TASMANIAN SCALEFISH FISHERY: ECOLOGICAL RISK ASSESSMENT

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Executive Summary

Two recognised ecological risk assessment (ERA) frameworks were used to identify the potential risks of the various fishing activities in the Tasmanian Scalefish Fishery. The first was a qualitative approach suited to fisheries with limited data and is closely aligned with the standard risk assessment approach utilised in occupational health and safety. The second is a semi-quantitative approach that is suited to fisheries for which data relating to catch, discards, post release survival and technical aspects of the fishery are available. For comparative purposes, this latter approach was applied to the gillnet fishery for which such data are available.

The Tasmanian Scalefish Fishery is a complex fishery involving a variety fishing methods. Each gear was therefore addressed separately. In order to perform the ERA, the fishery was segmented into smaller, more manageable components, namely (i) retained species, (ii) non-retained species and (iii) ecosystem impacts. A series of sub-components were defined to describe the fishing and ecological interactions and for each sub-component, hazardous events and their potential impacts were identified.

Risk analysis considers the source of risk, the possible consequences of the risk and how likely it is that the consequences will occur. Consequences and likelihood are assessed against specific objectives, which differ according to the component of the risk assessment. Consequence and likelihood are combined to produce an estimated level of risk associated with the particular hazardous event in question.

The assessment was conducted as a snapshot in time, capturing the risk profile of the fishery in 2012/13. *The risk profile may change over time*.

While little is known of the specific impacts of many of the fisheries/gears that are utilised within the Tasmanian Scalefish Fishery, it was possible to rule out major risks in many cases based on low levels of effort and small catches. In many cases the target, by-product and by-catch species encountered by these gears/fisheries are widely distributed and fished through a small proportion of their range. Fishing methods that did not have risk rankings of greater than low include automatic squid jig; beach seine, dip net, fish trap, hand collection, purse seine, spear, and trolling. Each of these fisheries were also assessed to have negligible to low negative impacts on protected species, the broader ecosystem or the physical habitats in which they operate.

Fisheries/gears with medium risk rankings include Danish seine, drop line, handline, octopus pot and squid jig. Only the gillnet fishery had high risk rankings. In the majority instances medium to high risks were associated with target and/or by-product species. As both Danish seine and gillnet methods can involve considerable levels of by-catch, impacts on discard species were ranked as medium risk, primarily due to limited information about the nature of the discards and impacts on the populations. Target species for which the medium risk assessments were made include Striped Trumpeter, Bastard Trumpeter, Sand Flathead, Southern Calamari and Pale Octopus, high risk assessments were for Banded Morwong and Blue Warehou. Medium or high levels of risk dictate that some level of specific management and/or monitoring is required. It is significant that the majority of these species are subject to specific management arrangements (including limited access, total allowable catches, trip limits and/or seasonal closures) as well as on-going biological monitoring programs.

Although many of the fishing methods involve interactions with protected species, for the most part these present a very low risk. Exceptions included Danish Seine which was assessed to

pose a medium risk to Spotted Handfish, and gillnetting which poses a medium risk to seabirds and a high risk to Maugean Skate. The rankings for the Spotted Handfish and Maugean Skate are based on the fact that these species are listed as endangered, have small population sizes and very restricted distributional ranges.

Apart from Danish seine, none of the methods pose greater than very low risk to benthic biota. For Danish seine activity a medium risk was identified, however, as fishing grounds tend to be very discrete and extensive areas are closed to the method, the ‘foot print‘ of the fishery is small relative to suitable habitat.

A summary of the ERA by fishing method is provided in the following table.

Summary of key ecological risks identified for the Tasmanian scalefish fishery by fishing method.

Where multiple levels of risk applied for a given hazard/impact group, the highest risk category is indicated. NA not applicable

Hazards and impacts		**Automatic squid jig**	**Beach seine**	**Danish seine**	**Dip net**	**Drop line**	**Fish trap**	**Gillnet**	**Hand collection**	**Hand line**	**Octopus pot**	**Purse seine**	**Spear**	**Squid jug**	**Trolling**
Retained spcies															
Target species		Very Low	Low	Low	Low	Medium	Low	High	Negligible	Medium	Medium	Negligible	Very Low	Medium	Low
Non-targeted by-product species		NA	Negligible	Very Low	Negligible	Very Low	Very Low	Medium	NA	Medium	Negligible	Very Low	Negligible	Negligible	Negligible
Bait collection		NA	NA	NA	NA	Very Low	Very Low	NA	NA	Very Low	NA	NA	NA	NA	NA
Non-retained species															
Protected or special species		Negligible	Negligible	Medium	Negligible	Very Low	Negligible	High	NA	Negligible	Negligible	Negligible	NA	Negligible	Negligible
General discard species		NA	Low	Medium	Negligible	Very Low	Negligible	Medium	NA	Negligible	NA	Negligible	NA	Negligible	Negligible
General ecosystem															
Ecosystem structure	*Ghost fishing*	NA	NA	NA	NA	NA	Very Low	Very Low	NA	NA	NA	NA	NA	NA	NA
	Discarding/provisioning	Negligible	Very Low	Very Low	NA	Very Low	NA	Low	NA	Very Low	NA	Very Low	NA	NA	NA
	Habitat/Benthic biota	NA	Very Low	Medium	NA	Negligible	Very Low	Negligible	NA	Negligible	Very Low	Very Low	NA	Negligible	NA
	Community structure	Very Low	Very Low	Low	Very Low	Very Low	Low	Medium	NA	Medium	Low	Very Low	Negligible	Low	Negligible
General environment	*Waste disposal (debris)*	NA	NA	NA	NA	Negligible	NA	Very Low	NA	Low	NA	NA	NA	Negligible	Negligible
	Direct land impacts	NA	Very Low	NA	NA	NA	NA	Negligible	NA	Negligible	NA	NA	Negligible	Negligible	Negligible

Contents

1 Introduction

1.1 Background

The Tasmanian Scalefish Fishery is a multi-gear and multi-species fishery harvesting a range of scalefish, shark and cephalopod species. Following best practice, an Ecological Risk Assessment (ERA) was initiated by the Tasmanian Department of Primary Industries, Parks, Water and Environment (DPIPWE) and the Institute for Marine and Antarctic Studies (IMAS). This report presents the results and findings of the Tasmanian Scalefish Fishery ERA and includes both the commercial and recreational components of the fishery. The assessment was based on existing knowledge and considered environmental risks of all aspects of fishing.

1.2 Workshop

As part of the assessment process a workshop was convened that included representatives from each of the main stakeholder groups. The aim of the ERA workshop was to provide a register of the main potential ecological risks that arise from the Tasmanian Scalefish Fishery. The workshop was held on 31st July 2013 at the IMAS Taroona laboratories.

Workshop participants of the workshop included:

Prof. Gregory Jenkins	University of Melbourne (Chair)
Todd Francis	Commercial fisher
Bill Smedley	Commercial fisher
Stewart Richie	Commercial fisher
Craig Garland	Commercial fisher
Neil Stump	Tasmanian Seafood Industry Council
Mark Nikolai	Tasmanian Association for Recreational Fishing
Dr Jeremy Lyle	IMAS
Dr Jessica André	IMAS
Dr Klaas Hartmann	IMAS
Dr Sean Tracey	IMAS
Dr Justin Bell	IMAS
Dr Neville Barrett	IMAS
David Jarvis	DPIPWE
Frances Seaborn	DPIPWE
Rod Pearn	DPIPWE
Alistair Morton	DPIPWE (Resource Management Conservation)

The present report builds on the outcomes of that workshop.

1.3 Tasmanian Scalefish Fishery

The commercial component of the Tasmanian Scalefish Fishery is a small-scale, coastal fishery generally operating within 3 nm of the coast. It is a multi-gear, mixed–species fishery in which fishers often utilise several types of gear to harvest a diverse range of fish, shark and cephalopod species. Fishing vessels are deployed from many ports and launching sites, are typically small (4–20 m length) and owner-operated, with less than three crew members (Ziegler *et al.*, 2013). Catches and economic returns by individual operators are often low. In the 2012/13 fishing season, the total scalefish catch of the fishery was around 611 tonnes. In addition, about 1260 tonnes of cephalopods (mostly Gould's squid) and 13 tonnes of sharks were landed by Tasmanian operators. In many respects the fishery is dynamic, with fishers adapting and changing their operations in response to changes in fish availability and in response to market requirements and opportunities. As a consequence, only a small proportion of the fleet has specialised in a single activity or targeting a primary species (Ziegler, 2012). For many operators, scalefish represent an adjunct to other fishing activities, for instance rock lobster fishing.

