines for sharks and rays in recreational fisheries in Australia – Dr. Sean Williamson ([Appendix 10](#))

In Australia, guidelines focused on recreational and game fishing of sharks have been limited to the [Best practice catch and release guidelines for Thresher Sharks in Victoria](#) developed by the VRFish, and the PIRSA Fisheries and Aquaculture [Recreational fishing guide on appropriate fishing gear and handling techniques for sharks and rays](#). Sean highlighted the key overseas examples, which include the [Careful catch and release guidelines](#) for large pelagic fish developed by NOAA Fisheries, and PIER and NOAA’s [Best fishing Practices for safe handling of common threshers](#).

Previous guidelines developed in Australia for commercial fisheries that cross-over in terms of the relevance of some on-board handling approaches, do’s and don’ts, included the [Shark and Ray Handling Practices](#) developed for the Australian Fisheries Management Authority managed commercial fisheries. Sean emphasised the importance of presentation of clear simple graphics in the educational materials

and best practice guides. The use of clear simple graphics allows for fast reading and unambiguous interpretation, which should be useful in various fishing situations. Commonly listed practices determined to represent best practice included use of circle hooks rather than J-hooks, use of heavy gear that can in-turn lead to reduced fight times, no gaffing in body, keeping animals in the water where possible and facing into current, covering of eyes, cutting or removing leader/hooks, reducing exposure to sun and minimising handling times.

Presentation 8. What information is the highest priority in post-release survival studies to support development and refinement of best-practice guidelines in recreational fisheries – Dr. Sean Tracey ([Appendix 11](#))

Some key points were the ‘ins and outs’ of influencing fishing behaviour, either in a regulatory vs voluntary control manner (or is it really about influence of cultural and behaviour shifts?). Key factors to consider in PRS studies were raised, as hook type, hook location, duration of fight and associated stress, handling at landing and resuscitation.

Previous studies of PRS of Shortfin Mako indicated a high PRS rate (French *et al.* 2015), with hook type being very important. If treated well the PRS of line caught Shortfin Makos was predictably high. Mortality can also occur with a short fight time. In recent PRS studies of Southern Bluefin Tuna (SBT; *Thunnus maccoyii*), hook type had a substantial effect on post release fate, with J-hooks leading to better survival outcomes. Treble hooks were associated with worse PRS outcomes for SBT. For broadbill swordfish, the PRS survival rate was low and indicated it was not a good candidate for catch and release. Circle hooks have been shown to reduce the incidences of deep hooking (e.g. in gills and stomach), and barotrauma is an important issue for the species when caught on rod and reel.

When working with fishers there can be confounding factors that can lead to the need for PRS estimates to be considered as minimum estimates of survival. Experiences with significant PRS results vs ‘indicative’ results showed the latter are still as recreational fishers do not necessarily value the importance or relevance of statistical significance. Consistent PRS results are helpful when delivering the message on handling practices. The importance of telling someone how to do something vs encouraging them in a way that is supported by science was emphasised, as was discussions regarding ownership of the final messaging of the study.

Presentation 9. Development of capture, handling and release guidelines in recreational and game fisheries for pelagic sharks – Dr. Paul Rogers ([Appendix 12](#))

This information stemmed from satellite tracking studies with recreational and game fishers over several years in Victoria and South Australia. In these studies, handling approaches aim to achieve 100% survival of released tagging candidates, as opposed to studies that aim to estimate PRS in response to standard fishing practices. Paul explained why capture handling and release guidelines are needed for pelagic shark species, with key points including that, fishers learn and refine ‘best practice’ approaches over time and new fishers need guidance and educational experiences to learn how to fish safely. Paul highlighted the importance of studies of PRS to inform the development of capture, handling and release guidelines. Working with scientists generates hands-on learning, ‘word of mouth’ flow of information and uptake based on the sentiment of shared ownership and value.

Key considerations for pelagic species listed were that they have different behavioural responses to fishing gear and capture, which means there is a need for careful pre-fishing planning, use of strong and reliable equipment and approach for each species. Some species, such as Shortfin Mako and, Thresher Shark, and are endothermic ram ventilators that are physically strong, have large body sizes and substantial body weights of >300 kg. Despite their size, weight and powerful nature they have organs (e.g. eyes and gills) that are sensitive to handling, which means they may need rapid and time efficient handling methods, whilst other species tend to be more robust to handling. Where possible, the best-case scenario tends to include handling whilst in the water for pelagic shark species.

Some of key points raised included, that there are very different practices across vessels with small intricate differences during different catch situations, which may possibly drive disparate PRS outcomes. Other learnings when capturing and satellite tagging pelagic sharks have included that the quickest catch and handling methods are generally the best. This was supported by the study of Heberer *et al.* (2010) (formerly NOAA) on the Thresher Shark that found that heavy (line breaking strain) fishing gear led to better survival outcomes and avoided tail hooking. The NOAA careful catch and release guidelines for Thresher Shark include to keep the animals in the water and swimming along-side the vessel, to cut the line as close as possible to the hook, to use non-offset circle hooks, to protect eyes and gills. The NOAA guides also recommend for the fishers to plan before starting fishing by discussing the best approach and using the appropriate handling gear for the target species or group (with similar catch and release scenarios).

Key points from the group discussion session following Session 2 were:

- Power analyses might not be very useful for field-based PRS studies. While these analyses deliver statistical significance estimation based on sample size of sharks to be tagged, they may not reflect the relative importance of the factors in the experimental designs.
- Blood chemistry approaches are likely to increase stress in sharks and rays, hence were considered ‘minimal’ estimates or highest stress level for recreational fisheries.
- Heavy breaking strain fishing gear increases fisher’s ability to control fish faster for tag-release. In some regions, this could also reduce fishing mortality by reducing incidence of seal depredation.
- Terminology – ‘sustainability’ is the wrong word here (e.g. recreational fishers do not resonate with sustainability because it is such a small catch/impact compared to global scale). Better alternate terms might include – accountability and responsibility, stewardship – as they resonate better.
- Handling guides should be easily digestible, with simple diagrams rather than use of detailed descriptive text (to avoid diluted messages). Avoiding the use of words reduces need for having the material developed in multiple languages.
- A question was asked regarding the existence of any evidence of changing trends in behaviours by game fishers, including how any existing guidelines have been taken up and how effective they have been.

4.1.4. Session 3: Communication, Engagement and Cultural Change (Chair: Sean Williamson)

Presentation 10. Lessons learned by engaging with recreational fishers. Extension approaches and their relative impacts. What are the challenges and strengths of different media? – Dr. Sean Tracey ([Appendix 13](#))

Sean Tracey presented a relevant case study of the “[Tuna Champions](#)” program. Sean and his team have been working with recreational fishery to conduct a large behaviour change project. The program has been engaging recreational fishers with citizen science opportunities, clear communication of scientific research and analyses which enables knowledge building within the sector.

The project has been providing extension and communication through use of print, central campaign website or information hub, social media (Instagram and Facebook), and by engaging celebrity ambassadors that resonate with the recreational fishing community to champion the key messaging. The program has maintained simple and inclusive messaging, with accessible communication materials. They have also been careful not to alienate target audience by using words such as ‘sustainability’. Stewardship, accountability, and responsibility are terms that are more likely to resonate with recreational fishing community.

The team believe that education and nudge theory could potentially be more effective than more regulations. Nudge theory proposes positive reinforcement and indirect suggestions to influence decision making and behaviour. It is possible to then see this snowball throughout the recreational fishing community.

Presentation 11. Attitudinal surveys relating to recreational fishing, gear and handling practices – Dr. Matt Heard ([Appendix 14](#))

Matt presented on a survey study of values, behaviours and the decision context for tournament fishers (Heard *et al.* 2016). Tournament fishers are a small proportion of all recreational fishers in Australia (5%). They exhibit a higher mean effort and catch of pelagic and migratory species, with Shortfin Mako being the most targeted shark.

Most respondents hold positive values towards sharks (Heard *et al.* 2016). The majority (> 85%) of fishers interviewed agreed or strongly agreed that; “it is important to me that all the fish that I release survive”, “I would be willing to use tackle and special handling practices that minimise damage to released sharks”, and “I like to ensure that a shark is released in a good condition”. Most recreational fishers do not believe that recreational fishing is a threat to shark populations and but do believe commercial fishing is a threat. Few respondents thought that more regulations are required for recreational fishing for sharks.

Although most tournament fishers hold positive values towards sharks, this is not necessarily reflected in their behaviours (Heard *et al.* 2016). In terms of behaviour, most tournament fishers surveyed used J-hooks exclusively (48%), with 36% using circle hooks exclusively and the rest (16%) using both. Over 60% of fishers surveyed reported releasing some or all of the sharks they caught.

Understanding the decision context; the values, knowledge and rules that inform decision making, for fishers is important (Colloff *et al.* 2018). Furthermore, championing some values and behaviours may provide positive outcomes.

Presentation 12. Behavioural dynamics and attitudinal changes in recreational fisheries. How do we measure and monitor uptake of the information? – Mr. Michael Burgess and Dr. Jessica Walsh ([Appendix 15](#))

Mike presented on VRFish’s experiences with representing recreational fishers in Victoria and improving fishing experiences for everyone. VRFish promotes fishing and the use of best practice to ensure stewardship of the fishery. VRFish employs a range of communication techniques including; a central brand website, traditional media (print, mailing lists), social media, electronic marketing and direct engagement with fishers at fishing events etc. VRFish conduct regular surveys of recreational fishers in Victoria and have access to ~100,000 email addresses of recreational fishing license holders who consented to being contacted by VRFish.

One relevant case-study VRFish worked on was the “Care for Cod” education campaign, which included pre- and post-campaign surveys. The large majority (93%) of recreational fishers think that proper fish handling is important. Respondents (29%) reported that the education campaign influenced some or all of their practices, with 23% already doing as recommended by the campaign.

In response to some issues around treatment of rays in Port Phillip Bay in 2017, VRFish surveyed recreational fishers about their interactions with rays. Only a small proportion of fishers (5%) targeted rays, skates or guitarfish, and most (91%) were unlikely to retain rays. However, there was a large proportion of respondents (44%) that were not confident in how to handle and return rays to the water unharmed.

Respondents to the ray survey strongly supported using the following extension methods; signage at ‘hotspot’ locations such as piers and jetties, conducting an education and awareness campaign, and development of a code of conduct for proper handling and release techniques.

Jess gave a talk about measuring the effectiveness of the handling practices extension campaign that will be undertaken by the Monash Project (FRDC Project 2018-042). Jess presented the preliminary design of the pre- and post-extension campaign surveys that will be conducted to evaluate the extension campaign. The surveys aim to assess awareness and knowledge, behaviour, and attitudes. The first survey will be completed prior to any extension activities and the follow-up survey will be conducted 6 months after the start of the extension activities. The surveys will ask questions related to level of fishing experience, frequency of fishing, location, target and caught species, gear use, likelihood of release for individual species, confidence in handling species, knowledge of handling practices, attitudes towards others handling practices, and demographic information. Jess welcomed advice and feedback from all the workshop attendees to aid in the development of these surveys.

Key points from the group discussion session following Session 3 were:

General points about communication and extension to recreational fishers:

- Within fishing communities there are role models that support the implementation of best practice behaviours and techniques (e.g. affiliated game fishing clubs practice tag and release supporting the NSW Game Fish Tagging Program).
- These role models influence public perception, which in-turn can drive or lead change within communities.
- Ambassadors / champions are very useful, such as the combination of celebrity champions (e.g. Al Mcglashan) and within community champions for the Tuna Champions program.
- Word of mouth is a powerful tool to get messages into the community.
- Some fishers are not willing to adopt recommended practices and change in culture in fisheries can take time.
- Examples where non-legislated approaches have worked include the case of the Rockhampton and Mackay Council where net free zones are implemented with a voluntary code of practice and a pledge that incorporates self-policing.
- Australia has a diverse community speaking an array of different languages, and hence new guidelines conveyed through websites and signage should be provided in other key languages.
- Important to make sure communications resonate with fishers using selective language (i.e. stewardship vs sustainability etc.). Something similar to the “no wastage” message adopted by the Tuna Champions program.
- Illustrations are far more effective than text. Short instructive videos are very popular and are useful.
- Use simple language.
- Utilise a mixed-media approach, with various methods for extension (social media, print, video, etc), linked via a central website, in conjunction with face-to-face communication.
- It is useful to maintain independence of campaigns / brands from government or other NGOs. There is not a huge amount of trust in government and there are other issues linked with regulatory and conservation policy, which might undermine efforts to elicit behaviour change.
- Messaging to other groups, outside of the recreational fishers, is important as well. This impacts upon the social licence for recreational fishing.

Discussion points related to the Monash Project Surveys:

- Photographs could be useful to check respondent's knowledge of species identification.
- Need to decide if individual shark species data is most important or if general attitudes towards sharks is sufficient.
- Important to have specific questions about small actions to detect behaviours and behavioural change.
- Include questions on reasons for release or retainment of fish.
- It was recommended that in order for the survey to detect changes in behaviour, the period between the pre- and post-surveys be extended (where possible).

5. Discussion

5.1. Identifying priority species of Chondrichthyans caught in recreational fisheries in Southern Australia

Available information suggests that the diversity of shark and ray species that are caught by recreational fishers in southern Australia is relatively similar across state jurisdictional boundaries, from southern WA, through SA, VIC, TAS, and Southern NSW. Major differences in the species caught in recreational fisheries would be more evident if looking at recreational fishing across all of Australia, with some tropical and sub-tropical species being only present northward from NSW and WA. For this reason, species predominantly found in the southern waters of Australia, from southern WA across to southern NSW and Tasmania were assessed for prioritisation for these projects.

As highlighted in presentation summaries and discussion points listed in the results, there are a range of linked factors to take into consideration when prioritising species for development of best-practice recreational fishing guidelines and for future PRS studies. We discuss these factors below. However, it is important to note that none of these factors should determine species prioritisation independently.

The conservation status of shark and ray species differs depending upon classification system (Huveneers; Appendix 6) – e.g. globally: CITES, IUCN, and locally the EPBC Act and SAFS status. Combining all classification systems, the two species of highest concern relevant to southern Australia are Shortfin Mako and School Shark.

A species vulnerability risk assessment for species caught in recreational fisheries in southern Australia has been simultaneously undertaken by Walker *et al.* (Appendix 7) for three climate change emissions scenarios and two fishing scenarios. No species are at a high risk from fishing pressure. Importantly, species conservation status may change into the near future due to climate change. Commonly targeted and caught species such as, Whaler Sharks, School Shark, and Elephantfish, are at medium risk for high emissions scenarios.

Within recreational fisheries there are species that are commonly targeted (Gummy Shark, Eagle Rays, Elephantfish, School Shark, Shortfin Mako etc.). Other species that are commonly bycaught (Port Jackson Shark, Guitarfish), and some are particularly biologically sensitive to capture and release with a high chance of post-release mortality (Thresher Shark, Shortfin Mako, Hammerheads etc). These factors should also inform species prioritisation for development of best-practice guidelines and future PRS studies.

Across Australia there is generally a high rate of release of captured sharks and rays, with approximately 82% released (National Survey 2000; Appendix 9). Some species are more commonly recorded as retained in some states, for example only 7% of School Shark in South Australia were released (SA State Survey 2013/14; Appendix 9). However, there can be multiple biological impacts for released animals. Furthermore, the biological impact of capture and release by recreational fishers on the animals varies significantly between species and species groups (R. Reina; Appendix 8). The physiological impacts of capture and release can have impacts on factors such as blood chemistry, behaviour, metabolic rate, immune function, reproductive output and post-release survival.

As initially suggested by Charlie Huveneers (Appendix 6), and generally agreed upon during discussions at the workshop, Kobe plot analyses could be informative for prioritisation of species. Individual species could be plotted on the Kobe plot incorporating the three variables of; recreational fishing catch rate, PRS rates, and conservation status. This type of analysis would be more robust if reliable species-specific recreational fishery catch data and release rates for each state become available in the future.

During the workshop we aimed to identify priority species for a) development of best-practice capture and handling guidelines and b) future post-release survival studies to assess and refine the guidelines. Through expert elicitation species were prioritised by factoring the elements listed above such as; their conservation status, recreational catch rate and post-release survival. Attendees were asked to complete a pre-workshop survey in which they prioritised their top five species for development of best-practice capture and handling guidelines and top five species for prioritisation for future post-release survival studies.

Respondents gave the following common reasons for prioritisation of particular species; sensitivity to handling and post-release mortality, catch rate, regularly bycaught, frequently released, difficult to handle or dangerous, often considered a “pest” species by fishers, lack of handling knowledge, conservation concern, often pregnant when caught and released, general community concern for species, number of previous reports of bad practices and mistreatment.

5.1.1. Priority species for development of best-practice capture and handling guidelines

The following list of species (Table 2) is a combination of species that are either; frequently targeted, frequently bycaught, susceptible to capture, are particularly difficult to handle. This list was generated from the pre-workshop surveys and then further refined through discussions at the workshop. We have also highlighted species that are not relevant for South Australia and/or Victoria, the two relevant jurisdictions for each of the FRDC-funded projects.

Table 2. List of species for southern Australia (NSW to WA):

Common Name/s	Species name (or genus name if group)
Blue Shark	<i>Prionace glauca</i>
Bronze Whaler #	<i>Carcharhinus brachyurus</i>
Dusky Whaler	<i>Carcharhinus obscurus</i>
Elephantfish	<i>Callorhynchus milii</i>
Fiddler Ray spp.	<i>Trygonorrhina</i> spp.
Greynurse Shark *	<i>Carcharias taurus</i>
Gummy Shark	<i>Mustelus antarcticus</i>
Hammerhead spp. (only Smooth Hammerhead for SA & VIC) #	<i>Sphyrna</i> spp. (only <i>S. zygaena</i> relevant for SA & VIC)
Port Jackson Shark	<i>Heterodontus portusjacksoni</i>
School shark #	<i>Galeorhinus galeus</i>
Sevengill spp.	<i>Notorynchus cepedianus</i> & <i>Heptranchias perlo</i>
Shortfin Mako	<i>Isurus oxyrinchus</i>
Smooth Stingray #	<i>Bathytoshia brevicaudata</i>
Southern Eagle Ray #	<i>Myliobatis australis</i>
Stingaree spp.	<i>Urolophidae</i> spp.
Thresher Shark	<i>Alopias vulpinus</i>
Tiger Shark *	<i>Galeocerdo cuvier</i>
Wobbegong spp.	<i>Orectolobidae</i> spp.

* Denotes species that are not relevant for SA and VIC jurisdictions. # Denotes species that should be prioritised for PRS studies.

At a national level the main difference was a greater prioritisation of; Hammerheads (Great (*Sphyrna mokarran*), Scalloped (*Sphyrna lewini*) and Smooth (*Sphyrna zygaena*)), Tiger Shark, Greynurse Shark, Blue Shark, and Sandbar Shark.

There was general discussion at the workshop about whether and how to group species for development of common messaging for the guidelines. It was suggested in the first group discussion session (4.1.2) that species could be grouped by potential hazard to fishers. For example, sharks with dangerous bite versus those without, and rays with barbs versus those without.

Respondents to the pre-workshop survey were also asked to list criteria for grouping species that could have similar handling practices. Commonly listed criteria were; morphology (body shape & size), respiratory mode (ram vs buccal pumping; related to activity level), feeding behaviour (relates to bait taken), reproductive mode (live bearing vs egg-laying), phylogeny (Rays vs Whalers vs Hammerheads).

We have made the decision to differentiate species into four groups including; sharks less than 1.5 m, sharks greater than 1.5 m, rays with a dangerous barb, and rays without a dangerous barb.

5.1.2. Species for prioritisation for future post-release survival studies

From discussions at the workshop, responses in the pre-workshop survey and consideration of published studies, several species were listed as priorities for future PRS studies, including Smooth Hammerhead (*S. zygaena*), Southern Eagle Ray (*M. tenuicaudatus*), School Shark (*G. galeus*), Bronze Whaler (*C. brachyurus*) and Smooth Stingray (*D. brevicaudata*) (Table 2). Within recreational fisheries, these species are commonly targeted and/or bycaught and there are some significant gaps in the information required to assess fishing impacts and the health of populations. A high rate of capture and release was an important factor for prioritisation (Southern Eagle Ray and Smooth Stingray). Importantly, the five species also represent a mix of the four groups we have decided to differentiate species into for the development of best-practice guidelines. Other species, that are commonly bycaught (Port Jackson Shark, Guitarfish), or were uncommon but particularly biologically sensitive to capture and release (e.g. Thresher Shark spp.), were also considered as requiring further attention in future PRS studies. There was discussion around the need for consideration of the tractability of conducting PRS studies of some species, and the relative value of building on existing PRS datasets, e.g. Shortfin Mako for which there are some existing PRS data. For the SARDI-led project (2018-055), further discussions with the project steering committee will provide input and assist with these considerations prior to finalisation of planning stages of the PRS field-study.

5.2. Important messages for best-practice capture and handling guidelines

There are multiple guidelines for capture and handling practices that already exist – in both an Australian and international context (Sean Williamson, Appendix 10). These guidelines use simple messaging, clear graphics and diagrams. Commonly listed positive practices in these previous guidelines informed, and are generally similar to, what we have proposed as practices that should be encouraged below.

It is necessary to provide guidelines for groups of like animals (e.g. large sharks vs small sharks) because best-practice capture and handling techniques are often similar for these groups irrespective of species. Previous guidelines have also grouped species in this way (e.g. PIRSA and AFMA guidelines; Appendix 10). However, species-specific messaging is still valid for some individual species (e.g. Thresher Shark) which may have unique biology that require specific practices. Although, there are already two Thresher Shark specific guidelines which have already been developed (VRFish and NOAA/PIER; Appendix 10).

We discussed that it is best to maintain simplified messaging and not overload fishers with too much specific information for different species. There was also some discussion about whether messaging should be tailored differently depending on the method of fishing, for example jetty vs boat vs shore-based fishing. It was decided that the best approach would be to break animals into four broad groups where best practice would involve slightly varied techniques. However, there are some techniques that are ubiquitously beneficial for safety of animals and fishers (such as circle hooks, not gaffing / grabbing gills etc.).

The following practices should be generally encouraged regardless of species; using circle hooks and heavy line or leader, using non-stainless hooks, removing the hook if possible (unless gut hooked), cut the line as short as possible if unable to remove the hook, when lifting ensuring that you support the body and do not lift the animal by the tail, using knot-less nets if using a net to lift, reducing fight time, and limiting time out of water to minimise exposure to the sun and air.

Now that we have decided to that messaging should be tailored for the four distinct groups of species. We propose the practices listed below for each group.

Specifically, for rays it should be encouraged to lift by grabbing the snout and/or spiracles if the animal needs to be removed from the water. In general, for dangerous rays with a barb it should be advised to leave the animal in the water if possible to do so whilst still removing the hook or cutting the line as short as possible. For non-dangerous rays without a barb the animal can more safely be removed from the water to remove the hook and release.

Sharks should always be lifted whilst supporting the body and holding the tail in order to keep the animal horizontal and prevent injury. If a shark has been caught from the shore, avoid landing the animal on rocks instead moving to a beach if possible. For sharks over 1.5 m it is advised to leave the animal in the water and attempt to remove the hook or cut the line as short as possible. For sharks under 1.5 m in length, when safe to do so the animal can more easily be removed from the water to remove the hook and release. If a shark is removed from the water, the animal can be calmed by covering the eyes with a smooth, wet and dark cloth.

There is an increasing need for fishers to undertake safe photography practices when fishing, especially in with the increase in fishing photography associated with cheaper camera technology and the increase in use of social media. Photography should not be broadly discouraged, in fact it can be quite useful in promoting fishing, improving both the social licence of recreational fishing and species identification. However, photography practices that reduce the time the fish spends out of water and practices that generally adhere to the best-practice guidelines listed above should be encouraged to improve welfare outcomes.

5.3. Key design aspects for future post-release survival studies

When designing PRS studies, it is important to assess factors that can readily be tested in both a practical and robust statistical sense (Sean Tracey; Appendix 11). Factors that may affect survival and that fit these categories include hook type, hooking location, duration of fight, handling at landing, resuscitation. Statistical analyses generally lose statistical power with increasing numbers of variables. Therefore, it is important not to test too many variables at once given low sample sizes typical of most studies.

During the workshop, the following variables were identified as being important to assess in PRS studies:

- Handling practices (e.g. best vs bad practice or gaffing vs leaving hook in)
- Hook left in vs taken out
- Hook type (Circle vs J-Hooks)
- Soak time
- Gear type (weight of line, reel type, drag etc.)
- Air exposure (duration)
- Water Temperature

5.4. Methods for extension of best-practice guidelines to recreational fishers

A multimedia approach to providing extension and communication is recommended. It is recommended to produce clear animations, photos and simple videos (1-3 minutes) for creating content to extend the key messages to the community. Extension can be achieved through use of print, a central campaign website or information hub, social media (Instagram and Facebook), and by engaging celebrity ambassadors that resonate with the recreational fishing community to champion the key messaging. Specifically disseminating information through tackle stores, licence registrations and renewals, fishing guides and phone apps are other methods to extend messaging to fishers who might not be exposed to the campaign otherwise.

It is important to maintain very simple and inclusive messaging with all communication materials. Furthermore, care should be taken not to alienate target audience by using words such as sustainability. Stewardship, accountability, and responsibility are terms that are more likely to resonate with recreational fishing community.

In order to improve extension of scientific knowledge of best-practice fishing, it is useful to engage recreational fishers in citizen science projects. This can be paired with scientific research and analysis. Following this, it is important to clearly communicate the results to the recreational fishing sector. This leads to effective knowledge building for recreational fishers (e.g. Tuna Champions; Sean Tracey - Appendix 13).

There can be some distrust of government, universities, academic researchers, NGOs, and relevant authorities within any community, as such it is useful if extension campaigns maintain an independent brand. For example, the Tuna Champions program is associated with the ARFF, FRDC, and IMAS / UTAS but maintains an independent brand that fishers build trust with. This can be facilitated through maintenance of a central website or information hub and various social media outlets.

It is important that extension campaigns targeting recreational fishers do not belittle and alienate the target audience. The vast majority of recreational fishers hold positive values towards sharks, even if these positive values are not always reflected in behaviours (Matt Heard Presentation; Appendix 14). Championing some values and behaviours may be effective to achieve positive outcomes for the fishery. Nudge theory could be useful in this regard, where positive reinforcement and indirect suggestions are utilised to influence behaviour and decision making.

5.6. Monitoring and measuring behaviour change in recreational fishers

As previously stated, the vast majority of recreational tournament fishers hold positive values towards sharks (tournament fisher survey; Matt Heard; Appendix 14). Majority (> 85%) of tournament recreational fishers 'strongly agree' or 'agree' that; it is important that fish that they release survive, they would be willing to use tackle and special handling practices that minimise damage to release sharks, they like to ensure that a shark is released in good condition. However, these positive values are not always reflected in behaviours.

Using pre-campaign and post-campaign surveys it is possible to assess the effectiveness of extension campaigns in causing behavioural change. It is important that surveys are designed properly with representative samples. A recent FRDC-funded workshop focused specifically on designing surveys for recreational fishers (Beckmann *et al.* 2019).

VRFish previously undertook an extension campaign for best practice freshwater Murray Cod (*Maccullochella peelii*) fishing in Victoria. A pre-campaign survey and follow-up survey after 12 months were undertaken to assess the effectiveness of the campaign. Around one fifth (18.72%) of respondents said that the campaign influenced all of their practices, 10.62% said that it influenced their fishing in some aspects, 22.77% were aware of the campaign but were already doing the right thing, and 38.95% were not aware of campaign.

It was also acknowledged during the workshop that it may be difficult to influence fringe behaviours. For example, it may be difficult to influence the behaviour of bad actors within the community who will do the wrong thing regardless of being informed about best-practice. However, by creating general behaviour change in recreational fishing towards best-practice behaviours, it is possible that these behaviours will become the 'social norm' which will potentially increase the uptake of these behaviours even by fishers who were previously acting poorly.

6. Conclusion

There was an identified need for behaviour change in capture and handling of sharks and rays in recreational fishing. A one-day workshop was completed in Adelaide (SA) in November 2019. We discussed the development of new, and refinement of existing, best-practice capture and handling guidelines. These guidelines can serve as a useful educational resource to enact behavioural change. A range of priority species of sharks and rays were identified for development of the guidelines (Table 3) and for prioritisation for future post-release survival studies (Table 4). In order to facilitate uptake by fishers, clear simple messaging should be tailored for the general type of animal caught. There are practices that should always be followed such as not lifting fish by the gills or tail. However, we suggest providing slightly different messaging for the following groups of sharks and rays; rays with a dangerous barb, rays without a dangerous barb, sharks under 1.5 m, and sharks over 1.5 m. When designing post-release survival studies, it is important to assess factors that affect survival that you can test (practically and statistically) such as hook type, hooking location, duration of fight, handling at landing, and resuscitation. A multimedia approach to providing extension and communication was recommended with clear animations, photos, simple videos, print media, a central campaign website or information hub, social media (Instagram and Facebook), and by engaging celebrity ambassadors that resonate with the recreational fishing community to champion the key messaging. Finally, using pre-campaign and post-campaign surveys it is possible to assess the effectiveness of extension campaigns in causing behavioural change. Following this one day workshop the Monash-led and SARDI-led projects will now design and refine best-practice capture and handling guidelines, complete a post-release survival study to inform the guidelines, and conduct an extension campaign with built in assessment of impact on fisher behaviour.

7. Implications

Previous surveys indicate that recreational fishers generally hold positive values towards sharks and rays. Most fishers surveyed also agree that releasing fish using methods that give the greatest change of post-release survival is important to them. The key messaging for best-practice capture and handling guidelines for sharks and rays discussed within this report serve as an educational resource for informing fishers of best-practice to enable positive outcomes for fishers and released animals.

The Monash-led project (FRDC 2018-042) will develop a set of best-practice capture and handling guidelines for recreational fishing of sharks and rays in Victoria and will complete an extension campaign to facilitate positive behavioural change of fishers.

The SARDI-led project (FRDC 2018-055) will complete a PRS study on one of the priority species identified within this report to further inform refinement of shark and ray capture and handling guidelines. This report summarises key messaging and techniques that can be adopted to enable behaviour change within recreational fisheries leading to positive outcomes for fishers and sharks and rays. A cross-jurisdictional and collaborative approach will enable the best-practice guidelines to be taken up by recreational fishers across Australia.

8. Recommendations

It is recommended that within relevant jurisdictions best-practice capture and handling guidelines for sharks and rays in recreational fishing be developed or refined to include the key messaging outlined in this report. We recommend providing guidelines for four groups of sharks and rays in order to simplify messaging. Future PRS studies concerned with recreational fishing in southern Australia should prioritise the following five species; Smooth Hammerhead, Southern Eagle Ray, School Shark, Bronze Whaler, and Smooth Stingray. PRS studies should be designed carefully to assess a select few variables that impact the mortality of released animals. Information gained from such studies should then be utilised to further refine any existing guidelines.

Extension campaigns to encourage uptake of best-practice guidelines should use a multimedia approach with clear simplified messaging and branding associated with the campaign. Surveying fishers prior to commencing the campaign and once the campaign is completed enables assessment of the effectiveness of the extension campaign in raising awareness and causing behavioural change. It is important that surveys are designed properly with representative samples.

8.1 Further development

There are specific activities that will now be undertaken by both projects associated with this workshop. The Monash-led project (FRDC 2018-042) will develop best-practice capture and handling guidelines for sharks and rays in Victoria. An extension campaign will then be undertaken to disseminate the key messaging from the guidelines to the recreational fishing community. Assessment of the impact of the extension campaign will be measured through the use of a pre-extension survey and a post-extension survey. The SARDI-led project (FRDC 2018-055) will conduct a post-release survival study in South Australia with the results informing further refinement of capture and handling guidelines.

Further PRS studies would be useful in providing more species-specific information for best-practice capture and handling. A national survey of current fisher behaviours to assess the current level of adherence to best-practice would be useful to identify and address current issues or gaps. Continual re-assessment of fishing behaviours would be ideal, this could be further facilitated by analyses of social media and fishing app data. Further development of fishing phone apps that incorporate key messaging from the guidelines should also be encouraged.

9. Extension and Adoption

Extension of the best practice guidelines to recreational fishers across southern Australia will be completed in collaboration between the Monash-led project, SARDI-led project, representatives from state governments and recreational fisher representative peak bodies from different states.

We will use websites and social media networks of all project partners, collaborators and funding agencies (Flinders University, Monash University, VFA, and VRFish, PIRSA, FRDC and SA MRFAC, NSW DPI, WA DPIRD - Fisheries) to disseminate information on best-practice safe-handling of Chondrichthyans during capture and release.

Outcomes of this workshop will be extended through the PIRSA and FRDC media team, the FRDC FISH magazine. The SA MRFAC, Fishcare volunteers, and VRFish will play roles in educating fishers and provision of online guideline updates and materials.

As a part of the Monash-led project a pre-extension survey of recreational fishers in Victoria is being conducted. The pre-extension survey of recreational fishers will determine baseline knowledge, techniques, confidence and behaviour during capture of chondrichthyans. Once we have the results from the initial 'pre-extension' survey, we will finalise the key messages and information to be contained within the handling guidelines.

We will produce text, photo, and video content for uploading to web-sites. Importantly we will create specific video content highlighting best-practice capture and handling protocols. This video content will be posted on VRFish, VFA, PIRSA, fishing club websites, and social media accounts. The communications videos are needed to visually communicate to the general public and other interested persons the importance of minimising the impact of capture on sharks, rays, and chimaeras, as well as providing the specific information on best-practice when dealing with these animals. They will be freely available to share as educational tools.

The project teams will produce brochures and other print material (such as booklets) outlining key messages of the safe-handling guidelines. The materials will explain the importance of minimising the impact of capture on sharks, rays, and chimaeras, as well as provide specific information on best-practice to humanely deal with these animals.

The print material will be the primary vehicle for promoting change in fisher behaviour, resulting in better post-capture outcomes for animals. An important task will be to recruit volunteer recreational fishers from VRFish's extensive network, to assist with distribution and promotion of the brochures and booklets in their local communities. The print material will also provide information (website address, social media accounts) directing audiences to learn more about the guidelines and view video content online. We will visit Victorian fishing clubs, bait & tackle shops, and fishing shows to give presentations about the guidelines and use these opportunities to distribute the printed materials. Print materials will also be distributed to bait & tackle shops and fishing clubs independently of these presentations.

A follow-up survey will be conducted by the Monash-led team to evaluate the success of the extension plan through the use of target audience surveys. Following the extension activities, the team will conduct a post-project survey to determine if the extension and adoption activities have resulted in measurable change in fisher knowledge, confidence and behaviour. Through these surveys we will also measure the effectiveness of various communication strategies in educating fishers.

10. References

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Appendices

Appendix 1: Project Staff

FRDC Project 2018-042:

Dr Richard Reina: Monash University
Dr Sean Williamson: Monash University
Dr Charlie Huveneers: Flinders University
Dr Corey Green: Victorian Fisheries Authority (VFA)
Mr Michael Burgess: VRFish
Dr Terence Walker: Monash University

FRDC Project 2018-055:

Dr Paul Rogers: South Australian Research and Development Institute (SARDI)
Dr Karen Evans: CSIRO
Dr Keith Rowling: PIRSA Fisheries and Aquaculture
Mr Phil Bolton: NSW DPI
Dr Toby Paterson: CSIRO

Appendix 2: List of workshop attendees

Name	Affiliation	State
Charlie Huveneers	Flinders University	SA
Chris Izzo	FRDC	SA
Gavin Begg	SARDI	SA
Graham Keegan	MRFAC	SA
Jamie Crawford	Industry / Recreational Fisher	SA
Jamie Hicks	DEW	SA
Jessica Walsh	Monash University	VIC
Jo Klemke	VFA	VIC
Julian Pepperell	Pepperell Consulting	QLD
Leonardo Guida	AMCS	QLD
Matias Braccini	WA DPIRD	WA
Matt Heard	DEW	SA
Michael Burgess	VRFish	VIC
Michael Gilby	VFA	VIC
Paul Rogers	SARDI	SA
Phil Bolton	NSW DPI	NSW
Richard Reina	Monash University	VIC
Sean Tracey	IMAS / UTAS	TAS
Sean Williamson	Monash University	VIC
Shannon Hurley	VNPA	VIC
Skye Barrett	PIRSA	SA
Terry Walker	Monash University	VIC
Troy Harris	PIRSA Fisheries	SA
Troy Rogers	SARDI	SA
Vic Peddemors	NSW DPI	NSW



Figure 2.1. Photo of the majority of workshop participants at SARDI on 26th November 2019. From left to right; Matt Heard, Jessica Walsh, Phil Bolton, Michael Burgess, Jo Klemke, Jamie Crawford, Julian Pepperell, Sean Tracey, Shannon Hurley, Michael Gilby, Terry Walker, Richard Reina, Leonardo Guida, Matias Braccini, Charlie Huveneers, Vic Peddemors, Sean Williamson, Paul Rogers, Troy Harris, Chris Izzo.

Appendix 3: Workshop Agenda

Workshop Program

Sharks and Rays

Priority species, handling guidelines, post-release survival, and extension approaches to support cultural change in recreational fisheries

26 November 2019

SARDI Aquatic Sciences, 2 Hamra Avenue, West Beach, Adelaide

FRDC Projects 2018-055 & 2018-042

Time-slot	Item
8:15	Tea and coffee on arrival
8:30	Acknowledgement of Country
8:45	INTRODUCTION, BACKGROUND and GOALS
Session 1	Priority species (groups) Facilitator: Richard Reina
9:00	<ul style="list-style-type: none">• Delegate questionnaire responses on priority species of sharks and rays that require development of capture, handling and release guidelines for recreational fisheries. (Sean Williamson - 10 min) (Note: 5 mins for changeover between talks)
9:15	<ul style="list-style-type: none">• Summary of outcomes of previous workshops and reviews that support prioritisation of research gaps for shark and rays in Australian recreational fisheries. (Charlie Huveneers - 10 min)
9:30	<ul style="list-style-type: none">• Species vulnerability assessment of chondrichthyans taken in recreational fisheries. (Terry Walker - 10 min)
9:45	<ul style="list-style-type: none">• Stress and patterns of biological and ecological sensitivity to capture of chondrichthyan groups. (Richard Reina - 10 min)
10:00	<ul style="list-style-type: none">• A summary of tag-recapture and survey information for sharks and rays in recreational fisheries. (Phil Bolton & Julian Pepperell - 10 min)

10:15	MORNING TEA
10:30	<p>Group Discussion (three nominated group leaders)</p> <p>Aims:</p> <ul style="list-style-type: none"> • Summarise the priority species (or groups) for development of post-release survival studies and safe-handling practice guidelines at a State and National level by building on the questionnaire response matrix. • Prioritise information gaps that need addressing in each case / species using a rank score.
Session 2	Handling guidelines for priority-species (groups): Design principles and considerations when developing post-release survival studies to inform best practice guides in recreational fisheries Facilitator: Paul Rogers
11:15	<ul style="list-style-type: none"> • Review of existing handling guidelines for sharks and rays in recreational fisheries in Australia. (Sean Williamson - 10 min)
11:30	<ul style="list-style-type: none"> • What information is the highest priority in post-release survival studies to support development and refinement of best practice guidelines in recreational fisheries. (Sean Tracey - 10 min)
12:00	<ul style="list-style-type: none"> • Development of capture, handling and release guidelines in recreational and game fisheries for pelagic sharks. (Paul Rogers - 10 min) <p>Group Discussion (three nominated group leaders)</p> <p>Aims:</p> <ul style="list-style-type: none"> • Discuss and summarise the key elements of safe capture and handling guidelines for each priority species (or grouping). • Identify key design aspects of post-release survival studies needed to assess, support and refine the proposed guidelines.
1:00	LUNCH
Session 3	Communication, Engagement and Cultural Change? Facilitator: Sean Williamson

1:30	<ul style="list-style-type: none"> • Lessons learned by engaging with recreational fishers. Extension approaches and their relative impacts. What are the challenges and strengths of different media? (Sean Tracey – 10 min)
1:45	<ul style="list-style-type: none"> • Attitudinal surveys relating to recreational fishing, gear and handling practices. (Matt Heard – 10 min)
2:00	<ul style="list-style-type: none"> • Behavioural dynamics and attitudinal changes in recreational fisheries. How do we measure and monitor uptake of the information? (Jess Walsh and Mike Burgess – 10 min)
2:15	<p>Group Discussion (three nominated group leaders)</p> <p>Aims:</p> <ul style="list-style-type: none"> • Summarise the best ways to communicate and extend fishing guidelines to the public based on learnings during case studies in Sessions 1 and 2. • Discussion of the best approaches for monitoring and measuring cultural change in recreational fisheries.
3:00	AFTERNOON TEA
3:15	GENERAL DISCUSSION (All participants)
	<ul style="list-style-type: none"> • Reach a group consensus on priority species of sharks and rays for development of handling guides and post-release survival studies at State and National scales. • Practical steps to encouraging modification of fisher behaviour in ways that align with 'best practice' capture, handling and release principles? • What are the key challenges, solutions, and gaps that need further attention following this workshop? • Summary discussion on the most suitable communication and engagement tool-box for recreational fisheries at the on-vessel (or individual), community (within fishery) and or national level.
4:30	WRAP-UP
4:45	CLOSE

Appendix 4: Introduction to SARDI- and Monash-led projects and their alignment (Paul Rogers & Richard Reina)

Matrix Table Project Alignment

Project Goals	FRDC 2018-042: Monash et al	FRDC 2018-055: SARDI et al
Identify species captured within recreational fisheries at a state and national level for prioritisation for improving capture, handling and release practices.	✓	✓
Establish best-practice capture, handling and release guidelines for priority species.	✓	✓
Identify species captured within recreational fisheries and operational factors for prioritisation for Post-Release Survival (PRS) Studies.		✓
Collect post-release survival data on some of the priority species in collaboration with recreational fishers using telemetry technology.		✓
Produce evidence-based educational material about the guidelines to inform sustainable rec fishing practices.	✓	✓
Support behavioural change through extension of educational materials.	✓	✓
Measure behavioural change through fisher surveys prior to and following extension / education campaign.	✓	