In relation to the recreational fishery, about 22% of all Tasmanians (almost 100 000 persons) participate in recreational fishing (Lyle *et al*., 2014b), the vast majority fishing in saltwater. Line fishing is the main activity undertaken by recreational fishers, followed by pot fishing, dive harvesting and the use of gillnets. A range of other fishing methods were also reported, including the use of spears, seine or bait nets, and hand collection, but these activities are quite minor in significance. Catch and effort for this sector are based on survey results (e.g. Tracey *et al.* 2013; Lyle *et al*., 2014b).

Fishing methods

For this assessment, potential ecological risks posed by each of the main fishing methods used in the Tasmanian Scalefish Fishery have been considered. In the case of gillnets, three categories based on mesh size and primary target species have been recognised.

Table 1 lists the various gear types and the primary retained species (adapted from Ziegler *et al.*, 2013). Each gear is described in more detailed in the relevant section.

Table 1. Gear types used in the Tasmanian Scalefish Fishery and their target/by-product species.

Gear type		Retained species
Automated jig		Gould's Squid
Beach seine		Australian Salmon, Garfish, Jack Mackerel, Yelloweye Mullet, mixed species
Danish seine		Flathead, Whiting
Dip net		Garfish, Southern Calamari
Drop line		Striped Trumpeter, Barracouta, mixed species
Fish trap		Wrasse
Gillnets	Banded morwong net	Banded Morwong, Longsnout Boarfish, Bastard Trumpeter
	Graball net	Blue Warehou, Bastard Trumpeter, Australian Salmon, Flounder, Mullet, mixed species, Atlantic Salmon, Ocean Trout
	Small mesh net/ Mullet net	Blue Warehou, Mullet, Australian Salmon, Pike, King George Whiting
Hand collection		Octopus
Hand line		Wrasse, Striped Trumpeter, Flathead, mixed species
Octopus pot		Octopus
Purse seine		Jack Mackerel, Garfish, Southern Calamari, Australian Salmon
Spear		Southern Calamari, Flounder, octopus
Squid jig		Southern Calamari, Gould's Squid
Troll		Barracouta, Australian Salmon

Access to the fishery

The commercial fishery is accessed through a licensing system. Owners of Scalefish fishing licence categories FLA, FLB or FLC can participate in the fishery, the latter being non-transferable. In addition to the general licence categories which allow the use of graballs (gillnet), hooks and fish traps, there are also gear specific licence categories, including automatic squid jig, beach seine, Danish seine, small mesh gillnet and purse seine licences. Species specific licences also apply for Australian Salmon, Banded Morwong, Mackerel, Southern Calamari and Wrasse (live). Fishers with Rock Lobster licences (but without an FLA or FLB) are also allowed to take scalefish. Licences are not required for recreational fishers using rod and reel; however are required to use gillnets, beach seines and set lines (i.e. droplines, longlines).

Retained species

In 2012/13, 124 species/groups were reported in the Tasmanian Catch Return logbooks. However, just 20 species constituted 99% of the total catch (Table 2).

Table 2. Species/Groups making up the majority of the catch of the Tasmanian Scalefish Fishery in 2012/13.

Species/Group	Catch (t)	% total
Gould's Squid	1071.8	56.8
Australian Salmon	331.3	17.6
Octopus	124.8	6.6
Southern Calamari	63.9	3.4
Southern Garfish	51.5	2.7
Bluethroat Wrasse	49.4	2.6
Banded Morwong	37.9	2.0
Tiger Flathead	31.4	1.7
School Whiting	16.5	0.9
Striped Trumpeter	13.0	0.7
Purple Wrasse	12.8	0.7
Bastard Trumpeter	9.4	0.5
Mullet	9.2	0.5
Blue Warehou	8.5	0.5
Gummy Shark	7.9	0.4
Ocean Perch	7.6	0.4
Snook	7.1	0.4
Sand Flathead	6.2	0.3
Silver Trevally	5.4	0.3
Leatherjacket	2.4	0.1

1.4 Physical environment

The Tasmanian Scalefish Fishery interacts with numerous habitats, including seagrass beds, sandy substrate and rocky reefs (Figure 1). These interactions vary in nature depending on the type of gear being deployed and the substrate on which the activity is occurring. Thus, the nature of these interactions are assessed individually for each fishing gear.

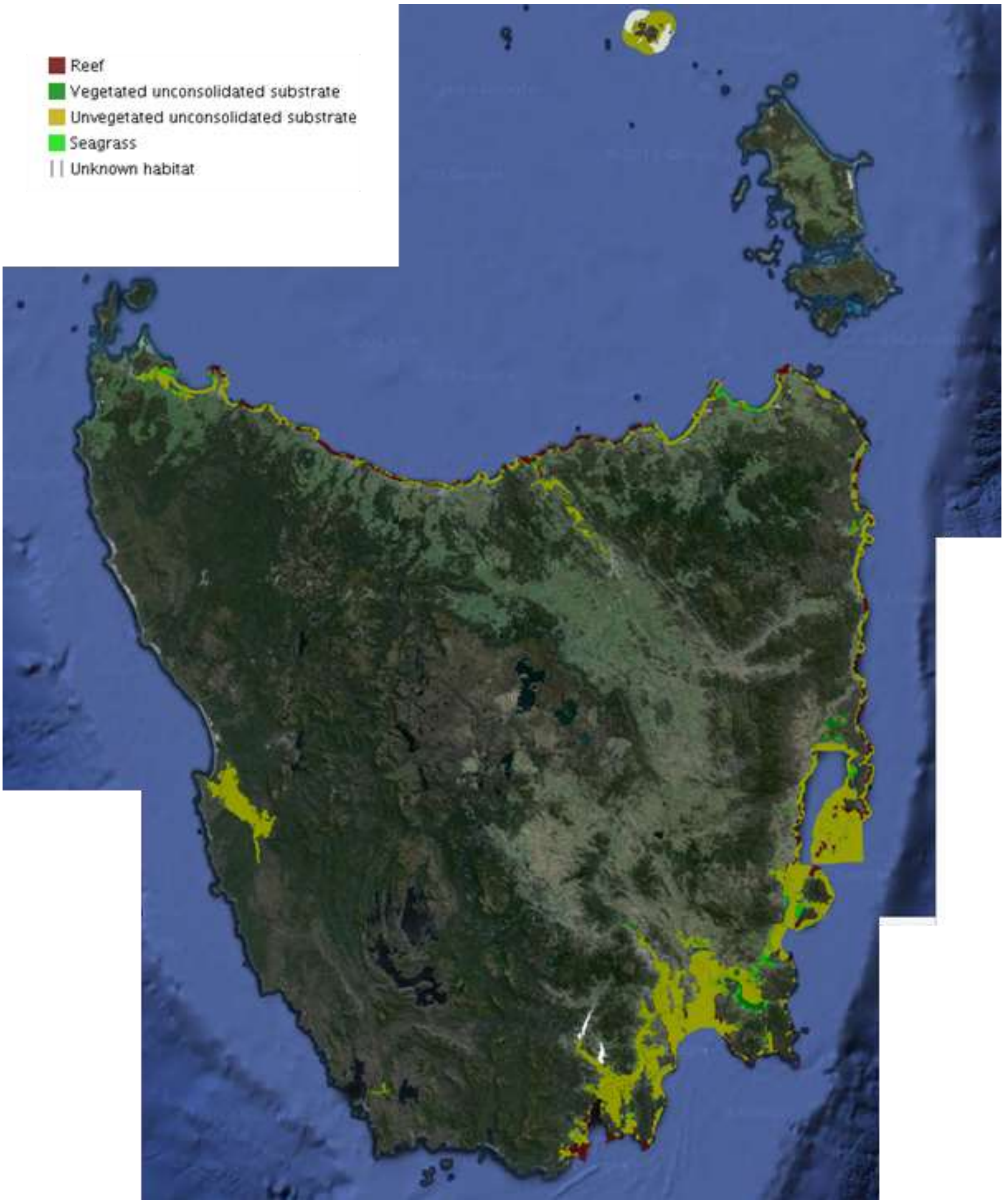

Figure 1: Benthic habitat of Tasmanian coastal waters

2 Objectives

The aim of this report was to undertake a formal Ecological Risk Assessment (ERA) for the Effects of Fishing on target, by-product and by-catch species as well as the habitats with which the Tasmanian Scalefish Fishery interact. This assessment was carried out separately for each fishing gear type and is primarily focussed on the commercial fishery.

3 Ecological Risk Assessment methods

Two recognised ERA frameworks were used to identify the potential risks of the various fishing activities in the Tasmanian Scalefish Fishery. The first is designed for fisheries for which limited data are available and is closely aligned with the standard risk assessment approach utilised in occupational health and safety situations. The second is a semi-quantitative approach, which is well suited to fisheries for which a reasonable quantity of data is available relating to catch, discards, post release survival and technical aspects of the fishery.

3.1 Qualitative risk assessment framework

The first approach utilised herein was modified from the national Ecologically Sustainable Development reporting framework for Australian fisheries (Fletcher *et al.*, 2002) and the FAO guide to implementing an Ecosystem Approach for fisheries (FAO, 2011). This approach was applied to all fishing sectors.

The key stages of this approach involve:

- Establishing the context
- Hazards and impact identification
- Risk analysis

3.1.1 Context

The following key features define the context of the ERA:

- The fishery being studied is the Tasmanian Scalefish Fishery.
- The assessment focuses on the main ecological issues across the fishery but does not include processing activities associated with the fishery.
- The assessment does not focus on the resource assessment and management, these are covered annually and reported in the Scalefish Fishery Assessment report.
- The assessment does not focus on community (indigenous or non-indigenous) well-being, national socio-economic well-being, governance or the impact of the broader environment on the fishery.
- The assessment is conducted as a snapshot in time, capturing the risk profile of the fishery in 2012/13. *The risk profile may change over time*.

3.1.2 Hazards and impact identification

The Tasmanian Scalefish Fishery is a complex fishery involving a variety fishing methods. Each gear was therefore addressed separately. In order to perform the ERA, the fishery was segmented into smaller, more manageable components according to Fletcher *et al*. (2002) and FAO (2011). For each gear, three components (Retained species, Non-retained species and Ecosystem impacts) and a series of sub-components were defined to describe the fishing and ecological interactions (details in Figure 2). For each sub-component, hazardous events and their potential impacts were identified (i.e. fishing activities that could result in a negative ecological impact). An example is provided in Table 3.

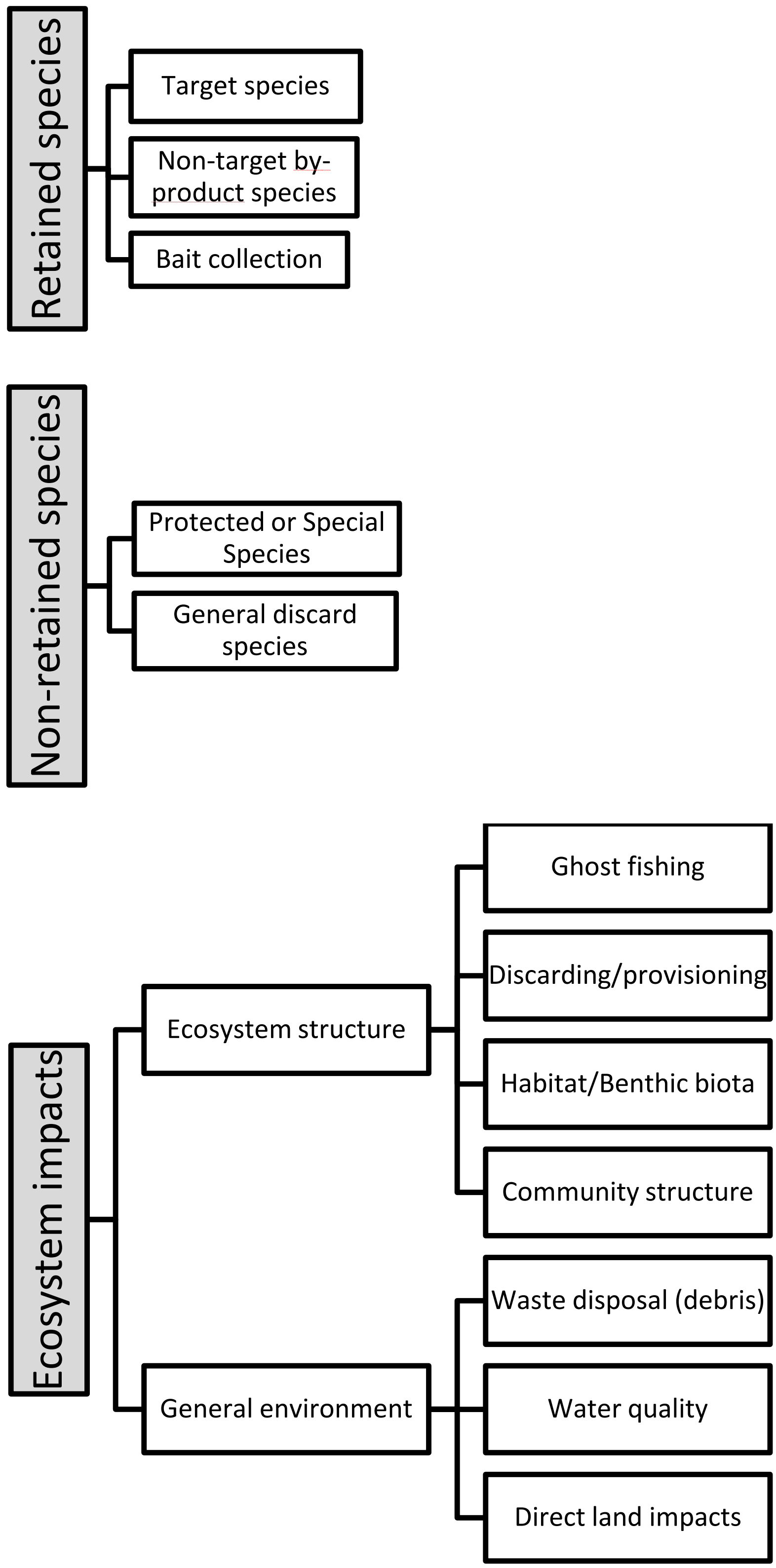

Figure 2. Component trees showing the three main components (grey) and sub-components (white) for the Ecological Risk Assessment of the Tasmanian Scalefish Fishery.

Table 3. Example of risk analysis for Automatic squid jig, showing one of the identified hazardous event and its potential impact, the assigned consequence and likelihood levels, and the final risk ranking for the hazardous event.

Automatic squid jig		**Hazardous event/Potential impacts**	**Consequence**	**Likelihood**	**Risk ranking**	**Justification**
General ecosystem						
Ecosystem structure	*Community structure*	Capture of Gould's Squid/ Disruption to trophic interactions	1	2	Very Low	Cephalopods are important in the food chain (both as predator and prey). Tasmania is a small part of the fishery compared to Commonwealth. Squid have highly variable abundance in Tasmanian waters from one year to the next. A shift may be hard to measure. It is unlikely that the level of fishing pressure imparted by Tasmanian vessels would adversely affect the Gould's Squid stock and the single, southern Australian stock has been assessed as sustainable (Flood *et al*. 2014)

3.1.3 Risk Analysis

Risk analysis considers the source of risk, the possible consequences of the risk and how likely it is that the consequences will occur. Consequences and likelihood are assessed against specific objectives, which differ according to the component of the risk assessment (i.e. retained species, non-retained species, ecosystem impacts, see Table 4). Consequence and likelihood are combined to produce an estimated level of risk associated with the particular hazardous event in question.

Table 4. Components of the risk assessment and objectives against which consequences and likelihood are assessed

Components/sub-components		Objectives
Retained species		
Target species		To maintain spawning biomass at least above the level where it is likely not to result in recruitment overfishing.
Non-target by-product species		
Bait collection		To maintain appropriate levels of biomass of bait species to minimize any significant impact on their dynamics and the broader ecosystem.
Non-retained species		
Protected /Special species		To keep the level of capture of this species at acceptable levels.
General discard species		To maintain appropriate levels of biomass of by-catch species to minimize any significant impact on their dynamics and the broader ecosystem.
General ecosystem		
Ecosystem structure	*Ghost fishing*	To maintain any impact on the wider ecosystem by fishing to be within acceptable levels.
	Discarding/provisioning	
	Habitat/Benthic biota	To maintain the spatial extent of habitat impacts from the fishing activity to a comparatively small percentage of the habitat/community.
	Community structure	To maintain any impact on the wider ecosystem by fishing to be within acceptable levels.
General environment	*Waste disposal(debris)*	
	Water quality	
	Direct land impacts	

Assignment of consequence level

In assigning the consequence level to each hazardous event, the following factors were taken into consideration:

- present state of safeguards and controls
- existing gear characteristics
- existing physical and working environment conditions
- existing procedures and management arrangements
- existing levels of experience and skills of personnel

Table 5 describes the five consequence levels (from Negligible to Extreme) used in the assessment of the Tasmanian Scalefish Fishery. The choice of consequence levels was based on what was acceptable to meet the objective for the specific component of the risk assessment. Details of the objectives and specific consequence tables for each component of the risk assessment can be found in Appendix 1.