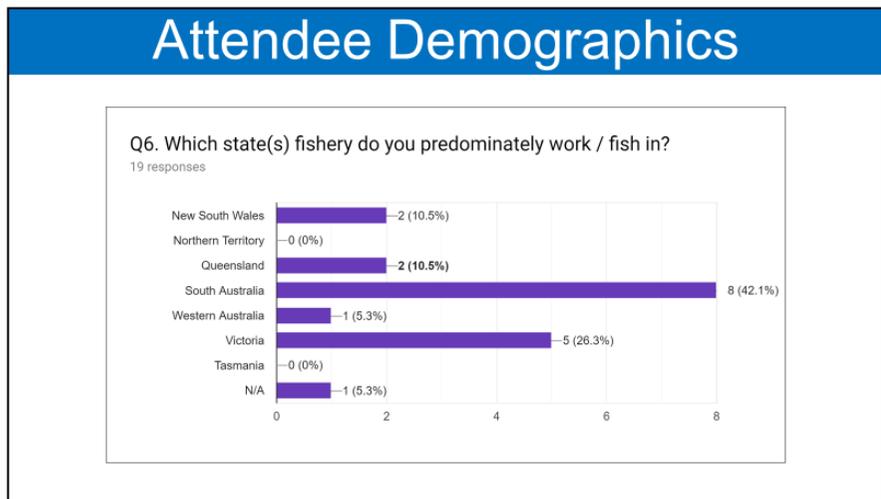
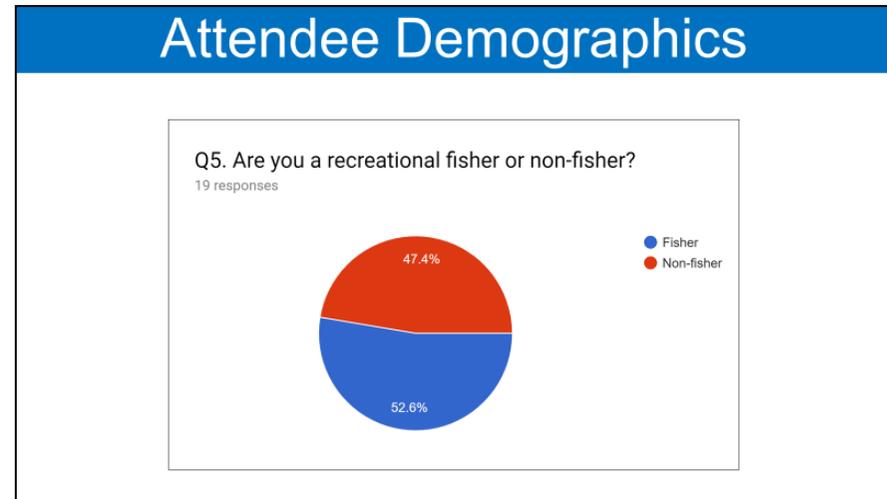


Appendix 5: Delegate questionnaire responses on priority species of sharks and rays that require development of capture, handling and release guidelines for recreational fisheries (Sean Williamson)

Workshop Survey Responses

Sean Williamson





Priority Species for Guidelines

State-level all respondents (18):

Rank	Species (# times listed)	Species (Weighted Ranking)
1	Bronze Whaler (10*)	Hammerhead (32)
2	Smooth Stingray (10*)	Gummy Shark (30)
3	Mako Shark (9*)	School Shark (29)
4	Eagle Ray (9*)	Mako Shark (28*)
5	Gummy Shark (8*)	Smooth Stingray (28*)
6	School Shark (8*)	Bronze Whaler (25)
7	Hammerhead (7*)	Eagle Ray (24*)
8	Fiddler Ray (7*)	Fiddler Ray (24*)
9	Shovelnose Ray (4)	Shovelnose Ray (15)
10	Port Jackson Shark (3)	Port Jackson Shark (10)

Priority Species for Guidelines

State-level SA only respondents (7):

Rank	Species (# times listed)	Species (Weighted Ranking)
1	Eagle Ray (7)	Eagle Ray (18)
2	Bronze Whaler (5*)	School Shark (17)
3	Smooth Stingray (5*)	Bronze Whaler (14*)
4	School Shark (5*)	Smooth Stingray (14*)
5	Gummy Shark (3*)	Hammerhead (10*)
6	Mako Shark (3*)	Gummy Shark (10*)
7	Hammerhead (2*)	Mako Shark (10*)
8	Fiddler Ray (2*)	Port Jackson Shark (7)
9	Port Jackson Shark (2*)	Fiddler Ray (6)
10	Dusky Shark (1*)	Dusky Shark (3)

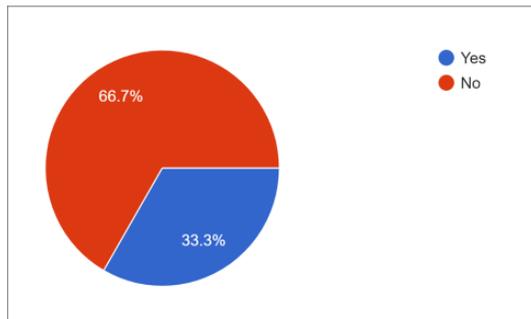
Priority Species for Guidelines

State-level VIC only respondents (4):

Rank	Species (# times listed)	Species (Weighted Ranking)
1	Gummy Shark (4*)	Gummy Shark (15)
2	Mako Shark (4*)	School Shark (12)
3	School Shark (3*)	Fiddler Ray (10*)
4	Fiddler Ray (3*)	Mako Shark (10*)
5	Smooth Stingray (2)	Smooth Stingray (5)
6	Bronze Whaler (1*)	Elephant Fish (3*)
7	Eagle Ray (1*)	Port Jackson Shark (3*)
8	Elephant Fish (1*)	Bronze Whaler (2)
9	Great White Shark (1*)	Eagle Ray (1*)
10	Port Jackson Shark (1*)	Great White Shark (1*)

Priority Species for Guidelines

Difference at National-level?



Priority Species for Guidelines

Difference at National-level?

Species listed in responses (4):

- Hammerheads (Great, scalloped, and smooth)
 - Grey Nurse Shark
 - Tiger Shark
 - Blue Shark
- Sandbar Shark

Priority Species for Guidelines

- Common Reasons for Species Prioritisation:
- Sensitivity to handling and post-release mortality
 - Catch rate
 - Species crosses jurisdictional boundaries
 - Regular bycatch
 - Frequently released
 - Difficult to handle / Dangerous
 - Often considered "Pest" due to depredation etc
 - Lack of handling knowledge / education
 - Conservation concern
 - Often pregnant when caught & released
 - General community concern for species
 - Number of reports of bad practices & mistreatment

PRS Studies

Species that would benefit most from Post-Release Survival (PRS) Studies?

4 people prioritised the same 5 species they listed for guidelines

Other common response were:

- Hammerheads
- Rays in general (esp. Eagle Rays)
 - Fiddler Rays
 - Whaler Sharks
 - Gummy Sharks
 - School Sharks
 - Mako Sharks

PRS Studies

What operational factors should be tested?

- Handling practices (Suggestion for varying levels from bad, good to best-practice)
 - Soak time
 - Hook type
- Gear type (weight of line, reel type, drag etc.)
 - Fisher perception towards shark
 - Air exposure
 - Temperature

Best-Practice Guidelines

Common responses for **Factors / Practices** that have greatest **negative** impact on species:

- Deliberate Harm / Mutilation
 - Water Depth
- Extended Time Out of Water
 - Long Soak / Fight Times
 - Damage During Hook Removal
- Hooking Location (lower vs upper jaw vs tail vs gut)
 - Hook Type (J worse than circle hooks)

Best-Practice Guidelines

Common responses for **Factors / Practices** that have greatest **positive** impact on species:

- Circle hooks (promoting mouth hooking)
 - Limited Time Out of Water
 - Short Soak / Fight Times
 - Hooks That Rust Quickly
- Efficiently and Effectively Removing Hook (Crimping barb)
 - Heavy Gear to Reduce Fight Time

Thanks!

We are extremely grateful for your time and level of detail provided in your responses!

There'll be more of the data from the Survey appearing in later talks

Appendix 6: Summary of outcomes of previous workshops and reviews that support prioritisation of research gaps for shark and rays in Australian recreational fisheries (Charlie Huveneers)

Summaries of outcomes of previous workshops

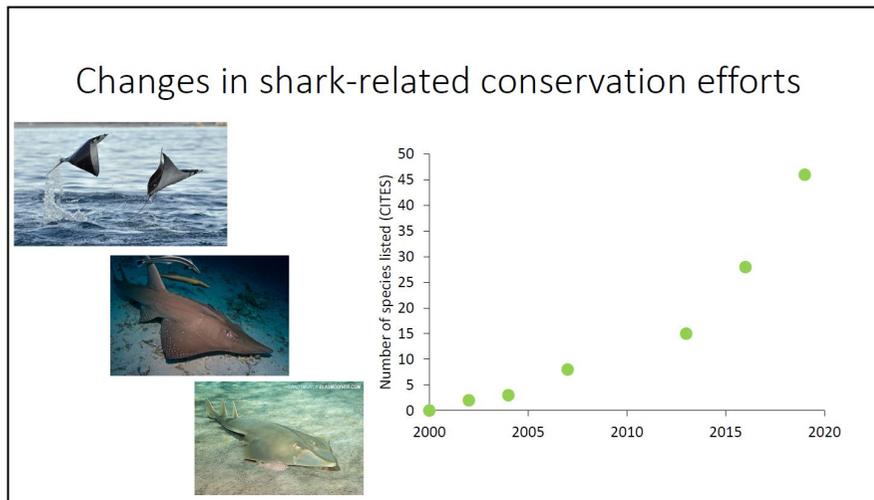
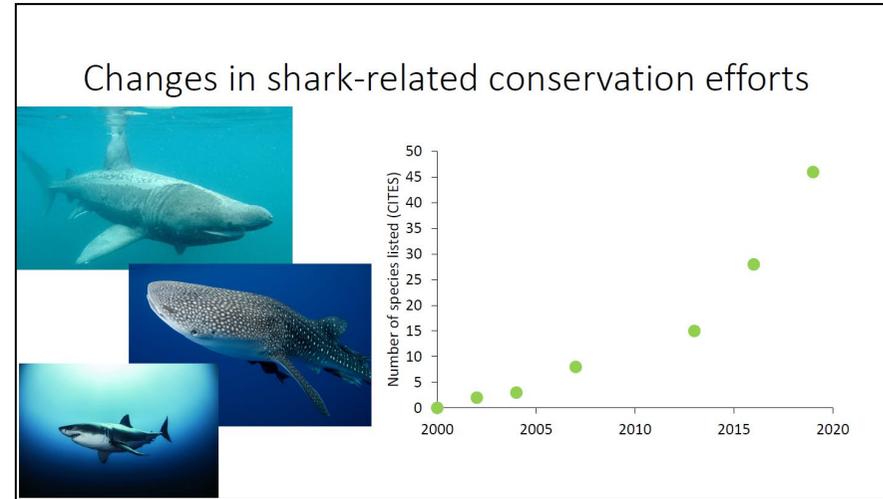
Prioritisation of research gaps for shark and rays in Australian recreational fisheries

A/Prof Charlie Huveneers

SOUTHERN SHARK ECOLOGY GROUP

Marine & Coastal Research Consortium
Organisms & Ecosystems

Flinders UNIVERSITY



Shark conservation workshops

IUCN SSC Shark Specialist Group

Marine Biodiversity Hub
National Environmental Science Programme

RED LIST

Western and Central Pacific Fisheries Commission

COMMON OCEANS

FRDC

OCEANS AND ATMOSPHERE
WORLD LEADERSHIP





Shark futures: A synthesis of available data on Mako and Porbeagle sharks in Australasian waters

Current status and future directions

Principle Investigator: Barry Bruce

August 2014



Workshop
• February 2012

- Post-release mortality estimates = important and needed (rec. and comm. catches)
- Recreational fishing catches need to be assessed

PROJECT
Sustainable Management of Tuna Fisheries and Biodiversity Conservation in the ABLU



REDUCING ECOSYSTEM IMPACTS OF TUNA FISHING

Joint Analysis of Shark Post-Release Mortality Tagging Results

Workshops
• January 2017
• June 2019

Post-release study



60 makos



20.5%

Higher for small sharks and high gangion ratio, **condition not significant** but important in other species

Conservation Physiology
Volume 3, 2015
10.1093/cophys/cow004



Research article

High survivorship after catch-and-release fishing suggests physiological resilience in the endothermic shortfin mako shark (*Isurus oxyrinchus*)

Robert P. French¹*, Jeremy Lyle¹, Sean Tracey¹, Suzanne Currie² and Jayson M. Semmens¹

¹Fisheries and Aquaculture Centre, Institute for Marine and Antarctic Studies, University of Tasmania, Hobart, Tasmania 7001, Australia
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30 makos



10%

Fight time <30 minutes
Physical/hook injuries contributing

Marine Biodiversity Hub
National Environmental Science Programme

Project A6 - Prioritisation of research and management needs for Australian elasmobranch species

Principal Investigator - Michelle Heupel
Australian Institute of Marine Science
Report on workshop - 17 and 18 November 2015



Marine Biodiversity Hub
National Environmental Science Programme

Shark Action Plan Policy Report

Michelle R Heupel, Peter M Kyno, William T White, Colin A Simpfendorfer

Project A11 - Shark action plan
5 December 2018

Michelle R - Research Plan v1 (2017) Revised 2 Aug 2019



A Report Card for Australia's Sharks

Colin Simpfendorfer¹, Andrew Chin^{1,2}, Peter Kyno³, Cassandra Rigby⁴, Samantha Sherman¹, William White⁴

March 2019



¹Centre for Sustainable Tropical Fisheries & Aquaculture, James Cook University
²Australian Institute of Marine Sciences
³Research Institute for the Environment and Livelihoods, Charles Darwin University
⁴CSIRO Australian National Fish Collection, National Research Collections



A Report Card for Australia's Sharks

Colin Simpfendorfer¹, Andrew Chin², Peter Kyme³,
Cassandra Rigby³, Samantha Sherman⁴, William White⁵
March 2019



¹Centre for Sustainable Tropical Fisheries & Aquaculture, James Cook University
²Australian Institute of Marine Science
³Research Institute for the Environment and Livelihoods, Charles Darwin University
⁴CSIRO Australian National Fish Collections, National Research Collections



194 Species assessed
6 Depleting Stocks
124 Sustainable Stocks
18 Depleted Stocks
9 Recovering Stocks
42 Undefined Stocks



Prioritising species

Common name	Scientific name	SAFS / Report card / IUCN	Australian Red List	Global Red List	EPBC Act	CMS	CITES
Greeneye spurdog	<i>Squalus chirocentrus</i>	Recovering	EN/NT	EN/NT			
Shortfin Mako	<i>Isurus paucus</i>	Depleting	VU	EN/VU	Migratory	App II	App II
School Shark	<i>Galeorhinus galeus</i>	Depleted	VU	VU	Conservation Dependent		
Porbeagle	<i>Lamna nasus</i>	Sustainable	NT	VU	Migratory	App II	App II
Dusky Shark	<i>Carcharhinus obscurus</i>	Recovering/Undefined	NT	VU		App II	
Blue Shark	<i>Prionace glauca</i>	Sustainable	NT	NT		App II	
Sharpnose sevengill shark	<i>Heptranchias perlo</i>	Sustainable	NT	NT			
Smooth Hammerhead	<i>Sphyrna zygaena</i>	Sustainable	NT	VU	Under assessment	App II*	App II*
Thresher Shark	<i>Alopias vulpinus</i>	Sustainable	LC	VU		App II	
Bronze Whaler	<i>Carcharhinus brachyurus</i>	Sustainable	LC	NT			
Broadnose Sevengill Shark	<i>Notorynchus cepedianus</i>	Sustainable	LC	DD			
Gummy Shark	<i>Mustelus antarcticus</i>	Sustainable	LC	LC			
Whiskery Shark	<i>Furgaleus macki</i>	Sustainable	LC	LC			
Wobbegong	<i>Orectolobus spp.</i>	Sustainable	LC	LC			
Port Jackson Shark	<i>Heterodontus portusjacksoni</i>	Sustainable	LC	LC			
Draughtboard Shark	<i>Cephaloscyllium laticeps</i>	Sustainable	LC	LC			
Hiddler Rays	<i>Trygonorrhina sp.</i>	Sustainable	LC	LC			
Coastal stingaree	<i>Urolophus ornatus</i>	Decreasing	EN	EN			
Melbourne Skate	<i>Spirinotus whitleyi</i>	Unknown	VU	VU			
Sandyback stingaree	<i>Urolophus bucculentus</i>	Decreasing	VU	VU			
Greenback stingaree	<i>Urolophus viridis</i>	Decreasing	VU	VU			
Yellowback stingaree	<i>Urolophus sufflavus</i>	Decreasing	VU	VU			
Stingarees	<i>Trygonoptera</i>	Stable	LC	LC			
Stingarees	<i>Urolophus sp.</i>	Stable	LC	LC			
Southern Eagle Ray	<i>Myliobatis australis</i>	Stable	LC	LC			
Thornback Skate	<i>Dentiraja lemprierei</i>	Unknown	LC	LC			
Smooth Stingray	<i>Bathytoshia brevicaudata</i>	Stable	LC	LC			
Black Stingray	<i>Bathytoshia lata</i>	Unknown	LC	LC			
Western Shoehorn Ray	<i>Alopiichthys vancouveriana</i>	Unknown	LC	LC			
Elephant Fish	<i>Callorhynchus milii</i>	Sustainable	LC	LC			

Prioritising species – Global CMS/CITES

Common name	Scientific name	SAFS / Report card / IUCN	Australian Red List	Global Red List	EPBC Act	CMS	CITES
Greeneye spurdog	<i>Squalus chirocentrus</i>	Recovering	EN/NT	EN/NT			
Shortfin Mako	<i>Isurus paucus</i>	Depleting	VU	EN/VU	Migratory	App II	App II
School Shark	<i>Galeorhinus galeus</i>	Depleted	VU	VU	Conservation Dependent		
Porbeagle	<i>Lamna nasus</i>	Sustainable	NT	VU	Migratory	App II	App II
Dusky Shark	<i>Carcharhinus obscurus</i>	Recovering/Undefined	NT	VU		App II	
Blue Shark	<i>Prionace glauca</i>	Sustainable	NT	NT		App II	
Sharpnose sevengill shark	<i>Heptranchias perlo</i>	Sustainable	NT	NT			
Smooth Hammerhead	<i>Sphyrna zygaena</i>	Sustainable	NT	VU	Under assessment	App II*	App II*
Thresher Shark	<i>Alopias vulpinus</i>	Sustainable	LC	VU		App II	
Bronze Whaler	<i>Carcharhinus brachyurus</i>	Sustainable	LC	NT			
Broadnose Sevengill Shark	<i>Notorynchus cepedianus</i>	Sustainable	LC	DD			
Gummy Shark	<i>Mustelus antarcticus</i>	Sustainable	LC	LC			
Whiskery Shark	<i>Furgaleus macki</i>	Sustainable	LC	LC			
Wobbegong	<i>Orectolobus spp.</i>	Sustainable	LC	LC			
Port Jackson Shark	<i>Heterodontus portusjacksoni</i>	Sustainable	LC	LC			
Draughtboard Shark	<i>Cephaloscyllium laticeps</i>	Sustainable	LC	LC			
Hiddler Rays	<i>Trygonorrhina sp.</i>	Sustainable	LC	LC			
Coastal stingaree	<i>Urolophus ornatus</i>	Decreasing	EN	EN			
Melbourne Skate	<i>Spirinotus whitleyi</i>	Unknown	VU	VU			
Sandyback stingaree	<i>Urolophus bucculentus</i>	Decreasing	VU	VU			
Greenback stingaree	<i>Urolophus viridis</i>	Decreasing	VU	VU			
Yellowback stingaree	<i>Urolophus sufflavus</i>	Decreasing	VU	VU			
Stingarees	<i>Trygonoptera</i>	Stable	LC	LC			
Stingarees	<i>Urolophus sp.</i>	Stable	LC	LC			
Southern Eagle Ray	<i>Myliobatis australis</i>	Stable	LC	LC			
Thornback Skate	<i>Dentiraja lemprierei</i>	Unknown	LC	LC			
Smooth Stingray	<i>Bathytoshia brevicaudata</i>	Stable	LC	LC			
Black Stingray	<i>Bathytoshia lata</i>	Unknown	LC	LC			
Western Shoehorn Ray	<i>Alopiichthys vancouveriana</i>	Unknown	LC	LC			
Elephant Fish	<i>Callorhynchus milii</i>	Sustainable	LC	LC			