Table 5. General consequence table with definitions of the various consequence levels.

Consequence Level	Description
0. Negligible	Very insignificant impacts. Unlikely to be even measurable at the scale of the stock/ecosystem/community against natural background variability.
1. Minor	Minimal 'impacts' that are highly acceptable and do not impact on meeting objective
2. Moderate	Maximum acceptable level of 'impact' and still meeting objective
3. Major	Above acceptable limit. Wide and long-term negative impacts and the objective is not being met
4. Extreme	Well above acceptable limit. Very serious, likely to require long restoration time to undo with the objective not being met by a considerable margin

Assignment of likelihood level

The likelihood of a particular hazardous event was defined as the likelihood that, given a particular set of fishing management arrangements, the hazardous event would result in the potential impact (from an accumulation of small events or from a single event). Table 6 describes the four likelihood levels (from Remote to Likely) used in the assessment of the Tasmanian Scalefish Fishery.

Table 6. Definitions for the likelihood levels.

Likelihood Level	Description
1. Remote	Insignificant probability of the particular consequence occurring (< 2% probability)
2. Unlikely	Some evidence that the particular consequence level could occur (2 – 10%)
3. Possible	The consequence level may occur but this is still not likely (10-40%)
4. Likely	The particular consequence level is expected to occur (> 40%)

Using the same example as previously presented in Table 3, the following was considered:

> *What is the likelihood that, at the current rate of exploitation and with the current management arrangements in place, the capture of Gould's squid by automatic squid jig would result in the impact of a disruption of trophic interactions in the ecosystem?*

In this specific example, a likelihood level of 2 (Unlikely: Some evidence that it could occur) was assigned.

Risk evaluation

The overall level of risk is based on the perceived consequence (C) multiplied by the perceived likelihood (L). Table 7 illustrates the risk assessment matrix used to determine the level of risk associated with each identified hazardous event. Table 8 illustrates the risk levels and their likely management responses. It should be noted that the assignment of a Medium or High risk level can result from taking the precautionary principle and may reflect a lack of information or evidence regarding the potential impact of a particular hazardous event.

Table 7. Risk matrix showing the risk scores (calculated from the consequence and likelihood levels) and their associated colour.

Likelihood (L) Level		Consequence (C) Level				
		Negligible	**Minor**	**Moderate**	**Major**	**Extreme**
		0	**1**	**2**	**3**	**4**
Remote	**1**	0	1	2	3	4
Unlikely	**2**	0	2	4	6	8
Possible	**3**	0	3	6	9	12
Likely	**4**	0	4	8	12	16

Table 8. Definition of the risk level and ranking colours, and the likely management response.

Risk Level	Risk Categories	Risk Scores (C x L)	Likely Management Response
Negligible		0	No management response required. Risks are non-existent or negligible.
Very Low	1	1 to 2	No management response required. Risks are broadly acceptable and are managed by current procedures.
Low		3 to 4	No specific management required. Risks are broadly acceptable and are managed by current procedures.
Medium	2	6 to 8	Specific management and/or monitoring are needed.
High	3	9 to 16	Increased management activities are needed.

3.2 Semi-quantitative risk assessment framework

A thorough description of the methods for this approach is provided in Hobday *et al*. (2011) and example assessments can be found on a variety of Australian Commonwealth fisheries on the AFMA website. This framework has also been applied to the Tasmanian gillnet fishery as part of a recently completed FRDC project for which a large quantity of data are available to supplement the analysis (Lyle *et al*. 2014a). This alternative assessment approach has been used to inform the qualitative assessment for gillnetting reported herein and, for comparative purposes, summary results from Lyle *et al*., (2014a) are presented as Appendix 2.

The assessment is carried out using a multi-tiered system involving:

- Scoping
- Scale, intensity, consequence analysis
- Productivity, susceptibility analysis
- A fully quantitative assessment

3.2.1 Scoping

Scoping provides the background information relating to the fishery and sub-fisheries that enable researchers, managers and stakeholders to agree on the scope of the fishery(s) and allows irrelevant components to be identified and removed from further analysis.

3.2.2 Scale, intensity, consequence analysis (SICA)

SICA is a qualitative screening process that further removes low risk activities while identifying those that require further, more detailed, investigation.

3.2.3 Productivity, susceptibility analysis (PSA)

PSA is a semi-quantitative process that analyses available biological and ecological attributes of each component. Where information is not available expert opinion can be sought to provide conservative estimates. Where there is no published information and expert opinion cannot make a reliable judgement a precautionary approach to uncertainty is taken. Thus, PSA analysis is more likely to result in false positives than in false negatives and the list of high risk species should not be interpreted as all being at high risk from fishing, rather that these are species that require a more detailed exploration before they can be classified as low risk (Walker *et al.*, 2007a).

3.2.4 Quantitative assessment

In fisheries science this is typically a formal stock assessment. This is a labour intensive process and requires detailed fishery, ecological and biological data. For the gillnet study, scoping, SICA and PSA analyses were undertaken to identify species for which gillnetting represents a potential high risk, providing insight into where further research and/or management responses should be directed.

4 Ecological Risk Assessments

4.1 Automatic squid jig

Gear description

Automatic squid jigging is carried out in Tasmanian waters to catch Gould's Squid. Jigging occurs at night and exploits the squids' strong attraction to light. Powerful lights are positioned along the vessel to attract the squid, which congregate next to the vessel in the shadowed area (Figure 3) and dart into the lit area to feed. A line with several barbless jigs is used on an elliptical spool, which is either automatic or hand operated. The rotation of the spool as the line is wound creates the jigging action. Squid caught on the lures are hauled over a roller, fall onto a wire mesh screen at the side of the vessel and slide onto the deck. Modern squid jigging machines can be controlled by a computer located in the vessel's wheelhouse, which can vary the fishing speed and pattern between machines.

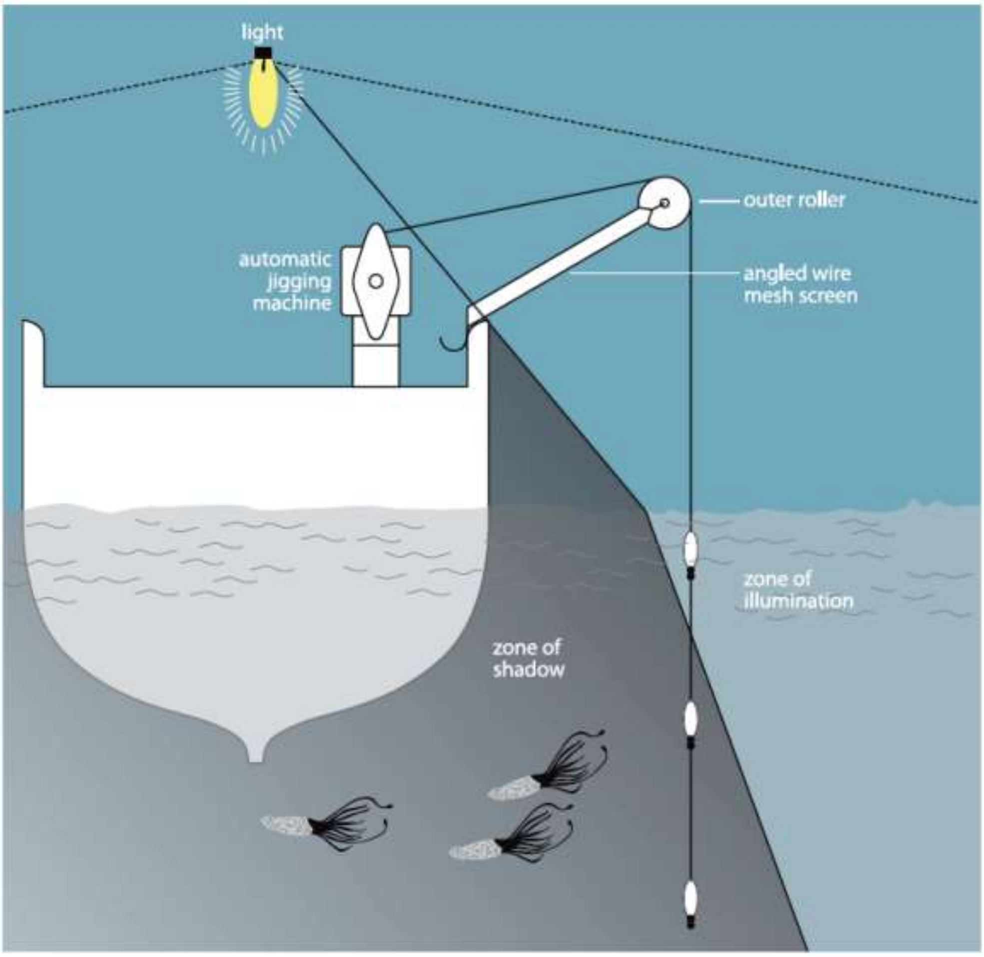

Figure 3. Automatic squid jigging gear (extracted from Flood et al. 2012)

Risk assessment

Automatic squid jigging was considered a low risk activity with regards to retained species, non-retained species and the general environment (Table 9).