Prioritising species – Global IUCN threatened

Common name	Scientific name	SAFS / Report card / IUCN	Australian Red List	Global Red List	EPBC Act	CMS	CITES
Greeneye spurdog	<i>Squalus chiroaculus</i>	Recovering	EN/NT	EN/NT			
Shortfin Mako	<i>Isurus paucus</i>	Depleted	VU	EN/VU	Migratory	App II	App II
School Shark	<i>Galeorhinus galeus</i>	Depleted	VU	VU	Conservation Dependent		
Porbeagle	<i>Lamna nasus</i>	Sustainable	NT	VU	Migratory	App II	App II
Dusky Shark	<i>Carcharhinus obscurus</i>	Recovering/Undefined	NT	VU		App II	
Blue Shark	<i>Prionace glauca</i>	Sustainable	NT	NT		App II	
Sharpnose sevengill shark	<i>Heptranchias perlo</i>	Sustainable	NT	NT			
Smooth Hammerhead	<i>Sphyrna zygaena</i>	Sustainable	LC	VU	Under assessment	App II*	App II*
Thresher Shark	<i>Alopias vulpinus</i>	Sustainable	LC	VU		App II	
Bronze Whaler	<i>Carcharhinus brachyurus</i>	Sustainable	LC	NT			
Broadnose Sevengill Shark	<i>Notorynchus cepedianus</i>	Sustainable	LC	DD			
Gummy Shark	<i>Mustelus antarcticus</i>	Sustainable	LC	LC			
Whiskery Shark	<i>Furgaleus macki</i>	Sustainable	LC	LC			
Wobbegong	<i>Orectolobus spp.</i>	Sustainable	LC	LC			
Port Jackson Shark	<i>Heterodontus portusjacksoni</i>	Sustainable	LC	LC			
Draughtboard Shark	<i>Cephaloscyllium laticeps</i>	Sustainable	LC	LC			
Fiddler Rays	<i>Trygonorrhina sp.</i>	Sustainable	LC	LC			
Coastal stingaree	<i>Urolophus ornatus</i>	Decreasing	EN	EN			
Melbourne Skate	<i>Spiniraja whitleyi</i>	Unknown	VU	VU			
Sandyback stingaree	<i>Urolophus bucculentus</i>	Decreasing	VU	VU			
Greenback stingaree	<i>Urolophus viridis</i>	Decreasing	VU	VU			
Yellowback stingaree	<i>Urolophus sufflavus</i>	Decreasing	VU	VU			
Stingarees	<i>Trygonoptera</i>	Stable	LC	LC			
Stingarees	<i>Urolophus sp.</i>	Stable	LC	LC			
Southern Eagle Ray	<i>Myliobatis australis</i>	Stable	LC	LC			
Thornback Skate	<i>Dentiraja lemprierei</i>	Unknown	LC	LC			
Smooth Stingray	<i>Bathytoshia brevicaudata</i>	Stable	LC	LC			
Black Stingray	<i>Bathytoshia lata</i>	Unknown	LC	LC			
Western Shoalnose Ray	<i>Aptychotrema vincentiana</i>	Unknown	LC	LC			
Elephant Fish	<i>Callorhynchus milii</i>	Sustainable	LC	LC			

Prioritising species – AU EPBC Act

Common name	Scientific name	SAFS / Report card / IUCN	Australian Red List	Global Red List	EPBC Act	CMS	CITES
Greeneye spurdog	<i>Squalus chiroaculus</i>	Recovering	EN/NT	EN/NT			
Shortfin Mako	<i>Isurus paucus</i>	Depleted	VU	EN/VU	Migratory	App II	App II
School Shark	<i>Galeorhinus galeus</i>	Depleted	VU	VU	Conservation Dependent		
Porbeagle	<i>Lamna nasus</i>	Sustainable	NT	VU	Migratory	App II	App II
Dusky Shark	<i>Carcharhinus obscurus</i>	Recovering/Undefined	NT	VU		App II	
Blue Shark	<i>Prionace glauca</i>	Sustainable	NT	NT		App II	
Sharpnose sevengill shark	<i>Heptranchias perlo</i>	Sustainable	NT	NT			
Smooth Hammerhead	<i>Sphyrna zygaena</i>	Sustainable	LC	VU	Under assessment	App II*	App II*
Thresher Shark	<i>Alopias vulpinus</i>	Sustainable	LC	VU		App II	
Bronze Whaler	<i>Carcharhinus brachyurus</i>	Sustainable	LC	NT			
Broadnose Sevengill Shark	<i>Notorynchus cepedianus</i>	Sustainable	LC	DD			
Gummy Shark	<i>Mustelus antarcticus</i>	Sustainable	LC	LC			
Whiskery Shark	<i>Furgaleus macki</i>	Sustainable	LC	LC			
Wobbegong	<i>Orectolobus spp.</i>	Sustainable	LC	LC			
Port Jackson Shark	<i>Heterodontus portusjacksoni</i>	Sustainable	LC	LC			
Draughtboard Shark	<i>Cephaloscyllium laticeps</i>	Sustainable	LC	LC			
Fiddler Rays	<i>Trygonorrhina sp.</i>	Sustainable	LC	LC			
Coastal stingaree	<i>Urolophus ornatus</i>	Decreasing	EN	EN			
Melbourne Skate	<i>Spiniraja whitleyi</i>	Unknown	VU	VU			
Sandyback stingaree	<i>Urolophus bucculentus</i>	Decreasing	VU	VU			
Greenback stingaree	<i>Urolophus viridis</i>	Decreasing	VU	VU			
Yellowback stingaree	<i>Urolophus sufflavus</i>	Decreasing	VU	VU			
Stingarees	<i>Trygonoptera</i>	Stable	LC	LC			
Stingarees	<i>Urolophus sp.</i>	Stable	LC	LC			
Southern Eagle Ray	<i>Myliobatis australis</i>	Stable	LC	LC			
Thornback Skate	<i>Dentiraja lemprierei</i>	Unknown	LC	LC			
Smooth Stingray	<i>Bathytoshia brevicaudata</i>	Stable	LC	LC			
Black Stingray	<i>Bathytoshia lata</i>	Unknown	LC	LC			
Western Shoalnose Ray	<i>Aptychotrema vincentiana</i>	Unknown	LC	LC			
Elephant Fish	<i>Callorhynchus milii</i>	Sustainable	LC	LC			

Prioritising species – AU IUCN threatened

Common name	Scientific name	SAFS / Report card / IUCN	Australian Red List	Global Red List	EPBC Act	CMS	CITES
Greeneye spurdog	<i>Squalus chiroaculus</i>	Recovering	EN/NT	EN/NT			
Shortfin Mako	<i>Isurus paucus</i>	Depleted	VU	EN/VU	Migratory	App II	App II
School Shark	<i>Galeorhinus galeus</i>	Depleted	VU	VU	Conservation Dependent		
Porbeagle	<i>Lamna nasus</i>	Sustainable	NT	VU	Migratory	App II	App II
Dusky Shark	<i>Carcharhinus obscurus</i>	Recovering/Undefined	NT	VU		App II	
Blue Shark	<i>Prionace glauca</i>	Sustainable	NT	NT		App II	
Sharpnose sevengill shark	<i>Heptranchias perlo</i>	Sustainable	NT	NT			
Smooth Hammerhead	<i>Sphyrna zygaena</i>	Sustainable	NT	VU	Under assessment	App II*	App II*
Thresher Shark	<i>Alopias vulpinus</i>	Sustainable	LC	VU		App II	
Bronze Whaler	<i>Carcharhinus brachyurus</i>	Sustainable	LC	NT			
Broadnose Sevengill Shark	<i>Notorynchus cepedianus</i>	Sustainable	LC	DD			
Gummy Shark	<i>Mustelus antarcticus</i>	Sustainable	LC	LC			
Whiskery Shark	<i>Furgaleus macki</i>	Sustainable	LC	LC			
Wobbegong	<i>Orectolobus spp.</i>	Sustainable	LC	LC			
Port Jackson Shark	<i>Heterodontus portusjacksoni</i>	Sustainable	LC	LC			
Draughtboard Shark	<i>Cephaloscyllium laticeps</i>	Sustainable	LC	LC			
Fiddler Rays	<i>Trygonorrhina sp.</i>	Sustainable	LC	LC			
Coastal stingaree	<i>Urolophus ornatus</i>	Decreasing	EN	EN			
Melbourne Skate	<i>Spiniraja whitleyi</i>	Unknown	VU	VU			
Sandyback stingaree	<i>Urolophus bucculentus</i>	Decreasing	VU	VU			
Greenback stingaree	<i>Urolophus viridis</i>	Decreasing	VU	VU			
Yellowback stingaree	<i>Urolophus sufflavus</i>	Decreasing	VU	VU			
Stingarees	<i>Trygonoptera</i>	Stable	LC	LC			
Stingarees	<i>Urolophus sp.</i>	Stable	LC	LC			
Southern Eagle Ray	<i>Myliobatis australis</i>	Stable	LC	LC			
Thornback Skate	<i>Dentiraja lemprierei</i>	Unknown	LC	LC			
Smooth Stingray	<i>Bathytoshia brevicaudata</i>	Stable	LC	LC			
Black Stingray	<i>Bathytoshia lata</i>	Unknown	LC	LC			
Western Shoalnose Ray	<i>Aptychotrema vincentiana</i>	Unknown	LC	LC			
Elephant Fish	<i>Callorhynchus milii</i>	Sustainable	LC	LC			

Prioritising species – AU SAFS status

Common name	Scientific name	SAFS / Report card / IUCN	Australian Red List	Global Red List	EPBC Act	CMS	CITES
Greeneye spurdog	<i>Squalus chiroaculus</i>	Recovering	EN/NT	EN/NT			
Shortfin Mako	<i>Isurus paucus</i>	Depleted	VU	EN/VU	Migratory	App II	App II
School Shark	<i>Galeorhinus galeus</i>	Depleted	VU	VU	Conservation Dependent		
Porbeagle	<i>Lamna nasus</i>	Sustainable	NT	VU	Migratory	App II	App II
Dusky Shark	<i>Carcharhinus obscurus</i>	Recovering/Undefined	NT	VU		App II	
Blue Shark	<i>Prionace glauca</i>	Sustainable	NT	NT		App II	
Sharpnose sevengill shark	<i>Heptranchias perlo</i>	Sustainable	NT	NT			
Smooth Hammerhead	<i>Sphyrna zygaena</i>	Sustainable	NT	VU	Under assessment	App II*	App II*
Thresher Shark	<i>Alopias vulpinus</i>	Sustainable	LC	VU		App II	
Bronze Whaler	<i>Carcharhinus brachyurus</i>	Sustainable	LC	NT			
Broadnose Sevengill Shark	<i>Notorynchus cepedianus</i>	Sustainable	LC	DD			
Gummy Shark	<i>Mustelus antarcticus</i>	Sustainable	LC	LC			
Whiskery Shark	<i>Furgaleus macki</i>	Sustainable	LC	LC			
Wobbegong	<i>Orectolobus spp.</i>	Sustainable	LC	LC			
Port Jackson Shark	<i>Heterodontus portusjacksoni</i>	Sustainable	LC	LC			
Draughtboard Shark	<i>Cephaloscyllium laticeps</i>	Sustainable	LC	LC			
Fiddler Rays	<i>Trygonorrhina sp.</i>	Sustainable	LC	LC			
Coastal stingaree	<i>Urolophus ornatus</i>	Decreasing	EN	EN			
Melbourne Skate	<i>Spiniraja whitleyi</i>	Unknown	VU	VU			
Sandyback stingaree	<i>Urolophus bucculentus</i>	Decreasing	VU	VU			
Greenback stingaree	<i>Urolophus viridis</i>	Decreasing	VU	VU			
Yellowback stingaree	<i>Urolophus sufflavus</i>	Decreasing	VU	VU			
Stingarees	<i>Trygonoptera</i>	Stable	LC	LC			
Stingarees	<i>Urolophus sp.</i>	Stable	LC	LC			
Southern Eagle Ray	<i>Myliobatis australis</i>	Stable	LC	LC			
Thornback Skate	<i>Dentiraja lemprierei</i>	Unknown	LC	LC			
Smooth Stingray	<i>Bathytoshia brevicaudata</i>	Stable	LC	LC			
Black Stingray	<i>Bathytoshia lata</i>	Unknown	LC	LC			
Western Shoalnose Ray	<i>Aptychotrema vincentiana</i>	Unknown	LC	LC			
Elephant Fish	<i>Callorhynchus milii</i>	Sustainable	LC	LC			

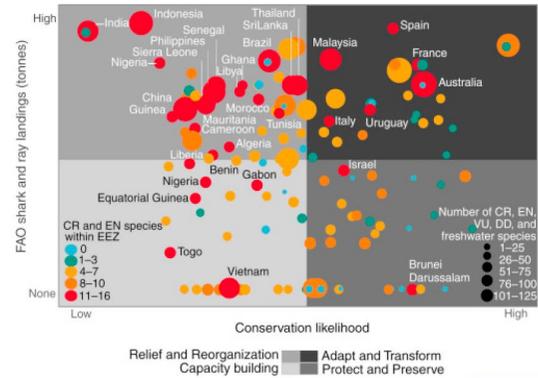
Prioritising species – Combined

Common name	Scientific name	SAFS / Report card / IUCN	Australian Red List	Global Red List	EPBC Act	CMS	CITES
Greeneye spurdog	<i>Squalus chloraculus</i>	Recovering	EN/NT	EN/NT			
Shortfin Mako	<i>Isurus paucus</i>	Depleted	VU	EN/VU	Migratory		App II
School Shark	<i>Galeorhinus galeus</i>	Depleted	VU	VU	Conservation Dependent		App II
Porbeagle	<i>Lamna nasus</i>	Sustainable	NT	VU	Migratory	App II	App II
Dusky Shark	<i>Carcharhinus obscurus</i>	Recovering/Undefined	NT	VU		App II	App II
Blue Shark	<i>Prionace glauca</i>	Sustainable	NT	NT		App II	App II
Sharpnose sevengill shark	<i>Heptranchias perlo</i>	Sustainable	NT	NT			
Smooth Hammerhead	<i>Sphyrna tiburo</i>	Sustainable	LC	VU	Under assessment	App II*	App II*
Thresher Shark	<i>Alopias vulpinus</i>	Sustainable	NT	VU		App II	App II
Bronze Whaler	<i>Carcharhinus brachyurus</i>	Sustainable	LC	NT			
Broadnose Sevengill Shark	<i>Notorynchus cepedianus</i>	Sustainable	LC	DD			
Gummy Shark	<i>Mustelus antarcticus</i>	Sustainable	LC	LC			
Whiskery Shark	<i>Furgaleus macki</i>	Sustainable	LC	LC			
Wobbegong	<i>Orectolobus spp.</i>	Sustainable	LC	LC			
Port Jackson Shark	<i>Heterodontus portusjacksoni</i>	Sustainable	LC	LC			
Draughtboard Shark	<i>Cephaloscyllium laticeps</i>	Sustainable	LC	LC			
Fiddler Rays	<i>Trygonorrhina sp.</i>	Sustainable	LC	LC			
Coastal stingaree	<i>Urolophus orarius</i>	Decreasing	EN	EN			
Melbourne skate	<i>Sphyrna tiburo</i>	Unknown	VU	VU			
Sandyback stingaree	<i>Urolophus bucculentus</i>	Decreasing	VU	VU			
Greenback stingaree	<i>Urolophus viridis</i>	Decreasing	VU	VU			
Yellowback stingaree	<i>Urolophus sufflavus</i>	Decreasing	VU	VU			
Stingarees	<i>Trypanoptera</i>	Stable	LC	LC			
Stingarees	<i>Urolophus sp.</i>	Stable	LC	LC			
Southern Eagle Ray	<i>Myliobatis australis</i>	Stable	LC	LC			
Thornback Skate	<i>Dentrotraja lemprieri</i>	Unknown	LC	LC			
Smooth Stingray	<i>Bathytoshia brevicaudata</i>	Stable	LC	LC			
Black Stingray	<i>Bathytoshia lata</i>	Unknown	LC	LC			
Western Shoelnose Ray	<i>Aptychotrema vincentiana</i>	Unknown	LC	LC			
Elephant Fish	<i>Callorhynchus milii</i>	Sustainable	LC	LC			

Prioritising species – Rec catches? PRS?

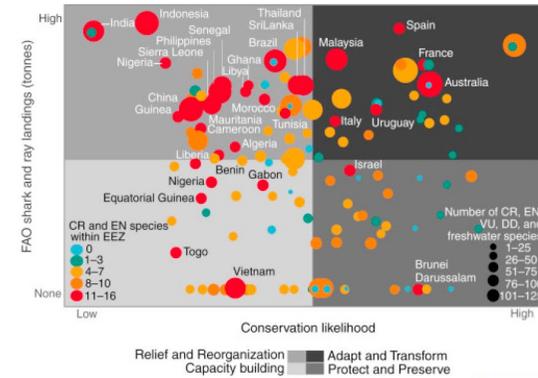
Common name	Scientific name	SAFS / Report card / IUCN	Australian Red List	Global Red List	EPBC Act	CMS	CITES
Greeneye spurdog	<i>Squalus chloraculus</i>	Recovering	EN/NT	EN/NT			
Shortfin Mako	<i>Isurus paucus</i>	Depleted	VU	EN/VU	Migratory		App II
School Shark	<i>Galeorhinus galeus</i>	Depleted	VU	VU	Conservation Dependent		App II
Porbeagle	<i>Lamna nasus</i>	Sustainable	NT	VU	Migratory	App II	App II
Dusky Shark	<i>Carcharhinus obscurus</i>	Recovering/Undefined	NT	VU		App II	App II
Blue Shark	<i>Prionace glauca</i>	Sustainable	NT	NT		App II	App II
Sharpnose sevengill shark	<i>Heptranchias perlo</i>	Sustainable	NT	NT			
Smooth Hammerhead	<i>Sphyrna tiburo</i>	Sustainable	NT	VU	Under assessment	App II*	App II*
Thresher Shark	<i>Alopias vulpinus</i>	Sustainable	LC	VU		App II	App II
Bronze Whaler	<i>Carcharhinus brachyurus</i>	Sustainable	LC	NT			
Broadnose Sevengill Shark	<i>Notorynchus cepedianus</i>	Sustainable	LC	DD			
Gummy Shark	<i>Mustelus antarcticus</i>	Sustainable	LC	LC			
Whiskery Shark	<i>Furgaleus macki</i>	Sustainable	LC	LC			
Wobbegong	<i>Orectolobus spp.</i>	Sustainable	LC	LC			
Port Jackson Shark	<i>Heterodontus portusjacksoni</i>	Sustainable	LC	LC			
Draughtboard Shark	<i>Cephaloscyllium laticeps</i>	Sustainable	LC	LC			
Fiddler Rays	<i>Trygonorrhina sp.</i>	Sustainable	LC	LC			
Coastal stingaree	<i>Urolophus orarius</i>	Decreasing	EN	EN			
Melbourne skate	<i>Sphyrna tiburo</i>	Unknown	VU	VU			
Sandyback stingaree	<i>Urolophus bucculentus</i>	Decreasing	VU	VU			
Greenback stingaree	<i>Urolophus viridis</i>	Decreasing	VU	VU			
Yellowback stingaree	<i>Urolophus sufflavus</i>	Decreasing	VU	VU			
Stingarees	<i>Trypanoptera</i>	Stable	LC	LC			
Stingarees	<i>Urolophus sp.</i>	Stable	LC	LC			
Southern Eagle Ray	<i>Myliobatis australis</i>	Stable	LC	LC			
Thornback Skate	<i>Dentrotraja lemprieri</i>	Unknown	LC	LC			
Smooth Stingray	<i>Bathytoshia brevicaudata</i>	Stable	LC	LC			
Black Stingray	<i>Bathytoshia lata</i>	Unknown	LC	LC			
Western Shoelnose Ray	<i>Aptychotrema vincentiana</i>	Unknown	LC	LC			
Elephant Fish	<i>Callorhynchus milii</i>	Sustainable	LC	LC			

Global shark & ray conservation priority



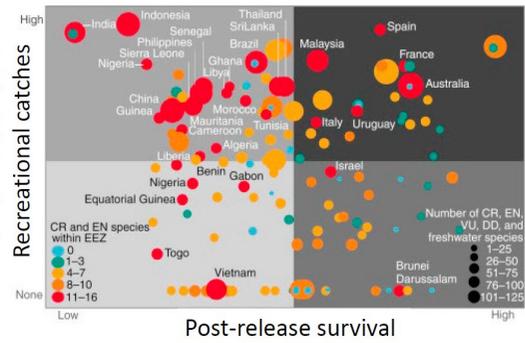
Dulvy et al (2017; Current Biology)

Recreationally-caught shark & ray conservation priority

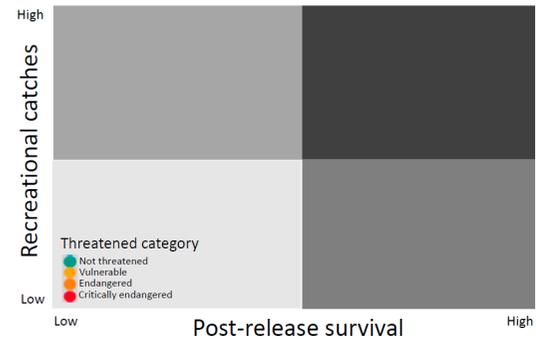


Dulvy et al (2017; Current Biology)