Table 9. Ecological risks identified for automatic squid jigging

Automatic squid jig	Hazardous event/ Potential impacts	Consequence	Likelihood	Risk ranking	Justification
Retained species					
Target species	Capture of Gould's Squid/ Potential change to population	1	1	Very Low	Average annual catch of 145.7 tonnes between 2000 and 2012. Short-lived species, lightly fished. The stock (which is shared with Commonwealth) is classified as sustainable (Flood *et al*., 2014). Moreover, the fishery has limited entry and effort (currently around 18 licences).
Non-retained species					
Protected /Special species	Short-tailed Shearwater attracted to light at night/ Potential change to population	0	1	Negligible	Fishing operates at night so few seabirds are attracted. Birds can get disorientated by lights as they return to their nest at dusk and can land on the deck. Birds are not however caught in the gear and there are generally no discards to entice birds to stay in the vicinity of the vessel. Some studies suggest that artificial light can considerably increase mortality in migrating birds and can also cause direct mortality due to bird strikes (reviewed by (Montevecchi, 2006)). The impact on Short-tailed Shearwater is unknown but it appears that fledglings are the only life stage that is vulnerable, particularly if there is a very large amount of light pollution (Rodríguez et al., 2014). This is not the case as few vessels participate in this fishery. Additionally, the Short-tailed Shearwater population is large and with a wide distribution so any impact is likely to be minimal at the population level.

		Fairy Prion attracted to light at night/ Potential change to population	0	1	Negligible	Fishing operates at night so few seabirds are attracted. Birds can get disorientated by lights as they return to their nest at dusk and can land on the deck. Birds are not however caught in the gear and there is no discards to entice birds to stay in the vicinity of the vessel. The Fairy Prion population is large and with a wide distribution so any impact is likely to be minimal at the population level.
General ecosystem						
Ecosystem structure	*Discarding/Provisioning*	Seals feeding on squid/Habituation of seals	0	1	Negligible	Highly seasonal and opportunistic behaviour, which is not expected to result in habituation.
		Sharks feeding on squid/Habituation of sharks	0	1	Negligible	Highly seasonal and opportunistic behaviour, which is not expected to result in habituation.
	Community structure	Capture of Gould's Squid/ Disruption to trophic interactions	1	2	Very Low	Cephalopods are important in the food chain (both as predators and prey). In Tasmanian coastal waters squid exhibit high natural variability in abundance. The ecosystem is thus expected to be resilient to such variability and fishery removals at current levels are not expected to impact significantly on trophic function.

4.2 Beach seine

Gear description

Beach seines may have a loose section of netting acting as the bunt area for retaining fish, or may have a bag at one end of the net or in the centre. Beach seine nets can be set around a sighted school of fish, or in an area where fish are known to congregate. The net is set from a dinghy (near-shore operation) or can be walked out in shallow water (shore-based operation), with the first length of rope being set perpendicular to the shore, the net set parallel to the shore, and the second rope set back to the shore (Figure 4). The ropes are then hauled onto the beach evenly, by hand or four-wheel drive vehicle, herding the fish into the net. Hauling continues until the net and fish are dragged onto the shore, or the fish are concentrated in the bag. Beach seine is a restricted commercial fishery with 25 beach seine A and 23 beach seine B licences, although few are currently active. Recreational fishers are permitted the use of a beach seine of up to 50 m and there are spatial restrictions.

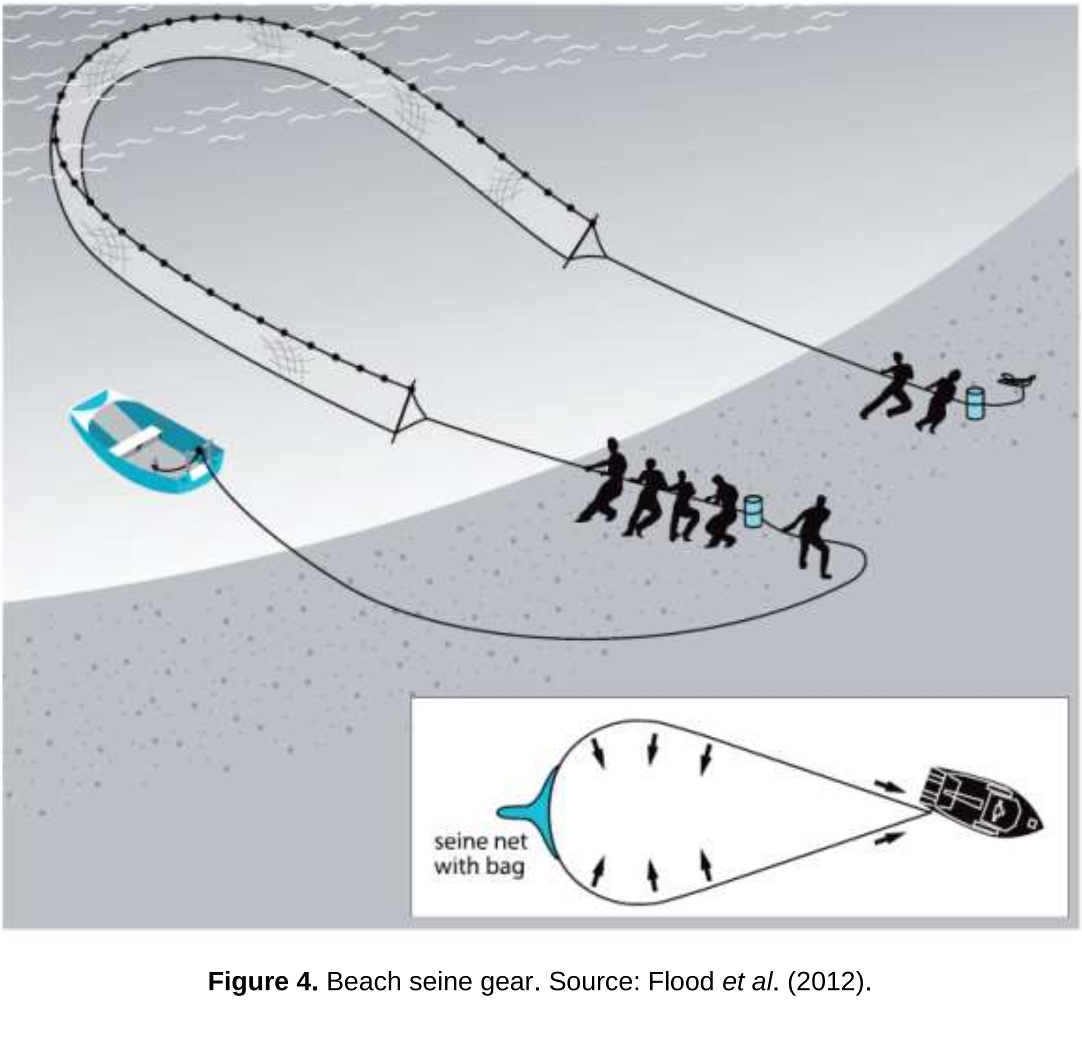

Figure 4. Beach seine gear. Source: Flood *et al*. (2012).

Risk assessment

Beach seining was considered a low risk activity with regards to retained species, non-retained species and the general ecosystem (Table 10).

Table 10. Ecological risks identified for beach seine. Beach seine operations have been split into near-shore and shore-based operations when warranted.

Beach seine	Hazardous event and potential impacts	Consequence	Likelihood	Risk ranking	Justification
Retained species					
Target species	Capture of Australian Salmon/ Potential change to population	1	2	Very Low	Average annual catch of 289 tonnes between 2000 and 2012. Australian Salmon population is large and classified as sustainable (Flood *et al*. 2014). Catch levels unlikely to lead to changes to the population.
	Capture of Southern Garfish/ Potential change to population	2	2	Low	Average annual catch of 42 tonnes between 2000 and 2012. Population age structure changed as a result of fishing pressure (reduction of older age classes) in the past but the population appears to be recovering. Current catch levels unlikely to result in further substantial changes to the population.
	Capture of Jack Mackerel/ Potential change to population	0	1	Negligible	Average annual catch of 9 tonnes between 2000 and 2012. Species exists outside the range of the fishery and stock classified as sustainable (Flood *et al*. 2014). Current catches are negligible due to the present lack of a fishery for the species in Tasmania.
	Capture of Mullet/ change to population	0	1	Negligible	Average annual catch of 3.5 tonnes between 2000 and 2012. An additional 7.1 tonnes were captured by the recreational sector, although only a small proportion by recreational beach seine. Mullet are widespread and not targeted in estuarine habitats, other than by anglers, where they are common. Catch levels unlikely to lead to changes to the population.

Non-target by-product species		Capture of mixed fish species/ Potential change to populations	0	1	Negligible	Low catch level of by-product species, average annual catch 5 tonnes of mixed species between 2000 and 2012, none exceeding 500 kg. Catches at these levels are not expected to negatively impact stocks.
Non-retained species						
Protected /Special species		Dolphins becoming entangled in net/ Potential change to population	0	1	Negligible	Dolphins are sometimes attracted to the fishing activity (especially in near-shore operations). Dolphins can get encircled within the net but rarely become entangled. Animals are released alive.
		Seals becoming entangled in net/ Potential change to population	0	1	Negligible	Seals are regularly attracted to the fishing operations and may become encircled but rarely entangled in the nets. Animals are released alive.
General discard species		Capture of mixed fish species/ Potential change to populations	1	3	Low	Some fish do get meshed/gilled occasionally but the gear is designed to herd fish and avoid this occurrence wherever possible. Bycatch is usually alive and released while the net is still in the water.
General ecosystem						
Ecosystem structure	*Discarding/provisioning*	Discarded fish attracting wildlife/changes to feeding behaviour leading to habituation	1	2	Very Low	Fish are released alive but seabirds and seals are attracted to the activity and do feed on discards. The scale of operation is however very small.
	Habitat/Benthic biota	Net dragging on the seafloor/Changes to seagrass habitat and benthic composition	1	2	Very Low	Impacts depends on the net construction (heavily weighted nets may lead to seagrass being torn free of the substrate). A study in South Australia (Fowler, 2005) found the effect of beach seine on seagrass beds to be negligible in the long term. Moreover, the inshore areas suitable for beach seine are restricted so the impact, if any, will be localised. The impact of beach seine is deemed small compared to other impacts affecting seagrass such as storms, pollution or anchoring in seagrass areas.

	Community structure	Capture of key species/ Changes to the trophic structure of ecosystem	1	2	Very Low	Shore-based operations: Target Southern Garfish with Southern Calamari as a by-product. Southern Calamari is both an important predator feeding on fish, crustaceans and other cephalopods, and an important prey species for fish, marine mammals and sea birds (Boyle and Rodhouse, 2005). However the level of Southern Calamari by-catch is small (annual average of 3.4 tonnes between 2000 and 2012), so that little change to the trophic structure is expected.
			1	2	Very Low	Near-shore operations: Target Australian Salmon, are a very common inshore predatory fish so likely play an important role in near-shore ecosystems. The species is highly mobile so it is difficult to estimate how much impact the removing of fish is having on the rest of the ecosystem. However, the eastern Australian Salmon stock is not overfished (Flood *et al.*, 2014) so little change to the trophic structure is expected.
General environment	*Direct land impacts*	Launching of vessel from beach/Degradation of foreshore	1	1	Very Low	Shore-based operations: Only one commercial operator is known to use beach access. There are many regulations in place regarding beach access in Tasmania, which is currently restricted to public access points only.

4.3 Danish seine

Gear description

Danish seining is similar to a beach seine but is used in near shore and coastal waters depths of up to 150 m. The nets are negatively buoyant, and the lengths of rope used off each wing can be more than 40 times the length of the actual net. The principle of setting and hauling a Danish seine is similar to that used for beach seining, but the process is undertaken from a boat rather than from the shore. The gear is set in a pear shape, with the net at the base of the pear and the ropes making up the sides (Figure 5). Retrieval of the net uses a combination of the forward movement of the vessel to close the net and hauling the ropes using a powered winch. At the time of this report, six licenses were issued but only four were active.

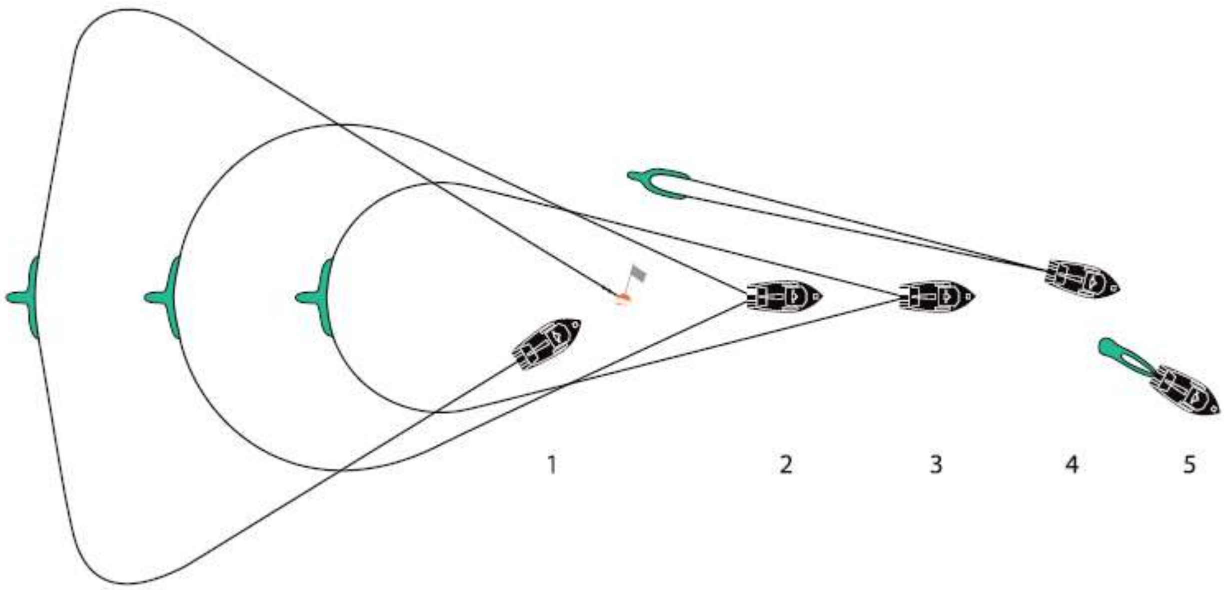

Figure 5. Danish seine gear (extracted from Flood et al. 2012)

Risk Assessment

Although Danish seining was considered a low risk activity with regards to retained species, community structure and provisioning, it was considered a medium risk activity with regards to non-retained species (specifically the critically endangered Spotted Handfish and general discard species) and the general ecosystem (i.e. benthic biota) (Table 11).

Table 11. Ecological risks identified for Danish seine

Danish seine	Hazardous event and potential impacts	Consequence	Likelihood	Risk ranking	Justification
Retained species					
Target species	Capture of Tiger Flathead/ Potential change to population	2	2	Low	Average annual catch of 46.9 tonnes between 2000 and 2012 taken from a relatively small area in the south east of Tasmania. While there has been evidence of a changing population, Tiger Flathead belong to a large, well-mixed population that migrates out of Tasmanian waters during the cooler months and the population as a whole is considered sustainably fished (Flood *et al*. 2014).
	Capture of Whiting/ Potential change to population	2	2	Low	Average annual catch of 37.1 tonnes between 2000 and 2012 taken from a relatively small area in the south east of Tasmania. The Tasmanian School Whiting stock is distinct from that of mainland Australia but the species is short-lived, fast growing and highly productive. Currently only one operator targets School Whiting.
Non-target by-product species	Capture of Sharks/ Potential change to population	1	1	Very Low	Mostly Elephantfish in summer, average annual catch of 0.9 tonnes between 2000 and 2012. Elephantfish are a relatively productive species and this level of catch is minimal compared to that of the Southern Shark Fishery.
	Capture of mixed fish/ Potential change to populations	1	1	Very Low	There are few other by-product species (average of 3 t per annum over last five years) captured during Danish seining in Tasmania and none of these species are captured at levels expected to negatively impact on their stocks.