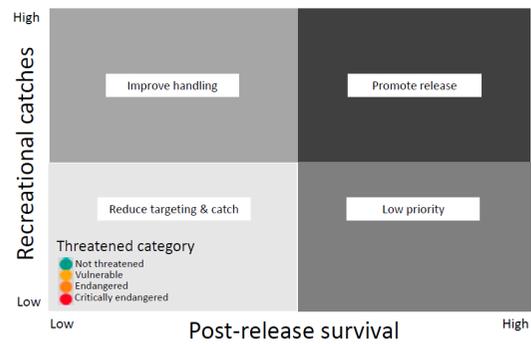
Recreationally-caught shark & ray conservation priority



Recreationally-caught shark & ray conservation priority



Recreationally-caught shark & ray



Available information used for calculating the components of vulnerability for each chondrichthyan species with >20% of its present distribution inside the ESA-PSA region

Taxonomic grouping	Common name	Ecological group	Presence-absence of species in each sub-region										Availability	Non-gillnet mean annual catch during 2000-06	Shark gillnet survey 2007-08	L _{max} (mm)	A _{max} (yr)	Trophic level					
			N	S	W	E	W	W	E	E	S	ESA							NW	PSA	shelf-sand	EG	
Galeomorphi (Galeomorph sharks)																							
Carcharhiniformes (Ground sharks)																							
Carcharhinidae (White sharks)																							
<i>Carcharhinus brevipinna</i>	Bronze whaler	Shelf-sand	P	P	P	P	P	P	P	P	P	P	P	0.850	0.100	17	0.900	B	101	2950	31	4.24	
<i>Carcharhinus obscurus</i>	Dusky shark	Shelf-sand	P	P	P	P	P	P	P	P	P	P	P	0.300	0.100			B		3650	32	4.23	
Sphyrnidae (Hammerhead sharks)																							
<i>Sphyrna tiburo</i>	Smooth hammerhead	Shelf-sand	P	P	P	P	P	P	P	P	P	P	P	0.700	0.200	3	0.960	B	78	3500	21	4.20	
Triakidae (Ground sharks)																							
<i>Gulcarhinus grunnius</i>	School shark	Shelf-sand	P	P	P	P	P	P	P	P	P	P	P	0.850	0.100	35	0.940	B	2814	1750	42	4.22	
<i>Maculoides omacronchus</i>	Gummy shark	Shelf-sand	P	P	P	P	P	P	P	P	P	P	P	0.900	0.100	185	0.940	T	6010	1850	16	3.96	
Heterodontiformes (Horn sharks)																							
Heterodontidae (Hornsharks)																							
<i>Heterodontus portusjacksoni</i>	Port Jackson shark	Shelf-reef	P	P	P	P	P	P	P	P	P	P	P	0.700	0.000	211				976	1650	35	3.46
Lamnidae (Mackerel sharks)																							
Lamnidae (Mackerel sharks)																							
<i>Lamna nasus</i>	Shortfin mako	Pelagic	P	P	P	P	P	P	P	P	P	P	P	0.300	0.000	2			5	3940	29	4.28	
Batoidea (Rays)																							
Myliobatiformes (Stingray and manta rays)																							
Dasyatidae (Stingray)																							
<i>Batyraja brevicaudata</i>	Smooth stingray	Shelf-sand	P	P	P	P	P	P	P	P	P	P	P	0.750	0.200	89	0.650			14	3.60		
<i>Batyraja lineata</i>	Brown stingray	Shelf-sand	P	P	P	P	P	P	P	P	P	P	P	0.700	0.200	96	0.260			14	3.60		
Myliobatidae (Eagle rays)																							
<i>Megobalaia australis</i>	Southern eagle ray	Shelf-sand	P	P	P	P	P	P	P	P	P	P	P	0.800	0.100	88	0.550	B	53		32	3.25	
Rhinoptiformes (Guitar rays)																							
Trygonorhinidae (Blunty ray)																							
<i>Trygonorhinus clunensis</i>	Southern fiddler ray	Shelf-sand	P	P	P	P	P	P						0.900	0.100	219	0.260			15	3.66		
Trygonidae (Spiny rays)																							
<i>Trygonoptera flaccidus</i>	Eastern fiddler ray	Shelf-sand							P	P				0.500	0.000	<1				15	3.66		
Holocephali (Chimaera)																							
Chimaeriformes (Chimaera)																							
<i>Callorhynchus milii</i>	Elephant fish	Shelf-sand	P	P	P	P	P	P	P	P	P	P	P	1.000	0.000	48	0.940	B	76	1200	23	3.83	

Table 5. Chondrichthyan catch by type of fishing in ESA-PSA region of southern Australia

Taxon	Mean annual catch (t) for 2000-06 (t)	Proportion of catch taken by each type of fishing (%)					Total
		Demersal industrial sector of Southern and Eastern Shark and Scalefish Fishery		Demersal non-industrial fisheries			
		Trawl	Hook	Non-shark gillnet	Shark gillnet (mesh-size 150-165 mm)		
Estimated catch from onboard scientific monitoring program (Walker and Gason 2007)							
Selachii (Sharks)	3731	95.9	3.9	0.1	-	-	100.0
Batoidea (Rays)	2641	98.9	1.1	0.0	-	-	100.0
Holocephali (Chimaera)	95	96.9	2.6	0.5	-	-	100.0
Total	6467	97.1	2.8	0.1	-	-	100.0
Reported catch from logbook program (Walker and Gason 2009)							
Selachii (Sharks)	4402	-	-	-	81.1	18.9	100.0
Batoidea (Rays)	289	-	-	-	0.0	100.0	100.0
Holocephali (Chimaera)	76	-	-	-	83.3	16.7	100.0
Total	4767	-	-	-	76.2	23.8	100.0
Total logbook plus observer program							
Selachii (Sharks)	8133						72.4
Batoidea (Rays)	2930						26.1
Holocephali (Chimaera)	171						1.5
Total	11234						100.0

10-step method for assessing vulnerability of chondrichthyan species to climate change, fishing & other anthropogenic stressors

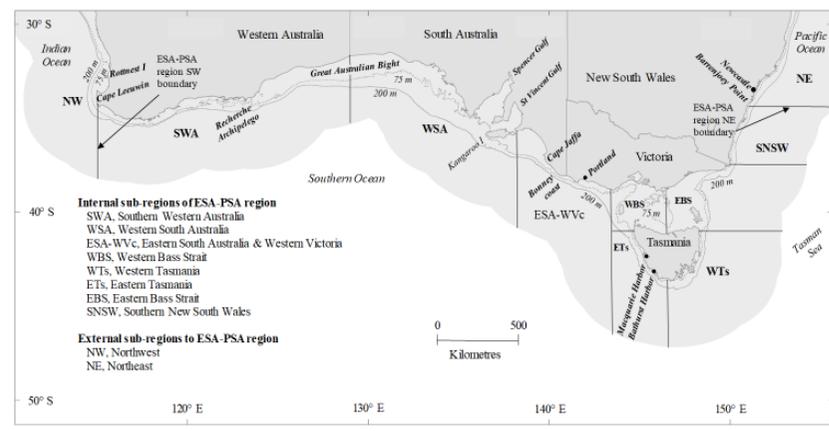


Fig. 1. ESA-PSA region of southern Australia and its internal and external sub-regions within the boundary of the Exclusive Economic Zone.

Appendix 8: Stress and patterns of biological and ecological sensitivity to capture of chondrichthyan groups (Richard Reina)

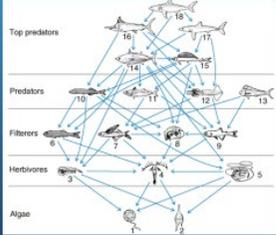
Stress and patterns of biological and ecological sensitivity to capture of chondrichthyan groups

Richard Reina,
School of Biological Sciences,
Monash University

 MONASH University 

Capture stress

Chondrichthyan at high risk because of ecology, physiology and life history traits

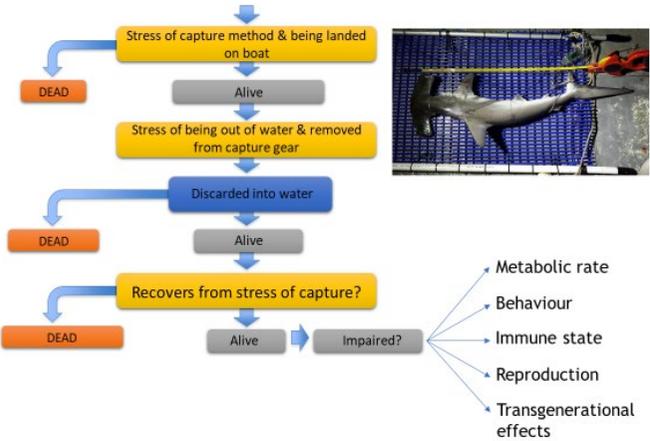


- high trophic position
- relatively low reproductive capacity
- long-lived and slow to mature
- high natural annual survivorship

Research



Consequences of capture



Stress of capture method & being landed on boat

DEAD

Alive

Stress of being out of water & removed from capture gear

DEAD

Discarded into water

DEAD

Alive

Recovers from stress of capture?

DEAD

Alive

Impaired?

- Metabolic rate
- Behaviour
- Immune state
- Reproduction
- Transgenerational effects

The stress response

- 1^o Catecholamines & glucocorticoids
- 2^o Lactate, glucose, blood pH, electrolytes
- 3^o Growth, immunity, reproduction

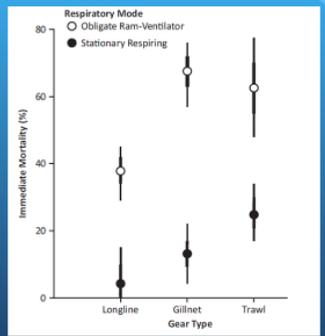


Species vary in their sensitivity

Higher sensitivity	Lower sensitivity
Ram ventilating	Stationary respiring
Pelagic	Benthic
Live-bearing	Egg-laying
High metabolic rate	Low metabolic rate
Large body size	Smaller body size
Sensitive to air exposure	Tolerant to air exposure




Gear type influences stress



Respiratory Mode
 ○ Obligate Ram-Ventilator
 ● Stationary Respiring

Immediate Mortality (%)

Longline Gillnet Trawl
 Gear Type

Dapp, D. R., T. I. Walker, C. Huveneers and R. D. Reina (2016). Respiratory mode and gear type are important determinants of elasmobranch immediate and post-release mortality. *Fish and Fisheries* 17: 507-524.

Capture and handling practices

Practices that minimise immediate and delayed stress will improve outcome for captured animals by reducing:

- physical damage
- energetic costs
- immune compromise
- reproductive consequences
- impaired swimming behaviour



Survey results

- **Q11. Commonly listed criteria for grouping species that could have similar handling practices:**
- Morphology (Body shape & size)
- Respiratory mode (Ram vs buccal pumping; related to activity level)
- Feeding behaviour (relates to baits taken)
- Reproductive mode (live-bearing)
- Phylogeny (E.G. rays vs whalers vs hammerheads)

Using this information - for discussion session

Can we design handling recommendations that group species sharing common characteristics?

What should these groups be?

Appendix 9: A summary of tag-recapture and survey information for sharks and rays in recreational fisheries (Phil Bolton & Julian Pepperell)



NSW GOVERNMENT | Department of Primary Industries

NSW DPI Game Fish Tagging Program - Shark Tagging Data

Phil Bolton – Recreational Fisheries Manager NSW DPI



GFTP Background

- Launched in 1973. Largest cooperative tagging program of its kind. Funded by the NSW Recreational Fishing Trust (NSW recreational fishing licence).
- Australia-wide and Western & Central Pacific Islands
- Numbers of fish:
 - Over 480,000 fish tagged
 - Over 8,400 fish recaptured
- Top five species:
 - Black marlin, yellowfin tuna, yellowtail kingfish, sailfish, dolphinfish



Total number of sharks tagged 1973 - 2019 (southern states)

Species	Number Tagged
MAKO SHARK	8191
HAMMERHEAD SHARK	5340
WHALER SHARK	5323
BLUE SHARK	5089
BRONZE WHALER	2502
TIGER SHARK	1296
EAGLE RAY	815
GUMMY SHARK	726
SCHOOL SHARK	601
BLACKTIP SHARK	474
THRESHER SHARK	122
BULL SHARK	67
WHITETIP SHARK	63
PORBEAGLE SHARK	2
SHOVEL NOSE SHARK	2
SEVEN GILL SHARK	1
Grand Total	30614



Spatial distribution of shark tag data – heat maps



Mako shark



Total
1973 - 2019

Recent
2010 - 2019

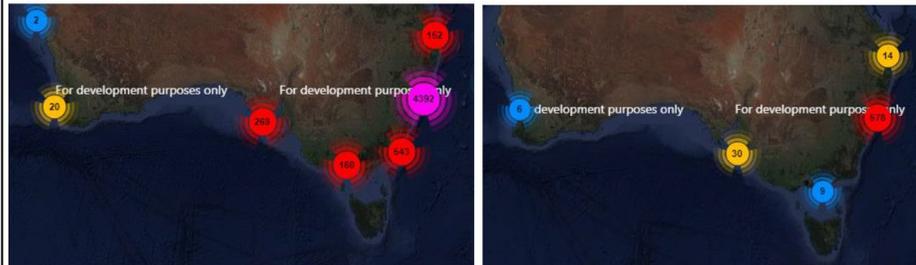
Whaler shark



Bronze Whaler shark



Hammerhead shark



Total
1973 - 2019

Recent
2010 - 2019

Blue shark



Total
1973 - 2019

Recent
2010 - 2019

Tiger shark



Total
1973 - 2019

Recent
2010 - 2019

Eagle Ray



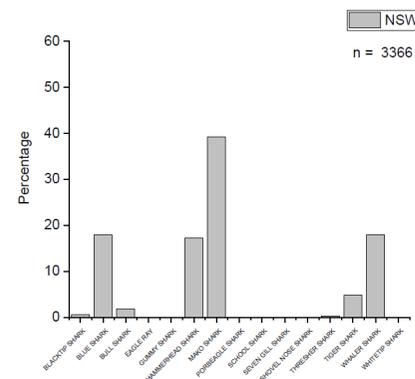
Total
1973 - 2019

Recent
2010 - 2019

Spatial distribution of shark tag data – by state

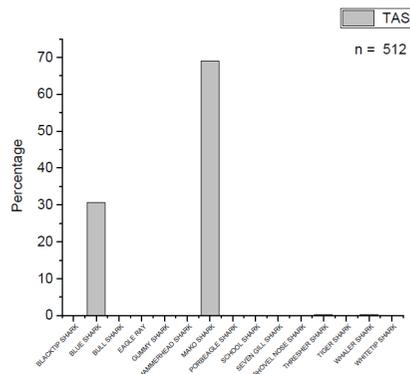


NSW sharks tagged 2010- 2019



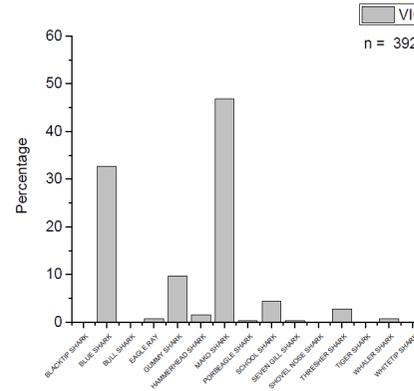
Species	Tag_Numbers	%
BLACKTIP SHARK	18	0.5
BLUE SHARK	605	18.0
BULL SHARK	64	1.9
EAGLE RAY	0	0.0
GUMMY SHARK	2	0.1
HAMMERHEAD SHARK	578	17.2
MAKO SHARK	1319	39.2
PORBEAGLE SHARK	0	0.0
SCHOOL SHARK	0	0.0
SEVEN GILL SHARK	0	0.0
SHOVEL NOSE SHARK	2	0.1
THRESHER SHARK	9	0.3
TIGER SHARK	163	4.8
WHALER SHARK	605	18.0
WHITETIP SHARK	1	0.0
Grand Total	3366	100.0

TAS sharks tagged 2010- 2019



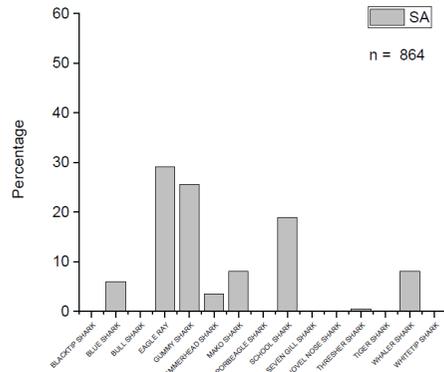
Species	Tag_Numbers	%
BLACKTIP SHARK	0	0.0
BLUE SHARK	157	30.7
BULL SHARK	0	0.0
EAGLE RAY	0	0.0
GUMMY SHARK	0	0.0
HAMMERHEAD SHARK	0	0.0
MAKO SHARK	353	68.9
PORBEAGLE SHARK	0	0.0
SCHOOL SHARK	0	0.0
SEVEN GILL SHARK	0	0.0
SHOVEL NOSE SHARK	0	0.0
THRESHER SHARK	1	0.2
TIGER SHARK	0	0.0
WHALER SHARK	1	0.2
WHITETIP SHARK	0	0.0
Grand Total	512	100.0

VIC sharks tagged 2010- 2019



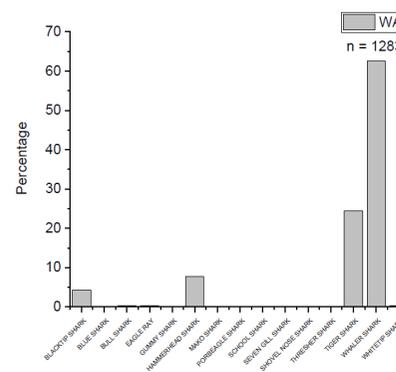
Species	Tag_Numbers	%
BLACKTIP SHARK	0	0.0
BLUE SHARK	128	32.7
BULL SHARK	0	0.0
EAGLE RAY	3	0.8
GUMMY SHARK	38	9.7
HAMMERHEAD SHARK	6	1.5
MAKO SHARK	184	46.9
PORBEAGLE SHARK	1	0.3
SCHOOL SHARK	17	4.3
SEVEN GILL SHARK	1	0.3
SHOVEL NOSE SHARK	0	0.0
THRESHER SHARK	11	2.8
TIGER SHARK	0	0.0
WHALER SHARK	3	0.8
WHITETIP SHARK	0	0.0
Grand Total	392	100.0

SA sharks tagged 2010- 2019



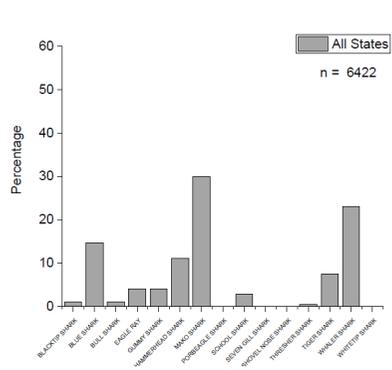
Species	Tag_Numbers	%
BLACKTIP SHARK	0	0.0
BLUE SHARK	52	6.0
BULL SHARK	0	0.0
EAGLE RAY	252	29.2
GUMMY SHARK	221	25.6
HAMMERHEAD SHARK	30	3.5
MAKO SHARK	70	8.1
PORBEAGLE SHARK	1	0.1
SCHOOL SHARK	164	19.0
SEVEN GILL SHARK	0	0.0
SHOVEL NOSE SHARK	0	0.0
THRESHER SHARK	4	0.5
TIGER SHARK	0	0.0
WHALER SHARK	70	8.1
WHITETIP SHARK	0	0.0
Grand Total	864	100.0

WA sharks tagged 2010- 2019

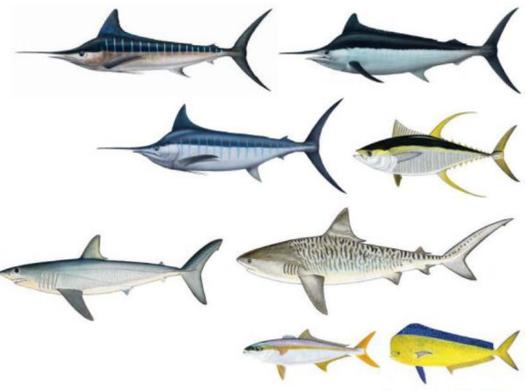


Species	Tag_Numbers	%
BLACKTIP SHARK	55	4.3
BLUE SHARK	0	0.0
BULL SHARK	3	0.2
EAGLE RAY	5	0.4
GUMMY SHARK	0	0.0
HAMMERHEAD SHARK	100	7.8
MAKO SHARK	0	0.0
PORBEAGLE SHARK	0	0.0
SCHOOL SHARK	0	0.0
SEVEN GILL SHARK	0	0.0
SHOVEL NOSE SHARK	0	0.0
THRESHER SHARK	1	0.1
TIGER SHARK	313	24.4
WHALER SHARK	802	62.5
WHITETIP SHARK	4	0.3
Grand Total	1283	100.0

Total sharks tagged 2010- 2019

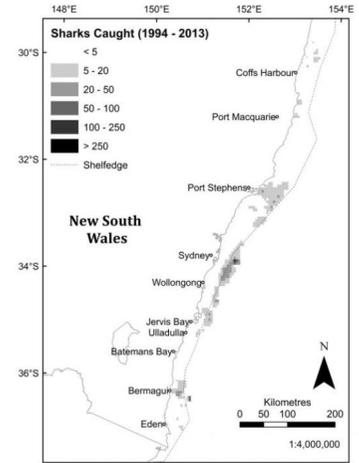
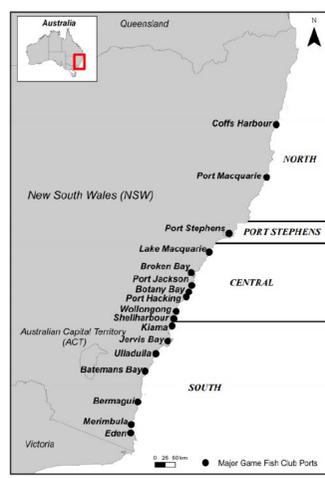


Species	Tag Numbers	%
BLACKTIP SHARK	73	1.1
BLUE SHARK	942	14.7
BULL SHARK	67	1.0
EAGLE RAY	260	4.0
GUMMY SHARK	261	4.1
HAMMERHEAD SHARK	714	11.1
MAKO SHARK	1926	30.0
PORBEAGLE SHARK	2	0.0
SCHOOL SHARK	181	2.8
SEVEN GILL SHARK	1	0.0
SHOVEL NOSE SHARK	2	0.0
THRESHER SHARK	26	0.4
TIGER SHARK	478	7.4
WHALER SHARK	1484	23.1
WHITETIP SHARK	5	0.1
Grand Total	6422	100.0



Images © Bernard You for all species except blue and black marlin © NSW DPI

NSW Game Fish Tournament Monitoring Program 1993 - 2018



Mako shark												
Financial year	Sched data						Combination of sched and interview data					
	No. caught	Released (%)	No. released	No. captured	Mean weight (kg)	Total captures (kg)	No. caught	Released (%)	No. released	No. captured	Mean weight (kg)	Total captures (kg)
1994	54	63.0	34	20	139.5	2790	54	62.3	34	20	139.5	2790
1995	56	62.5	35	21	166.7	3501	56	62.5	35	21	172.6	3624
1996	99	69.7	69	30	88.4	2652	99	69.7	69	30	103.7	3112
1997	11	72.7	8	3	-	-	11	72.7	8	3	-	-
1998	30	76.7	23	7	-	-	30	76.7	23	7	-	-
1999	320	86.3	276	44	109.5	4819	323	85.7	277	46	143.3	6593
2000	153	75.2	115	38	143.4	5450	153	75.2	115	38	143.0	5435
2001	118	56.8	67	51	146.3	7459	118	57.3	68	50	149.1	7456
2002	123	71.4	88	35	154.1	5394	123	71.4	88	35	154.1	5394
2003	64	64.1	41	23	150.3	3457	74	65.8	49	25	133.7	3343
2004	58	61.4	36	22	176.8	3889	63	51.9	33	30	162.9	4888
2005	118	70.9	84	34	128.8	4379	120	69.6	83	37	152.3	5633
2006	31	45.2	14	17	193.1	3282	46	24.1	11	35	170.4	5965
2007	60	61.0	37	23	125.6	2889	67	39.1	26	41	125.7	5155
2008	84	61.5	52	32	146.7	4693	102	63.0	64	38	134.4	5069
2009	105	52.9	56	49	133.5	6541	110	52.4	58	52	151.1	8015
2010	189	65.4	124	65	147.5	9586	198	65.7	130	68	142.2	9671
2011	105	65.7	69	36	164.7	5928	105	66.4	70	35	164.4	5754
2012	182	67.4	123	59	139.9	8252	187	67.4	126	61	131.6	8028
2013	222	84.2	187	35	151.9	5318	302	82.1	248	54	122.9	6635
2014	79	82.4	65	14	186.7	2614	83	81.0	67	16	177.8	2845
2015	129	77.0	99	30	134.2	4027	128	73.4	94	34	117.1	3982
2016	134	79.7	107	27	169.3	4572	134	79.7	107	27	169.3	4572
2017	86	79.1	68	18	152.4	2743	86	79.1	68	18	152.4	2743
2018	60	90.0	54	6	173.9	1043	60	90.0	54	6	173.9	1043
Total	2670		1931	739		105278	2832		2006	827		117746
Annual mean	107	70	77	30	149	4577	113	67	80	33	147	5119

Blue shark												
Financial year	Sched data						Combination of sched and interview data					
	No. caught	Released (%)	No. released	No. captured	Mean weight (kg)	Total captures (kg)	No. caught	Released (%)	No. released	No. captured	Mean weight (kg)	Total captures (kg)
1994	19	42.1	8	11	113.1	1244	19	42.1	8	11	113.1	1244
1995	32	62.5	20	12	95.0	1140	32	62.5	20	12	95.0	1140
1996	156	59.6	93	63	105.6	6654	156	59.6	93	63	105.4	6637
1997	12	91.7	11	1	-	-	12	91.7	11	1	-	-
1998	22	95.5	21	1	-	-	22	95.5	21	1	-	-
1999	91	82.4	75	16	101.5	1625	96	77.3	74	22	89.3	1964
2000	30	86.7	26	4	74.0	296	30	86.7	26	4	74.0	296
2001	38	71.1	27	11	123.6	1360	38	74.3	28	10	120.8	1208
2002	32	75.0	24	8	110.8	886	33	71.9	24	9	110.8	997
2003	13	46.2	6	7	139.5	976	14	50.0	7	7	139.3	975
2004	4	50.0	2	2	93.0	186	5	60.0	3	2	93.0	186
2005	13	76.9	10	3	78.8	236	15	73.3	11	4	111.4	446
2006	11	63.6	7	4	88.5	354	13	53.9	7	6	120.8	724
2007	9	62.5	6	3	103.0	309	5	33.3	2	3	129.4	388
2008	50	59.2	30	20	96.5	1931	52	58.8	31	21	102.3	2148
2009	57	59.7	34	23	123.2	2834	65	63.1	41	24	91.7	2200
2010	65	64.6	42	23	116.0	2668	66	65.2	43	23	109.6	2520
2011	22	68.2	15	7	113.3	793	22	68.2	15	7	113.3	793
2012	41	80.5	33	8	81.4	652	42	83.3	35	7	82.1	575
2013	57	79.0	45	12	104.4	1253	71	74.7	53	18	115.9	2086
2014	45	95.2	43	2	137.2	274	44	95.2	42	2	137.2	274
2015	77	81.7	63	14	130.4	1826	78	80.3	63	15	112.5	1688
2016	48	87.5	42	6	95.6	573	48	87.5	42	6	95.6	573
2017	52	80.4	42	10	93.5	935	52	80.4	42	10	93.5	935
2018	7	85.7	6	1	62.3	62	7	85.7	6	1	62.3	62
Total	1003		731	272		29067	1037		748	289		30059
Annual mean	40	72	29	11	103	1264	41	71	30	12	105	1307

Tiger shark												
Financial year	Sched data						Combination of sched and interview data					
	No. caught	Released (%)	No. released	No. captured	Mean weight (kg)	Total captures (kg)	No. caught	Released (%)	No. released	No. captured	Mean weight (kg)	Total captures (kg)
1994	67	19.4	13	54	188.8	10197	67	19.4	13	54	187.9	10146
1995	55	14.6	8	47	277.4	13038	55	14.6	8	47	310.0	14569
1996	68	19.1	13	55	224.4	12343	68	19.1	13	55	215.9	11874
1997	54	20.4	11	43	189.0	8127	54	20.4	11	43	189.0	8127
1998	31	16.1	5	26	183.1	4761	31	16.1	5	26	183.0	4758
1999	78	32.1	25	53	320.1	16965	78	31.2	24	54	235.5	12717
2000	57	45.6	26	31	235.7	7306	57	45.6	26	31	226.9	7033
2001	35	37.1	13	22	221.0	4862	35	37.1	13	22	231.8	5100
2002	49	39.6	19	30	209.6	6288	49	39.6	19	30	208.6	6258
2003	29	72.4	21	8	341.0	2728	29	73.3	21	8	341.0	2728
2004	33	15.2	5	28	226.2	6334	43	19.1	8	35	287.2	10051
2005	35	20.0	7	28	289.5	8105	32	21.9	7	25	290.3	7257
2006	48	39.6	19	29	247.7	7182	47	36.5	17	30	247.5	7425
2007	21	33.3	7	14	228.7	3202	23	33.3	8	15	186.6	2800
2008	38	18.9	7	31	205.9	6383	38	18.9	7	31	240.1	7442
2009	16	18.8	3	13	155.4	2021	17	11.8	2	15	195.5	2992
2010	45	35.6	16	29	203.6	5905	44	33.3	15	29	204.1	5918
2011	36	41.7	15	21	228.6	4800	36	41.7	15	21	232.9	4892
2012	50	32.0	16	34	278.8	9409	49	30.0	15	34	278.6	9471
2013	14	30.8	4	10	215.3	2153	13	30.8	4	9	242.0	2178
2014	27	52.6	14	13	199.8	2597	29	63.6	18	11	196.8	2164
2015	27	50.0	14	14	387.1	5420	27	54.2	15	12	390.4	4684
2016	28	56.0	16	12	296.4	3556	28	56.0	16	12	296.4	3556
2017	37	50.0	18	18	193.5	3483	37	50.0	18	18	193.5	3483
2018	31	48.4	15	16	216.5	3463	31	48.4	15	16	216.5	3463
Total	1009		330	679		160628	1017		333	683		161086
Annual mean	40	34	13	27	238	6426	41	35	13	27	241	6443

Hammerhead sharks												
Financial year	Sched data						Combination of sched and interview data					
	No. caught	Released (%)	No. released	No. captured	Mean weight (kg)	Total captures (kg)	No. caught	Released (%)	No. released	No. captured	Mean weight (kg)	Total captures (kg)
1994	59	83.1	49	10	93.0	930	59	83.1	49	10	93.0	930
1995	18	77.8	14	4	-	-	18	77.8	14	4	-	-
1996	29	89.7	26	3	126.0	378	29	89.7	26	3	126.0	378
1997	39	89.7	35	4	-	-	39	89.7	35	4	-	-
1998	23	100.0	23	0	-	-	23	100.0	23	0	-	-
1999	35	91.4	32	3	109.0	327	36	86.1	31	5	109.0	545
2000	64	90.6	58	6	95.3	572	64	90.6	58	6	90.8	544
2001	60	88.3	53	7	117.3	821	60	88.1	53	7	117.3	821
2002	42	71.4	30	12	109.3	1312	42	70.7	30	12	109.3	1312
2003	37	86.5	32	5	-	-	37	86.1	32	5	80.0	400
2004	21	95.2	20	1	-	-	20	100.0	20	0	-	-
2005	17	93.3	16	1	-	-	18	87.5	16	2	-	-
2006	16	87.5	14	2	-	-	17	88.2	15	2	-	-
2007	9	100.0	9	0	-	-	9	100.0	9	0	-	-
2008	4	100.0	4	0	-	-	4	100.0	4	0	-	-
2009	10	90.0	9	1	-	-	10	90.0	9	1	190.0	190
2010	11	90.9	10	1	77.0	77	12	91.7	11	1	77.0	77
2011	13	84.6	11	2	84.0	168	14	85.7	12	2	84.0	168
2012	21	95.2	20	1	81.1	81	21	95.2	20	1	81.0	81
2013	10	90.0	9	1	129.2	129	10	90.0	9	1	129.2	129
2014	18	100.0	18	0	-	-	21	100.0	21	0	-	-
2015	39	97.4	38	1	120.6	121	38	97.2	37	1	120.6	121
2016	34	100.0	34	0	-	-	34	100.0	34	0	-	-
2017	35	100.0	35	0	-	-	35					

Whaler sharks	Sched data						Combination of sched and interview data					
	Financial year	No. caught	Released (%)	No. released	No. captured	Total captures (kg)	No. caught	Released (%)	No. released	No. captured	Mean weight (kg)	Total captures (kg)
1994	48	56.3	27	21	116.9	2454	48	56.3	27	21	116.9	2454
1995	15	40.0	6	9	134.0	1206	15	35.7	5	10	134.0	1340
1996	42	78.6	33	9	191.5	1724	42	78.6	33	9	191.5	1724
1997	46	80.4	37	9	-	-	46	80.4	37	9	-	-
1998	76	89.5	68	8	-	-	76	89.3	68	8	-	-
1999	31	67.7	21	10	105.0	1050	32	65.6	21	11	105.0	1155
2000	56	73.2	41	15	178.5	2678	56	73.2	41	15	173.4	2600
2001	22	68.2	15	7	224.7	1573	22	68.2	15	7	224.7	1573
2002	14	71.4	10	4	162.0	648	14	69.2	10	4	162.0	648
2003	41	82.9	34	7	87.5	612	42	82.1	34	8	78.3	627
2004	19	76.5	15	4	209.0	836	18	66.7	12	6	169.7	1018
2005	30	86.7	26	4	-	-	27	86.4	23	4	-	-
2006	10	90.0	9	1	-	-	12	90.0	11	1	58.0	58
2007	25	80.0	20	5	147.8	739	26	87.0	23	3	76.5	230
2008	10	70.0	7	3	115.3	346	11	63.6	7	4	116.3	465
2009	14	76.9	11	3	134.0	402	16	75.0	12	4	140.7	563
2010	60	96.7	58	2	156.7	313	61	75.0	46	15	113.6	1703
2011	37	77.1	29	8	103.4	827	37	77.1	29	8	99.0	792
2012	17	88.2	15	2	136.1	272	20	85.0	17	3	108.9	327
2013	24	95.8	23	1	173.0	173	28	92.9	26	2	149.0	298
2014	16	91.7	15	1	-	-	14	92.3	13	1	68.0	68
2015	13	100.0	13	0	-	-	13	100.0	13	0	-	-
2016	46	88.9	41	5	82.6	413	46	88.9	41	5	82.6	413
2017	17	88.2	15	2	72.7	145	17	88.2	15	2	72.7	145
2018	121	92.6	112	9	133.4	1201	121	93.3	113	8	133.3	1066
Total	850		701	149		17612	860		692	168		19287
Annual mean	34	80	28	6	140	927	34	78	28	7	123	917

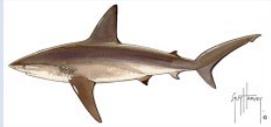
Appendix 2 Annual recreational catch (total, kept and released numbers) in NSW/ACT waters during 2013/14 by residents aged five years and older - by reporting group and species. SE is standard error; values in bold indicate relative standard error > 40%; values in italics indicate fewer than 30 households recorded catches of the species.

Reporting group	Standard Fish Name	Scientific name/s	Total		Kept		Released	
			Number	SE	Number	SE	Number	SE
Sharks	Gummy Shark	<i>Mustelus antarcticus</i>	4,000	1,553	1,020	432	2,980	1,449
	Hammerhead Shark	Sphymidae - undifferentiated	2,030	1,824			2,030	1,824
	Mako Shark	<i>Isurus oxyrinchus</i>	297	209			297	209
	Port Jackson Shark	<i>Heterodontus portusjacksoni</i>	3,240	1,715			3,240	1,715
	School Shark	<i>Galeorhinus galeus</i>	386	385	386	385		
	Tiger Shark	<i>Galeocerdo cuvier</i>	268	247			268	247
	Whaler Shark	Carcharhinidae	13,488	6,634	1,683	978	11,805	6,504
	Wobbegong Shark	Brachaeluridae - undifferentiated	9,510	5,234			9,510	5,234
	Shark, other	Several families - undifferentiated	613	458			613	458
	Rays	Shovelnose Ray	<i>Aptychotrema rostrata</i>	35,627	10,515	1,959	864	33,668
Ray, other		Dasypatiidae - undifferentiated	34,506	7,064	234	233	34,272	7,060
Ray, unspecified		Dasypatiidae - undifferentiated	1,103	713			1,103	713

Recreational Surveys

Shark & Ray Harvest and Release

Julian Pepperell



National 2000/01

Common name	No. Caught	S.E. Caught	No. Kept	S.E. Kept	No. Released	S.E. Released	% Released
Sharks & Rays	1,252,728		228,320	25,140	1,024,408		81.8

New South Wales 2013/14

Common name	No. Caught	S.E. Caught	No. Kept	S.E. Kept	No. Released	S.E. Released	% Released
Gummy shark	4,000	1,553	1,020	432	2,980	1,449	75
Hammerhead shark-undiff.	2,030	1,824			2,030	1,824	100
Mako shark	297	209			297	209	100
Port Jackson shark	3,240	1,715			3,240	1,715	100
School shark	386	385	386	385			0
Shark, other	613	458			613	458	100
Tiger shark	268	247			268	247	100
Whaler shark-undiff.	13,488	6,634	1,683	978	11,805	6,504	88
Wobbegong shark	9,510	5,234			9,510	5,324	100
Shovelnose ray	35,627	10,515	1,959	864	33,668	10,243	95
Ray, other	34,506	7,064	234	233	34,272	7,060	99
Ray, unspecified	1,103	713			1,103	713	100

South Australia 2013/14

Common name	No. Caught	S.E. Caught	No. Kept	S.E. Kept	No. Released	S.E. Released	% Released
Shark, Gummy	11,597	4,549	8,822	3,690	2,775	1624	24
Shark, Port Jackson	4,313	2,129	38	39	4,275	2128	99
Shark, School	7,749	5,596	7,208	5,496	541	469	7
Shark, Spurdog/Dogfish	2,772	1,703	0	0	2,772	1703	100
Shark, Unknown	584	461	0	0	584	461	100
Shark, Whaler	723	530	0	0	723	530	100
Shark, Wobbegong	467	465	0	0	467	465	100
Rays/Skates	9,489	4,361	0	0	9,489	4361	100

Queensland 2013/14

Common name	No. Caught	S.E. Caught	No. Kept	S.E. Kept	No. Released	S.E. Released	% Released
Bronze whaler shark	##	##	##	##	##	##	##
Gummy shark	##	##			##	##	##
Hammerhead shark	3,300	1,000	##	##	3,300	1,000	100
Shark, unspecified	55,000	15,000			52,000	14,000	95
Tiger shark	##	##			##	##	##
Whaler and weasel sharks-unspecified	24,000	5,000	##	##	24,000	5,000	100
Wobbegong-unspecified	##	##			##	##	##
Shovelnose ray and guitarfish-unspecified	30,000	5,300	##	##	28,000	4,900	93
Rays &	66,000	17,000	##	##	66,000	17,000	100

Western Australia 2015/16

Common name	No. Caught	S.E. Caught	No. Kept	S.E. Kept	No. Released	S.E. Released	% Released
Blacktip reef shark	1,419	273	207	77	1,212	251	85
Bronze whaler	1,235	251	354	87	881	232	71
Dusky whaler	1,467	573	230	94	1,237	555	84
Grey nurse shark	27	20	0	0	27	20	100
Gummy sharks	934	204	521	129	413	154	44
Hammerhead shark	214	57	53	33	161	47	75
Lemon shark	146	61	0	0	146	61	100
Port Jackson shark	1,047	210	37	36	1,011	207	97
Sandbar shark	108	54	0	0	108	54	100
Tiger shark	199	75	0	0	199	75	100
Whiskery shark	379	143	180	62	199	100	53
Whitetip reef shark	539	240	43	25	496	235	92
Wobbegong	660	167	99	37	561	163	85
Other whaler	366	192	65	34	300	186	82
Other shark	2,739	519	389	153	2,350	480	86
Sawfishes	90	42	0	0	90	42	100
Western shovelnose ray	288	76	0	0	288	76	100
Other rays/skates	2,241	364	38	37	2,203	362	98

Northern Territory 2009/10

Common name	No. Caught	S.E. Caught	No. Kept	S.E. Kept	No. Released	S.E. Released	% Released
Sharks & Rays	27,738	3,454	1,506	448	26,232	3,378	94.6

Tasmania 2012/13

Common name	No. Caught	S.E. Caught	No. Kept	S.E. Kept	No. Released	S.E. Released	% Released
Sharks & Rays	38,641	5,033	9,299	1,603	29,342	4,039	75.9

Tasmania 2012/13

Common name	Line	Set-line	Gillnet	Pot	Seine
Gummy shark	***	**	*		
School shark	*	*	*		
Spurdog	**		**	*	
Draughtboard shark	**	**	*	**	
Elephantfish	*		*		
Shark, other	**	*	*		
Shark, unspec	*	*	*		
Skates/Rays	**	**	*		*

Appendix 10: Review of existing handling guidelines for sharks and rays in recreational fisheries in Australia (Sean Williamson)

Previous Handling Guidelines

Sean Williamson



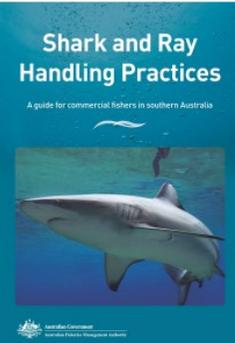
MONASH
University

Relevant Guidelines

AFMA Commercial

Shark and Ray Handling Practices

A guide for commercial fishers in southern Australia



PIRSA Recreational



Recreational fishing guide on appropriate fishing gear and handling techniques of sharks and rays

Relevant Guidelines

NOAA Catch & Release



Poisson *et al.* Tuna Purse Seiners

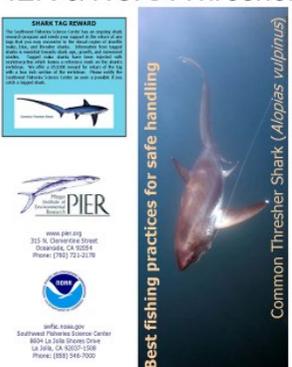


Good practices to reduce the mortality of sharks and rays caught incidentally by tropical tuna purse seiners.