Non-retained species						
Protected /Special species	Capture of sea birds/ Potential change to populations	0	1	Negligible	Cormorant, albatrosses, gannet and short-tailed shearwater can be attracted to fishing activity but birds do not get entangled in the net.
	Capture of Spotted Handfish/ Potential change to population	2	3	Medium	Spotted Handfish can occur at depths of up to 30m but are unlikely to be present below about 15m. The precise location of populations is unknown, as is the precise depths fished by Danish seiners. As such, there is potential that the species range partially overlaps with Danish seine operations. Due to the mesh size of the nets it is unlikely that Spotted Handfish will be retained if caught. A Medium ranking was therefore assigned due to the species critically endangered status and the lack of information on the potential overlap of fishing grounds with Spotted Handfish habitat.
General discard species	Discard of Fish/ Potential change to populations	2	3	Medium	Discards may be substantial but not quantified. Discards include gurnard/latchet, stingarees, skate as well as juveniles of a range of species (e.g. juvenile Jackass Morwong, whose post release survival is low). While there is likely to be some impact, the spatial scale of Danish seine effort is small relative to the distributional range of the by-catch species. Nevertheless, a complete lack of information on this fishing method in Tasmanian state waters means that risk to discards cannot be ruled out.
General ecosystem						
Ecosystem structure *Discarding/provisioning*	Discarded fish attracting wildlife/Addition of nutrients into food chain	1	2	Very Low	While discarding occurs, the fishery is small and operators do not fish regularly so the fishery is not expected to have a large impact due to provisioning or through the addition of nutrients.

Habitat/Benthic biota	Net dragging on the seafloor/Changes to benthic composition	2	3	Medium	Operates on soft sediments, there is a risk of damage to sponges and other sessile organisms as the net and ground ropes are dragged across the substrate. Areas fished are, however, very defined so impacts will be localised.
Community structure	Capture of key species/ Changes to the trophic structure of ecosystem	2	2	Low	Target species include Tiger Flathead (important predator) and School Whiting (important prey species). Difficult to estimate how much impact the removing of fish is having on the rest of the ecosystem. However, the Tiger Flathead population is considered sustainable and only one operator targets School Whiting so little change to the trophic structure is expected.

4.4 Dip net

Gear description

A dip net is a hand held net no larger than 1 metre across with a mesh greater than 20 mm (Figure 6). Dip nets are mainly used to target schools of Southern Garfish at night and Southern Calamari are captured opportunistically. Recreational fishers may use a dip net but this is believed to be a rarity.

Figure 6. Dip net gear.

Risk Assessment

Dip netting was considered a low risk activity with regards to retained species, non-retained species and the general ecosystem (Table 12).

Table 12. Ecological risks identified for dip net.

Dip net		Hazardous event and potential impacts	Consequence	Likelihood	Risk ranking	Justification
Retained species						
Target species		Capture of Southern Garfish/ Potential change to population	2	2	Low	Average annual catch of 18.3 tonnes between 2000 and 2012. Population age structure changed as a result of fishing pressure (reduction of older age classes) in the past but the population appears to be recovering. Current catch levels unlikely to result in further substantial changes to the population.
		Capture of Southern Calamari/ Potential change to population	1	1	Very Low	Average annual catch of 3.5 tonnes between 2000 and 2012. The population status is undefined but dip net catches are very low and unlikely to lead to substantial changes to the population.
Non-target by-product species		Capture of mixed fish species/ Potential change to population	0	1	Negligible	The method is highly selective with minimal by-product average of less than 1 tonne of mixed species between 2000 and 2012.
Non-retained species						
Protected /Special species		Capture of sea birds/ Potential change to populations	0	1	Negligible	Seabirds could possibly be attracted to lights but are not caught in the gear.
General discard species		Discard of Fish/ Potential change to populations	0	1	Negligible	Method is highly selective, by-catch and discards are minimal.
General ecosystem						
Ecosystem structure	*Community structure*	Capture of key species/ Changes to the trophic structure of ecosystem	1	1	Very Low	The gear selectively removes target species but the dip net fishery is very small and so is expected to have very little impact on community structure.

4.5 Drop line

Gear description

A dropline is an unattended line set vertically with one end weighted and a buoy attached to the other (Figure 7). Commercial fishers are permitted to use up to 200 hooks at any one time, with no restriction on the number of drop lines used. Recreational fishers are restricted to a single dropline with no more than 15 hooks. Commercial fishers predominantly use this gear to target Striped Trumpeter. Recreational fishers also target Striped Trumpeter as well as deploying the gear in offshore waters to target Blue-eye Trevalla, Gemfish and other species. Tasmanian commercial scalefish fishers are only permitted to take 50 kg of Blue-eye Trevalla per trip and holders of a Southern Rock Lobster licence are permitted to take 100 kg per trip. Nevertheless, landings are <1 t annually. The recreational catch of Blue-eye Trevalla is believed to be low and is a Commonwealth managed species so is not considered in this assessment.

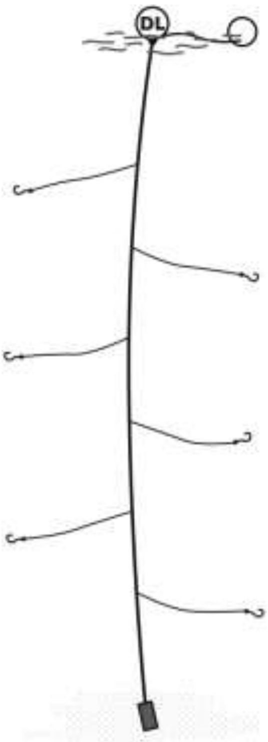

Figure 7. Drop line. Source: DPIPWE.

Risk Assessment

Drop lining was considered a medium risk activity for the target species (Striped Trumpeter) but as a low risk activity with regards to other retained species, non-retained species and general ecosystem (Table 13).

Table 13. Ecological risks identified for drop line.

Drop line	**Hazardous event and potential impacts**	**Consequence**	**Likelihood**	**Risk ranking**	**Justification**
Retained species					
Target species	Capture of Striped Trumpeter/ Potential change to population	2	3	Medium	Average annual catch of 7.3 tonnes between 2000 and 2012. Fishing in combination with natural variability has led to changes in the population, although there is recent evidence of recovery. Commercial and recreational drop line fisheries are however small.
Non-target by-product species	Capture of Sharks/ Potential change to population	1	1	Very Low	Mostly Gummy and School Sharks, average annual catch of 0.3 tonnes each between 2000 and 2012. Catch of sharks is regulated by trip and bag limits.
	Capture of mixed scalefish/ Potential change to populations	1	1	Very Low	Average annual catch of 2 tonnes of mixed species between 2000 and 2012, none exceed 0.7 t. These levels of catch are not expected to translate into changes in populations.
Bait collection	Capture of mixed fish/ Potential change to populations	1	1	Very Low	Small quantities of mixed species are used as bait.
Non-retained species					
Protected /Special species	Capture of sea birds/ Potential change to populations	1	1	Very Low	Interactions are possible with Short-tailed shearwaters and albatrosses. There is greater control over the fishing process compared with longlines, setting and hauling occurs beside the boat so birds can be discouraged from taking baits.

		Capture of seal/ Potential change to population	0	1	Negligible	Interaction with seals occurs during fishing operations, mainly depredating fish caught on the lines; seals rarely get hooked or tangled in the lines.
General discard species		Discard of Fish/ Potential change to populations	1	1	Very Low	Ocean Perch account for the majority of discards. These species are abundant and wide-spread, populations are unlikely to be affected.
		Discard of Sharks/ Potential change to populations	0	1	Negligible	Very few sharks are caught or discarded by the drop line fishery and populations are unlikely to be impacted.
General ecosystem						
Ecosystem structure	*Discarding/provisioning*	Discarded fish attracting wildlife/Habituation of marine mammals	1	1	Very Low	Seals and killer whales (mainly for the commercial Blue-eye Trevalla fishery) can interact with the fishing operations, depredating the lines. Interactions tend to be opportunistic and not expected to result in habituation.
	Habitat/Benthic biota	Contact with seafloor/Changes to benthic composition	0	1	Negligible	Only a small weight interacts with the benthos.
	Community structure	Capture of key species/ Changes to the trophic structure of ecosystem	1	2	Very Low	Target species include Striped Trumpeter, one of many predator species within the shelf ecosystem and thus unlikely to be a key trophic link. In any case relative biomass appears low compared with other species at similar trophic level.
General environment	*Waste disposal*	Entanglement of marine species in debris/ Reduction of populations	0	2	Negligible	There is potential for marine mammals to get entangled in lost gear. However, gear loss assumed to be minimal and not expected to impact on marine mammal populations.