Poisson F., Vermet A. L., Séret B., Dagorn L.

Relevant Guidelines

PIER & NOAA Thresher



Best fishing practices for safe handling

Common Thresher Shark (*Alopias vulpinus*)

VRFish Thresher



Best practice catch, release and handling guidelines for

thresher sharks

in Victoria

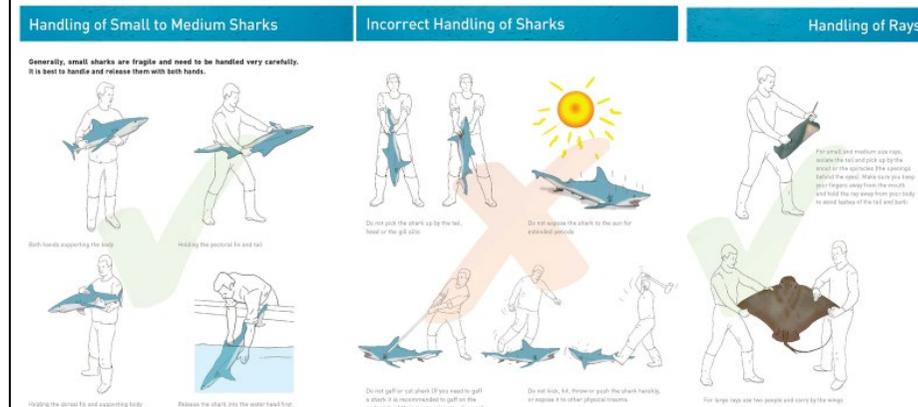
Best-Practice Guidelines

Q14. Commonly listed useful and practical **aspects** of guides:

- Simple messaging
- Little text, dot points
- Clear graphics / diagrams

Simple Messaging & Clear Graphics

AFMA Guide



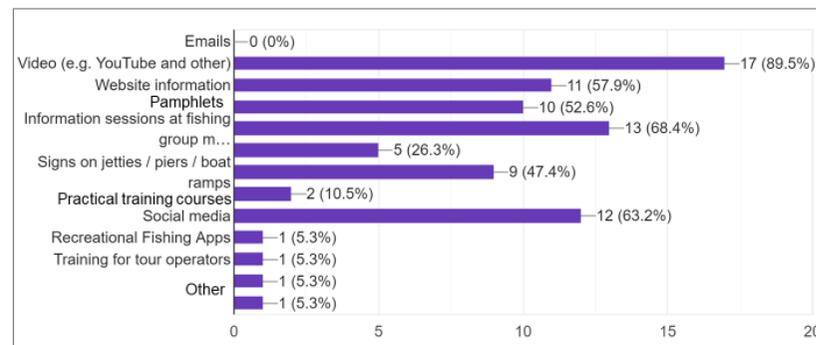
Best-Practice Guidelines

Commonly listed practices of guides:

- Use circle hooks, heavy line & gear
 - Reduce fight time
- Keep animal in water where possible
- No gaffing in the body (lower jaw preferred)
 - Do not: lift by tail or squeeze gills
- Calm shark by covering eyes with smooth, wet and dark cloth
 - If can't remove hook, cut leader as short as possible
 - Help recovery if needed by facing into current
 - Release ASAP and reduce exposure to sun and air

Best-Practice Guidelines

Q15. Most effective method for extension of guides?



Appendix 11: What information is the highest priority in post-release survival studies to support development and refinement of best practice guidelines in recreational fisheries (Sean Tracey)

WHAT INFORMATION IS THE HIGHEST PRIORITY IN POST-RELEASE SURVIVAL STUDIES TO SUPPORT DEVELOPMENT AND REFINEMENT OF BEST PRACTICE GUIDELINES IN RECREATIONAL FISHERIES

ASSOC. PROF. SEAN TRACEY



UNIVERSITY of TASMANIA

IMAS
INSTITUTE FOR MARINE & ANTARCTIC STUDIES

DOES THE ANIMAL SURVIVE POST RELEASE - AND HOW TO TEST THIS

- Study species
 - Big/small
 - Migratory/resident
- Study method
 - Containment
 - tagging

FACTORS THAT MAY AFFECT SURVIVAL

- Can you test it?
 - Practical
 - Statistical considerations
- Can you control it?
 - Regulatory
 - Voluntary

FACTORS THAT MAY AFFECT SURVIVAL

- Hook type
- Hooking location
- Duration of fight
 - Stress
- Handling at landing
- Resuscitation

CONFOUNDING FACTORS

- Handling for tagging
- Damage through tagging / stress through confinement
- Temptation to not tag 'unhealthy' animals with expensive tags
- Minimum estimates of survival?
- Are the recreational sector going to embrace best practice?

CONSIDERATIONS

- Cost of capture/sampling
- Tag types
 - Non-reporting tags
- Quantify/qualify physiological condition
 - ACCESS/RAMP
 - Blood chemistry
- Secondary impacts of physiological stress (how to measure)
- Secondary data

SHORTFIN MAKO

- Method = sPATs (n = 33)
- Post-release survival rate = 90% (95%CI: 80 – 97)
- Circle hooks = significantly lower probability of deep hooking
- Three individuals in poor condition at release; two appeared moribund and lifeless and the other exhibited severe bleeding; only the latter of these three did not survive.
- Bloods indicated increased stress with fight time and temp
 - No evidence related to mortality (sample size)
- Three mortalities occurred after short fight times
 - two of these sharks were foul hooked.
- **MESSAGE: Hook type important, PRS relatively high**



SOUTHERN BLUEFIN TUNA

- Method = PATs (n = 54)
- Post-release survival rate = 83.0% (95% CI: 75.9%–90.7)
 - Lower for treble hooks = 60%
- Circle hooks = significantly lower probability of deep hooking
- Fight time related to stress
- Stress, hooking location, temp and handling not significantly related to PRS (sample size)
- **MESSAGE: Hook type important, PRS relatively high**



SWORDFISH

Understanding the movement, behaviour and post-capture survival of recreationally caught Swordfish from southeast Australia
 – a pilot study
 Sean Tracey & Julian Pepperell



- Post-release survival rate = 78% (95%CI: 80 – 97)
- Considering post-landing mortality combined with post-release mortality an overall survival rate of Swordfish landed was estimated at 41%.
- Circle hooks = significantly lower probability of deep hooking
- Bloating due to gas in swim bladder
- Deep hooking
- **MESSAGE: Hook type important, PRS relatively high, PCS low**

Contents lists available at ScienceDirect
Fisheries Research
 Journal homepage: www.elsevier.com/locate/fishres

ATLANTIC HALIBUT

Survival of Atlantic halibut (*Hippoglossus hippoglossus*) following catch-and-release angling
 Keno Ferter^{a,*}, Audun H. Rikardsen^a, Tor H. Evensen^a, Martin-A. Svenning^a,
 Sean R. Tracey^b



- Method = PATs and Acoustic tags
- Post-release survival rate (short term) = 100%
 - Longer term = indeterminate (at least 72%)
- **MESSAGE: PRS relatively high. (reluctance to (illegal) C&R in some European countries)**

TRANSLATING RESULTS TO A CODE OF BEST PRACTICE

- A 'clear' result make things much easier
- Are you reporting on 'statistical significance' or 'indicative' results?
 - Who is your target audience?
- Were any of the 'factors' significant/relevant?
- Are you communicating the COP in regard to the study species or broader taxa?
- Are you 'telling' or 'encouraging'?
- Who 'owns' the COP and messaging?

Careful Catch and Release

Ethical Angling
As ethical anglers, we tackle and release fish which maintain their health when they are released. There are several ways to do this, and we encourage you to use the best practices available to you. For more information, visit www.noaa.gov and search for "ethical angling" or "U.S. Code of Angling Ethics".

Atlantic Highly Migratory Species
Atlantic highly migratory species include blue, black, white, yellow, and oceanic tunas, as well as swordfish, mahi-mahi, and wahoo. These species are managed in the Atlantic Ocean, Caribbean, and Gulf of Mexico.

Fishing Regulations
Atlantic HMP fishing regulations and management plans are available at: www.noaa.gov or www.fishbase.org.

Fishing Permits
Federal vessel fishing permits are required to fish for HMP species in the Atlantic Ocean, Caribbean, and Gulf of Mexico. For more information, visit www.noaa.gov or www.fishbase.org.

Tagging Programs
NOAA Fisheries has several tagging programs available. For more information, visit www.noaa.gov or www.fishbase.org.

NOAA FISHERIES
11th Street, NW, Washington, DC 20541
Phone: 202-735-5300
Fax: 202-735-5301
www.noaa.gov

Do not remove the fish from the water... even for a picture!
Research shows that when a fish is held out of the water, it can suffer from hypoxia (low oxygen) and other stressors. To keep the fish safe, keep it in the water as long as possible. If you must lift the fish, use a net or a bucket of water to keep it submerged.

Use circle hooks and dehooking devices.
Research shows that when a fish is held out of the water, it can suffer from hypoxia (low oxygen) and other stressors. To keep the fish safe, keep it in the water as long as possible. If you must lift the fish, use a net or a bucket of water to keep it submerged.

Reduce the fight time.
Prolonged fighting can cause fish to become exhausted and stressed. To reduce fight time, use appropriate tackle and techniques. Avoid using live bait and avoid using artificial lures that create a lot of commotion in the water.

Pls. About
Being debarking devices and safe handling gear for the fish are critical to ensuring the fish's health and safety. Use appropriate gear and techniques to handle the fish safely.

Off-set Hook
You MUST use an off-set circle hook. This type of hook is designed to catch the fish by the jaw, which reduces the risk of injury and stress. It also makes it easier to remove the hook safely.

Keep the fish in the water, boat-side, while safely removing the hook.
If you cannot safely remove the hook, cut the leader as short as possible. Use a dehooking device to safely remove the hook. Do not use a knife or other sharp object to remove the hook.

See Federal Regulations at 50 CFR 622.21(a)(1) for Atlantic highly migratory species. That text makes it clear that it is illegal to remove a fish from the water and hold it out of the water for any purpose, including for a picture.

Marine Ecosystems

Innovative ways to ensure the future sustainability of the recreational fishery for shortfin makos in Victoria

Rogers, P. J. and Bailleut, F.
SARDI Publication No. F2014/00618-1
SARDI Research Report Series No. 872

SARDI Aquatic Sciences
PO Box 120, Heathcote SA 5027
October 2015

The State of Victoria, Department of Economic Development, Jobs, Transport & Resources Recreational Fishing Grants Program (RFGP) Report

PREMIUM CLEAN ENVIRONMENT
VICTORIA State Government
SOUTH South Australia
SARDI South Australia Research Institute

Your fishing licence fees at work

Satellite tagging of shortfin makos

The Victorian Government is using innovative fishing licence fees to help South Australia's fisheries scientists tag shortfin makos and ensure essential research questions:

- How long do they spend in Victorian waters?
- Are they linked to other mako populations in other regions?

In December 2012, four makos ranging in length from 1.2 to 2.8 metres were satellite tagged off Portland with the assistance of volunteer anglers and the Victorian Fish and Game Fishing Club.

The data from this project will be used to estimate mortality of shortfin makos in the Rney and identify important habitats for this iconic shark species.

Data and images will also contribute to a Guide of Practice for the sustainable handling and release of pelagic sharks.

You can follow the movements of tagged makos online at www.sardiresearch.gov.au or visit www.sardiresearch.gov.au for more information about this project.

For more information about the Recreational Fishing Grants Program visit www.rfgp.vic.gov.au

PREMIUM CLEAN ENVIRONMENT
VICTORIA State Government
SOUTH South Australia
SARDI South Australia Research Institute

360° reWater

THE MACHINERY OF MAHO
A NEW PERSPECTIVE
BLUE MARLIN HOTSPOT

SHORTFIN MAKO RESEARCH IN VICTORIA

Shortfin mako research in Victoria

Shortfin makos are a highly migratory species that spend most of their lives in the open ocean. They are known for their speed and agility, and are considered one of the most powerful predators in the world. Research in Victoria aims to understand their behavior, migration patterns, and the impact of fishing pressure on their population.

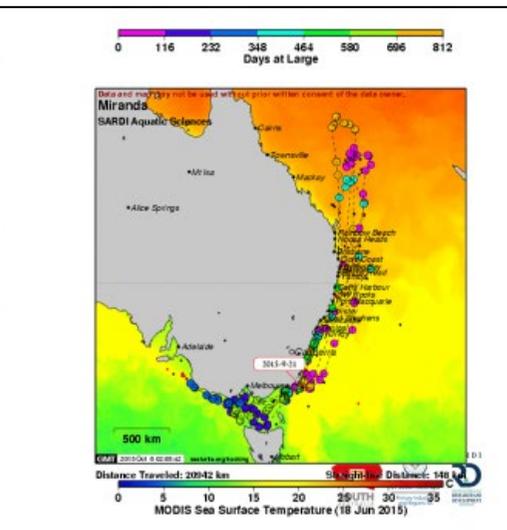
Key findings from the research include:

- Shortfin makos are found in the waters off the coast of Victoria, particularly around the Phillip Island and Portland areas.
- They are highly migratory and can travel long distances between feeding grounds.
- Research has identified important habitats for shortfin makos, including the Rney and the Phillip Island area.

For more information, visit www.sardiresearch.gov.au

Step 5

In some cases, long-handled bolt-cutters can be used to cut the hook shank or turn the hook out of the jaw by twisting in the same direction as the circle of the hook. Care should be taken to not make contact with the eyes of the shark with the bolt-cutters or other tools. If the hook cannot be safely removed, cable cutters can be used to cut the leader as close as possible to the hook without risking being bitten (~0.5-1 m away from the mouth), which is generally from above the head of the shark and behind the line from the tip of the snout to the pectoral fin.



Catch and handling procedures

Read and handle gear and handling procedures must be followed and followed in order of capture, which is also the correct handling sequence and order of capture.

Sharks and rays are protected under the Wildlife Conservation Act 2001 and it is illegal to capture, kill, export, transport, or trade in any shark or ray. It is also illegal to export, transport, or trade in any shark or ray. It is also illegal to export, transport, or trade in any shark or ray.

Sharks and rays are protected under the Wildlife Conservation Act 2001 and it is illegal to capture, kill, export, transport, or trade in any shark or ray.

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Sharks and rays are protected under the Wildlife Conservation Act 2001 and it is illegal to capture, kill, export, transport, or trade in any shark or ray.

Map of the PIRAZA region showing fishing zones and locations.

Recreational fishing guide on appropriate fishing gear and handling techniques of sharks and rays

Handling Procedures

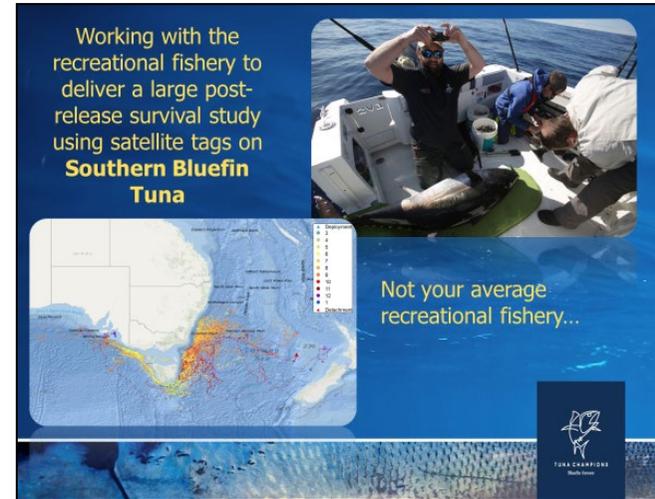
1. When catch and release fishing, handle gently on the vessel and/or on the beach. Do not use a net or other equipment to handle the shark or ray.
2. If the shark or ray is to be kept, handle gently on the vessel and/or on the beach. Do not use a net or other equipment to handle the shark or ray.
3. If the shark or ray is to be kept, handle gently on the vessel and/or on the beach. Do not use a net or other equipment to handle the shark or ray.
4. If the shark or ray is to be kept, handle gently on the vessel and/or on the beach. Do not use a net or other equipment to handle the shark or ray.
5. If the shark or ray is to be kept, handle gently on the vessel and/or on the beach. Do not use a net or other equipment to handle the shark or ray.

Key species needing guidelines are:

Impacting factors and drivers are:

Explanatory variables in PRS studies used to inform development of guidelines include:

Appendix 13: Lessons learned by engaging with recreational fishers. Extension approaches and their relative impacts. What are the challenges and strengths of different media? (Sean Tracey)



Regulation! Enforcement! Legislation!
...or education and a nudge?

Education:
Based on facts provided by science and also learning from the commercial sector

Nudge theory:
Proposes positive reinforcement and indirect suggestions as ways to influence the behaviour and decision making of groups or individuals

Snowball effect:
A process that starts from an initial state of small significance and builds upon itself

TUNA CHAMPIONS
Ready to serve

CATCH
Get geared up to reduce SDT fight times, without net drift

HANDLE
Be prepared for handle with care

RELEASE
Losing got? Check, revive, survive

KEEP
Dispatch humanely, then bleed, gut and chill for the ultimate taste... and no waste

PREPARE
Process, store, portion - make the most of every fish

Who can be a Tuna Champion? Everyone can!

TUNA CHAMPIONS
Ready to serve

TARFish Bulletin
Majestic game species inspires a champion's mentality

Sea Fishing Guide 2018-19

BlueWater
BIGGEST MARLIN IN 45 YEARS

BlueWater
THE INS AND OUTS OF TAGGING TUNA

BlueWater
LIFE OF THE AM

BlueWater
GONE FISHING FOR THE DAY

Beyond words...

TUNA CHAMPIONS IN PRINT

TUNA CHAMPIONS
Ready to serve

IT'S ABOUT WHAT WE DO WITH WHAT WE CATCH

SMALL MOVES MAKE A DIFFERENCE

ABOUT SET
BE A TUNA CHAMPION
AMBASSADORS
SHOP
LINKS
WHO WE ARE
GET IN TOUCH

TUNE UP YOUR TUNA SKILLS

An information hub and a pledge...

www.tunachampions.com.au

TUNA CHAMPIONS
Ready to serve

...to a switched-on community

TUNA CHAMPIONS ON SOCIAL MEDIA

IT'S ABOUT WHAT WE DO WITH WHAT WE CATCH

SMALL MOVES MAKE A DIFFERENCE

...to a switched-on community

TUNA CHAMPIONS ON SOCIAL MEDIA

www.tunachampions.com.au

YOU ARE INVITED TO THE WORLD PREMIERE OF

Life on the Line

AN AL MCGCLASHAN PRODUCTION
BROUGHT TO YOU BY ARFF, ASMA, FDOC AND THE TUNA CHAMPIONS

November 6, 2019 7 pm
IMAX Melbourne Museum
Rathdowne Street, MELBOURNE Victoria
RSVP: Please register here at eventbrite for this FREE event

...to inspire and share what we're learning

TUNA CHAMPION AMBASSADORS

YOU ARE INVITED TO THE WORLD PREMIERE OF

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...to inspire and share what we're learning

TUNA CHAMPION AMBASSADORS

...to the highest level of government

THE TUNA CHAMPION MOVEMENT

“ In support of the Tuna Champion program, all fished weighed in have to be gill-gutted for the month-long **Hooked On Tuna** competition for 2019...

Michael Cottee
Tourism and
Events Manager,
Glenalg Shire
Council, Victoria

“ With the help of the Tuna Champion movement, competitions are moving from whole-fish weigh-ins to gill-gutted. We're seeing a real change in how people bring in the fish, including how much ice they take on their boat.”

John Johnstone, Owner,
Portland Bait & Tackle

Momentum is building...

“ We'll have Tuna Champions stickers on single hook lures throughout the store to encourage those entering the comp to use them.”

Owners Alicia Bolitho
and Shane Hodgens
Tackle World
Port Lincoln

NATIONALS *for Regional Australia* **2019 CAMPAIGN**

POLICY DOCUMENT

In 2015, we prepared a review, *Improve and Engage: Marine Plans in Commonwealth-managed waters*, to look at how we manage our waters. We've been working on it ever since - and we're still here.

On 1 July 2018, we've managed to get 100% of our 14 National Marine Parks across the North, South, East, South-west, Tasmanian East and Central Tasmanian regions across the shelf. That's a big deal. It means we can now manage our waters in a way that's better for the people who live and work in those areas. It also means we can now manage our waters in a way that's better for the environment. It's a big deal.

We also recognise the contribution of the Tasmanian East and Central Tasmanian regions to the success of the campaign. We're proud to have them as part of our team.

We also recognise the contribution of the Tasmanian East and Central Tasmanian regions to the success of the campaign. We're proud to have them as part of our team.

We also recognise the contribution of the Tasmanian East and Central Tasmanian regions to the success of the campaign. We're proud to have them as part of our team.

Local First

TUNA CHAMPIONS

WHO CAN BE A TUNA CHAMPION?

EVERYONE CAN!

Catch. Handle. Keep. Release. Prepare.

Small moves make a difference.




TUNA CHAMPIONS

TUNA CHAMPIONS

Bluefin forever

tunachampions.com.au

Facebook: [tunachampions](https://www.facebook.com/tunachampions)

Instagram: [@bluefin38](https://www.instagram.com/bluefin38)

YouTube: [Tuna Champions](https://www.youtube.com/TunaChampions)

Email: sean.tracey@utas.edu.au

AUSTRALIAN RECREATIONAL FISHING FOUNDATION

UNIVERSITY OF TASMANIA

IMAS INSTITUTE FOR MARINE AND ANTARCTIC STUDIES

FRDC

Tuna Champions is an initiative of the Australian Recreational Fishing Foundation in collaboration with the Institute for Marine and Antarctic Studies at the University of Tasmania. It is funded by the Australian Government through the Fisheries Research and Development Corporation.

Appendix 14: Attitudinal surveys relating to recreational fishing, gear and handling practices (Matt Heard)

Values, Behaviours and the Decision Context for Tournament Anglers

Matthew Heard^{a,d}, Stephen Sutton^b, Paul Rogers^c, Charlie Huvencers^d

^a Department for Environment and Water, Adelaide, Australia

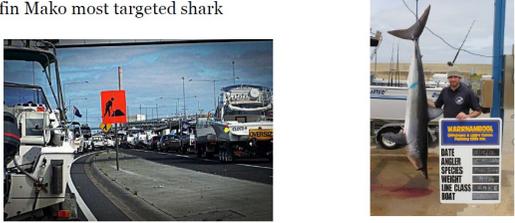
^b Atlantic Salmon Federation, New Brunswick, Canada

^c SARDI- Aquatic Sciences, Adelaide, Australia

^d College of Science and Engineering, Flinders University, Adelaide, Australia

Tournament Anglers

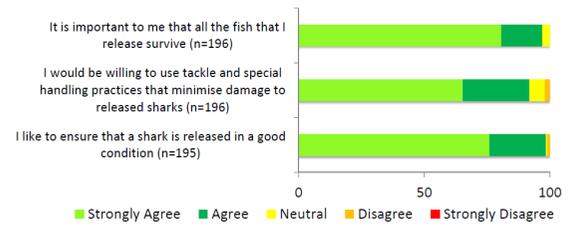
- Small proportion ($\approx 5\%$) of recreational anglers in Australia
- Higher than average effort and catch of pelagic/migratory species
- Shortfin Mako most targeted shark



Survey Design

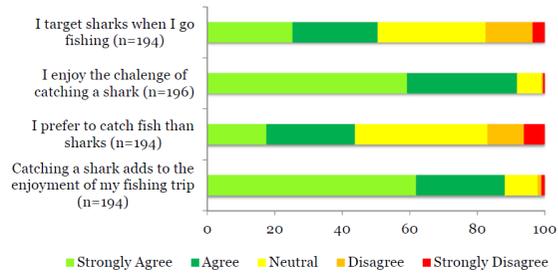
- Angler behaviors
 - Targeting pelagic sharks
 - % caught and released
 - Hook shape and leader material
- Angler values;
 - Importance of releasing sharks in a good condition
 - Value of catching sharks
 - Existence value of sharks
 - Fishery specific

Importance of releasing a shark in a good condition

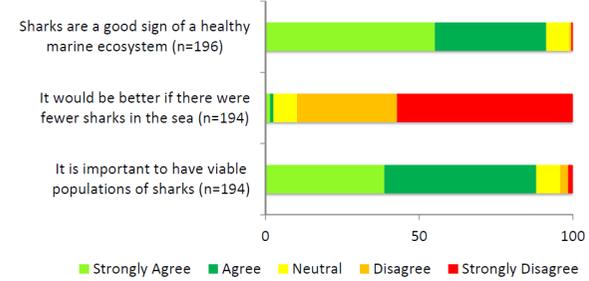


Statement	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
It is important to me that all the fish that I release survive (n=196)	~75%	~25%	0%	0%	0%
I would be willing to use tackle and special handling practices that minimise damage to released sharks (n=196)	~65%	~35%	0%	0%	0%
I like to ensure that a shark is released in a good condition (n=195)	~70%	~30%	0%	0%	0%

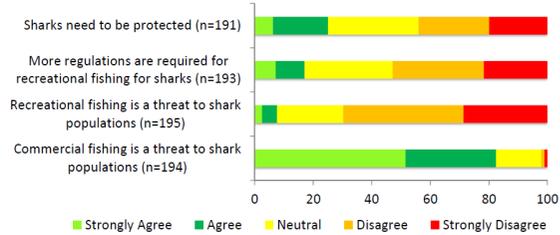
Value of catching a shark



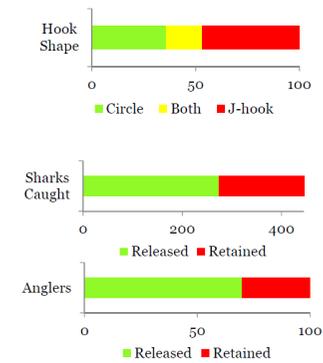
Existence value of sharks



Fishery specific values



Angler Behaviours



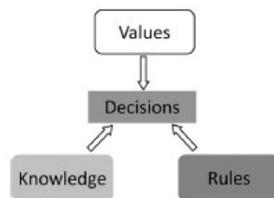
Analysis

- Angler Values;
 - Importance of releasing sharks in a good condition
 - Value of catching sharks
 - Existence value of sharks
 - Fishery specific
 - Angler behaviors
 - Targeting pelagic sharks
 - % caught and released
 - Hook shape and leader material
- Cronbach's α
- Binary LRM's

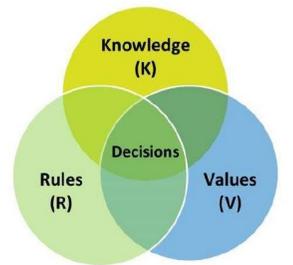
Values and Behaviours

- Decision to target pelagic sharks
 - Value of catching a shark
- Catch and release
 - Existence value of sharks
 - More regulations are required for fishing of sharks
- Hook shape
 - Value of catching a shark
 - Sharks need to be protected
- Leader material
 - Existence value of sharks
 - Sharks need to be protected

Decision Making

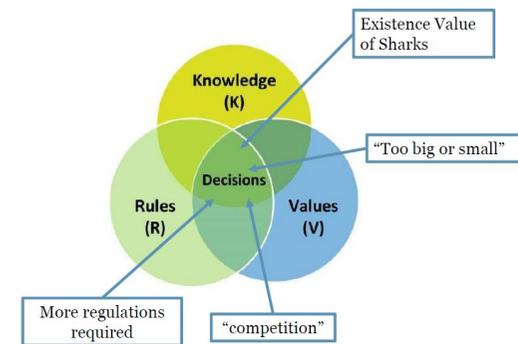


Decision Context

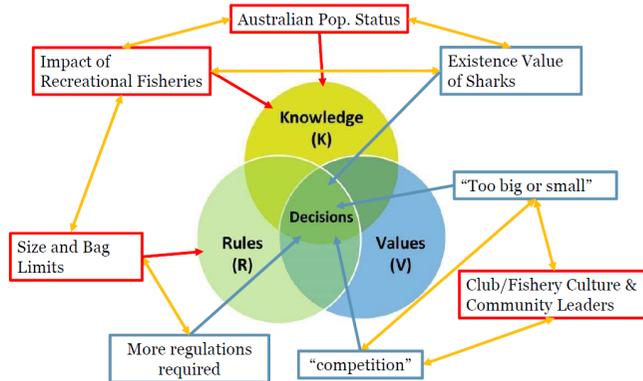


Goddard et.al 2016

Decision - C&R over Retain



Decision - C&R over Retain



Key Conclusions

- Vast majority hold positive values towards sharks
- Positive values are not always reflected in behaviours
- Championing some values and behaviours may provide results
- We need to consider the **decision context** for fishers

Acknowledgements

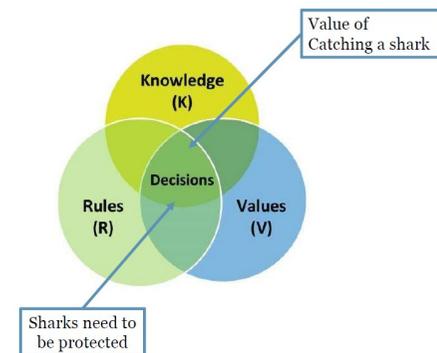
- Funding bodies
 - Save our Seas Foundation
 - Neiser Foundation
- Colleagues from the Southern Shark Ecology Group, SARDI and Flinders University
- Recreational, charter and game fishers



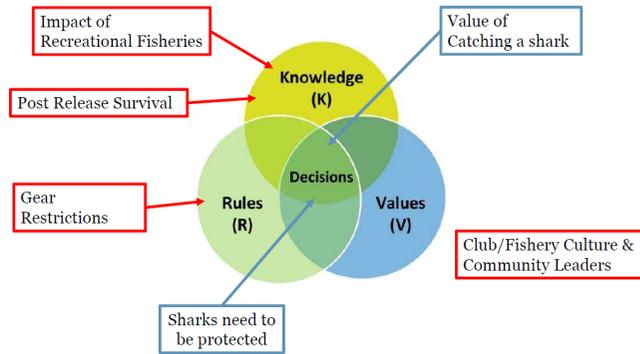
Helping South Australians conserve, sustain and prosper



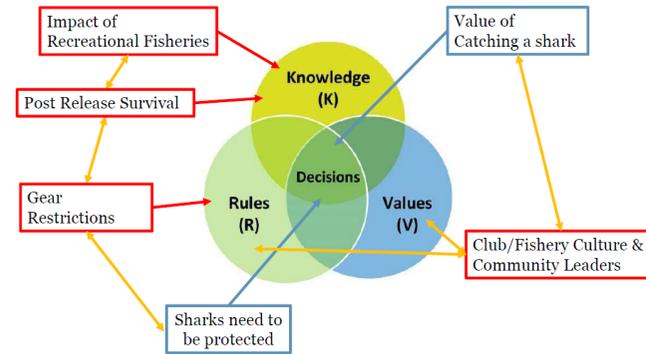
Decision - Hook Type



Decision - Hook Type



Decision - Hook Type



Appendix 15: Behavioural dynamics and attitudinal changes in recreational fisheries. How do we measure and monitor uptake of the information? (Jess Walsh and Mike Burgess)

 **MONASH**
University

Measuring effectiveness of handling practices campaign

Before and after survey

Sean Williamson, Carly Cook, Jessica Walsh, Richard Reina
School of Biological Sciences, Monash University

Aim & Methods

- To determine the effect of the handling practices campaign on recreational fishers.
 - Increased awareness and knowledge
 - Changed behaviour
 - Changed attitudes (?)
- Baseline survey – early next year
- Second survey 6 months after campaign
- Target population: Recreational fishers in Victoria
 - VRFish email list
 - Other methods of distribution to capture other demographic groups of fishers



 **MONASH** University

How frequently do you go fishing for recreational purposes along the coast or at sea?
Think about how many times you went in the last year.

- More than once a week
- At least once a week
- At least once a month
- At least once every 2-3 months
- At least once every 6 months
- At least once every year
- Less than once a year
- I don't go fishing on the coast or at sea

Which locations within Victoria and South Australia have you fished at within the last two years? (Tick all that apply)

- beaches, bays & coastlines
- boats in coastal waters
- boats in offshore waters
- estuaries

- Level of experience
- Frequency of fishing
- Location
- Main target species



Survey questions

- Which species of shark caught, number caught & gear
- Per species:
 - Likelihood of release (and reasons)
 - Confidence in handling to reduce risk of human injury & harm to animal
 - Estimation of post-release survival
 - Knowledge of specific handling practices to minimise harm or death to animal
- Handling practices in general (easy/difficult aspects or species, important factors)
- Attitudes towards others' handling practices
- Usefulness of guidelines & effective methods of communication
- Demographics



If you caught a shark from each species, how likely are you to try and release it?

By release, we mean to let the animal go alive, rather than keeping it or killing it.

	Very likely	Likely	Neither likely nor unlikely	Unlikely	Very unlikely
Mako	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Gummy shark	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Banjo shark	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

What are the main reasons why you would release a shark or ray?

- Not good eating
- Not the correct size (too big or too small)

Feedback

- Focus on
 - species they have caught OR
 - most common or vulnerable species?
- Help developing questions about specific handling practices per species
- Open ended questions or pre-filled
 - Reasons for release
 - Easy/difficult/important aspects of handling
 - Barriers to changing fishers' behaviour
- Questions on attitudes towards handling practices
- Adapt survey to different groups of fishers – beginner vs experienced
- Any other data to collect?

Jessica.Walsh@monash.edu OR Sean.Williamson@monash.edu



VRFISH
VICTORIAN RECREATIONAL FISHING PEAK BODY

Shark and Ray Workshop

*Behavioural dynamics and attitudinal changes in recreational fisheries.
How do we measure and monitor uptake of the information?*

Michael Burgess, Executive Officer

Let's make fishing better, for everyone.

 Your fishing licence fees at work

Who is VRFish

- Independent, apolitical Recreational Fishing Peak body in Victoria
- Funded through our constituents by their Recreational Fishing Licence fees
- Not for profit, Company Limited by Guarantee
- Mission to **Make fishing better, for everyone!**
- Provide advice to Government and other stakeholders
- Advocate for the interests of recreational fishers and be a voice for our fish



OUR PRIORITIES



ACCESS
Fixing our boat ramps and defending your fishing rights to access our waterways.



HABITAT
Improving our vital fish habitats through protection, restoration and enhancement.



WATER
Keeping our rivers flowing and defending recreational and environmental water allocations.



PROMOTE
Promoting fishing in Victoria, creating new and vibrant fisheries and supporting the next generation of fishers.



BEST PRACTICE
Supporting our fishers to take a lead role in the stewardship of our fish and waterways, fish responsibly and promote fish for the future.



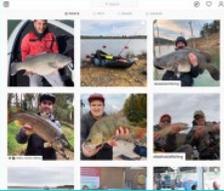
VICTORIAN RECREATIONAL FISHING PEAK BODY



Direct Engagement



Social Media

Website



Traditional Comms




Electronic Marketing




Surveys



- We are in the business of understanding recreational fishers views and level of support on variety of issues
- Surveys are a useful tool to collect broad and diverse views and help us form a consolidated position
- Allows fishers to have their say
- VRFish has access to Recreational Fishing License Holders emails ~ 100,000 (Tick box on license application)
- Depending on the end use and data requirements, surveys are distributed
 - Via all our communication channels
 - Random sample of RFL license holders via email invite



VRFish Ray Survey
Please let us know what you think about proposed changes to ray regulations

VRFish (the Victorian Recreational Fishing Peak Body) is keen to hear your views on the Victorian Government's proposal to reform the recreational take of rays, snakes and gulf-tairfish by:

- prohibiting the take of rays greater than 1.5 metres in width;
- reducing the bag limit for all snakes, greater fish and all other rays to 1 per day; and
- prohibiting the take of rays, snakes and gulf-tairfish from or within 400 metres of any man made structure.

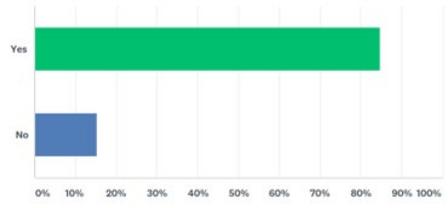
www.vrfish.com.au

#makefishingbetter



Support for VRFish Surveys

Q24 Please indicate if you would like to be involved in future surveys conducted by VRFish?

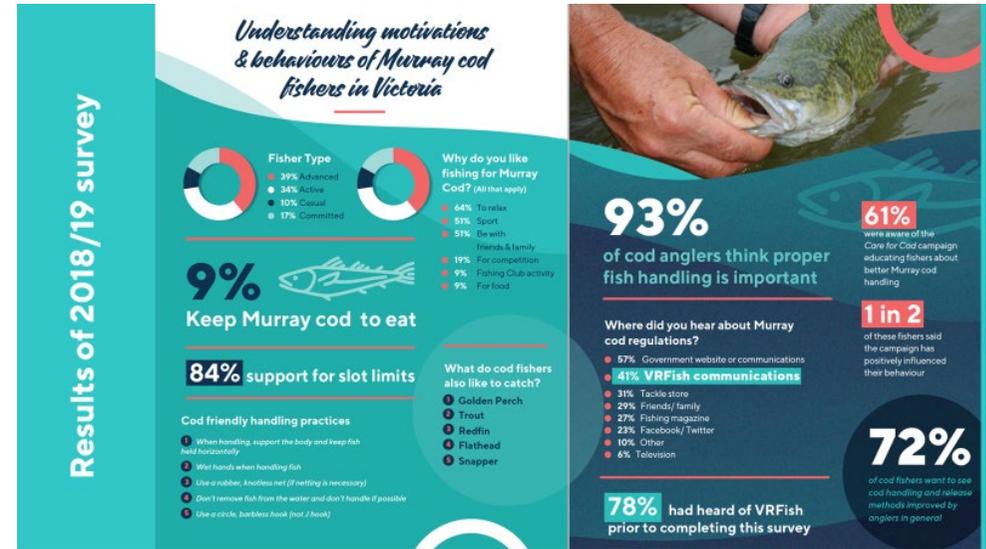
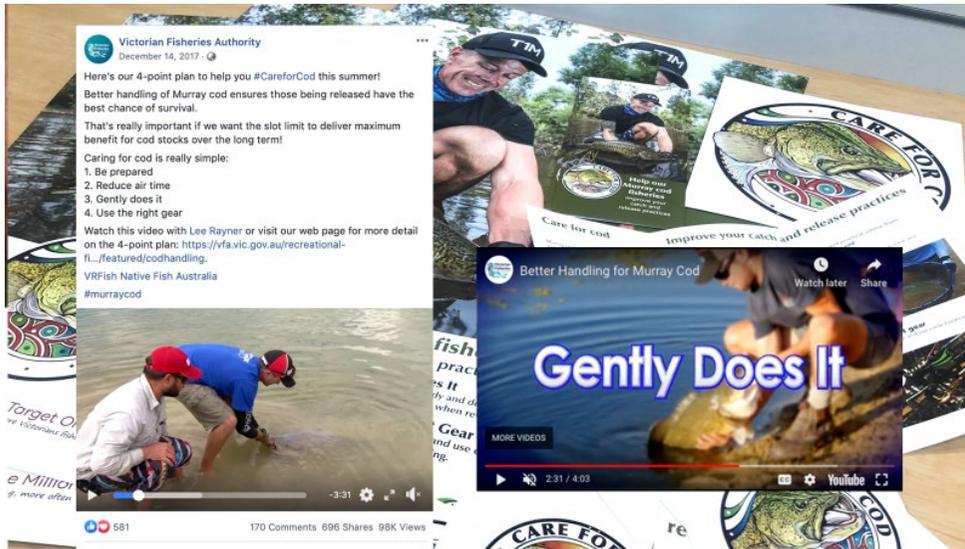


Response	Percentage
Yes	85%
No	15%

www.vrfish.com.au

#makefishingbetter





Care for Cod Campaign (after 12 months)

Campaign influenced all practices	18.72%
Campaign has influenced me in some aspects	10.62%
Campaign has not influenced me	3.71%
Aware of campaign but need more information	5.23%
Aware of campaign but already doing as recommended	22.77%
Not aware of campaign	38.95%

Cod Angler perspectives

"There are too many big fish being put under stress for the sake of a photo"

"With social media I still see fish held up by gills or out of the water for a long time or rolling around on the ground"

"A lot of people aren't educated about it"

"People take the happy snap and through the excitement they forget the practices"

"Many anglers don't know the correct safe way to handle them, I didn't until just 2 years ago when someone posted it on my Murray Cod Victoria, Facebook page"

Suggestions how to improve campaign

- Larger scale communications and more exposure
- Social media
- Information at tackle stores
- Advertising – TV and print
- Send out information in license renewals
- Ambassadors

www.vrfish.com.au

#makefishingbetter



Ray Survey

- 5.5% specifically targeted rays, skates or guitarfish
- 91.4% were unlikely to keep and retain a 'ray'
- 44.4% were not confident how to handle a 'ray' and return it to the water unharmed
- Highest supported strategies:
 1. Signage at 'hotspot' piers and jetties (89.1%)
 2. Education and awareness campaign, including enhanced information in the Recreational Fishing Guide and App (88.2%)
 3. Code of conduct for proper handling and release of rays, skates and guitarfish (80.5%)

www.vrfish.com.au

#makefishingbetter



Fisher perspectives

- *"Unfortunately those currently doing the wrong thing will not change their ways simply because the rules change. Enforcement and education is a better option in my opinion"*
- *"Banjo sharks suck"*
- *"There are so many skates. They damage equipment and can pose a danger to some. Not sure we need to worry about the numbers"*
- *"I have on many occasions put banjo's back into the water from other fisherman. Certainly isn't a great look those around fishing and not fishing".*

www.vrfish.com.au

#makefishingbetter