4.6 Fish trap

Gear description

Fish traps can be set in a wide range of depths but are typically fished in relatively shallow waters over reef substrate. Traps are made in a variety of shapes and sizes depending on the target species (Flood *et al.*, 2012) (Figure 8). In Tasmania, fish traps tend to be rectangular and must be no larger than 200 x 200 x 100 cm, with a minimum mesh size of 25 mm and an entrance no wider than 250 mm. Commercial scalefish operators are permitted to use up to two baited traps. Fish traps, often in combination with hand lines, are used to capture wrasse as part of the live wrasse fishery.

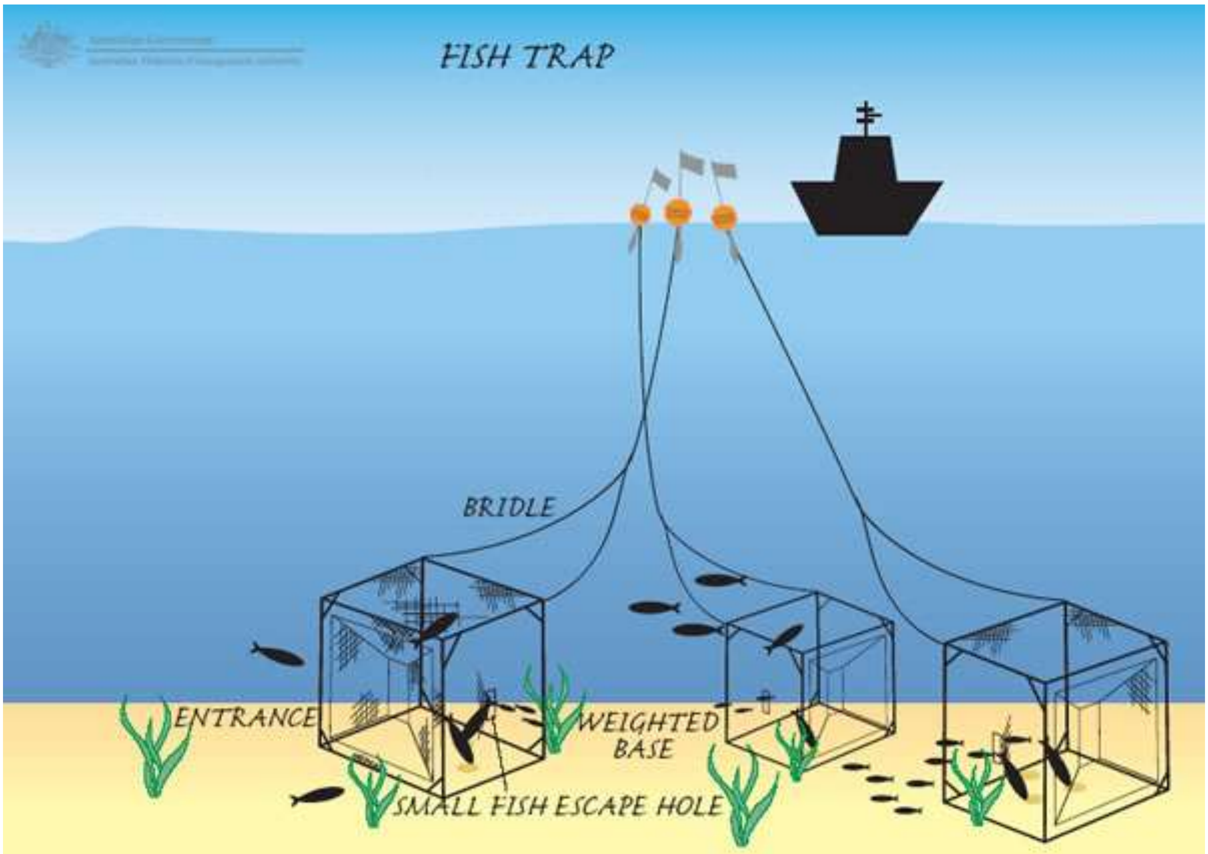

Figure 8. Fish trap. Source: AFMA

Risk Assessment

Fish trapping was considered a low risk activity with regards to the target species and risks to non-retained species and the general ecosystem were assessed as low or negligible (Table 14)

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Table 14. Ecological risks identified for fish trap**.**

Fish trap	Hazardous event and potential impacts	Consequence	Likelihood	Risk ranking	Justification
Retained species					
Target species	Capture of Bluethroat Wrasse/ Potential change to population	2	2	Low	The trap fishery for wrasse is significantly smaller than it has been historically due to the banning of the preferred bait for trap fishing (abalone guts) in 2008. Current fish trap catch levels are low, with the Bluethroat Wrasse component being less than 4 tonnes in 2012/13, and thus in itself not expected to lead to changes in the population. In combination with other methods, the commercial catch of Bluethroat Wrasse was around 49 tonnes, and there are no clear indicators that overfishing is occurring.
	Capture of Purple Wrasse/ Potential change to population	2	2	Low	As for Bluethroat Wrasse, although the reduction in trap effort has had a greater impact for Purple Wrasse, with catches more than halving over the past few years. Less than 2 tonnes were taken by traps and the overall commercial catch was 13 tonnes in 2012/13. Traps have traditionally been used to target Purple Wrasse, the shift from traps usage due to the bait issue has reduced pressure on the species and thus current catch levels are not expected to result in changes to the population.

Non-target by-product species		Capture of mixed fish/ Potential change to populations	1	1	Very Low	Leatherjacket is the main by-product species, with an average annual catch of 7 tonnes between 2000 and 2012. Current catch levels are not expected to lead to changes in the populations, especially with the reduction in trap effort.
Bait collection		Capture of scalefish species/ Potential change to population	1	1	Very Low	Since the banning of abalone gut as bait fish traps are now baited with fish. Common baits are Australian Salmon, Barracouta and Jack Mackerel. Despite a potential increase in the capture of these species, anecdotal evidence suggests most fishers purchase their bait. The size of the trap fishery means they are unlikely to have any significant impact on these abundant species, hence no change in populations is expected.
Non-retained species						
Protected /Special species		Capture of Syngnathids/ Potential change to populations	0	1	Negligible	Seahorses and Pipefish can attach to the fish trap. However, very few specimens are caught and most, if seen, can be released alive, so this is not expected to lead to changes in populations.
General discard species		Discard of Leatherjacket/ Potential change to populations	0	1	Negligible	Leatherjacket is the most common discarded species. Fish are released alive and survival rates are high.
		Discard of fish/ Potential change to populations	0	1	Negligible	A range of fish can be caught in fish traps but due to the fishing method, these are released alive and survival rates are high.
General ecosystem						
Ecosystem structure	*Ghost fishing*	Lost gear continuing to fish/ Potential impact on community structure	1	1	Very Low	Traps are occasionally lost and as long as there is bait/dead fish in them they have to potential to continue to catch fish. Losses are, however, expected to be very small and traps are expected to breakdown over time.

	Habitat/Benthic biota	Contact with seafloor/Changes to benthic composition	1	1	Very Low	Fish traps rest on the benthos but are set over reef so are unlikely to cause changes to the benthic composition.
		Tangling in macroalgae/Changes to the algal composition	1	1	Very Low	Tangling in macroalgae does occur but the fishery is small and not expected to lead to change in algal composition.
	Community structure	Selective harvesting of wrasse/ Change to local population structure	2	2	Low	Wrasse are an important predator in coastal reef ecosystems. Given the Wrasse fishery is concentrated in certain areas of the east and south east coast, there is some possibility that localised depletions may occur. Implications for the reef ecosystem are unclear, although a relatively large minimum size limit will provide protection for a component of the populations.

4.7 Gillnet

Gear description

Gillnets are made of a panel of mesh attached to a floating line (head line) with either small floats threaded on a rope at the top, or buoyant rope, and a sinking line (ground line) either constructed of weights attached to a rope, or a lead core rope, on the bottom. The mesh is attached to the head and ground lines in such a way that the panel of netting hangs in the water in curtain-like folds (Figure 9). A variety of gillnets are used in Tasmania. These include:

- *Graballs* have a stretched mesh size of 105–140 mm (typically around 114 mm) and are used to target Blue Warehou, Bastard Trumpeter, escapee salmonids and other species less frequently. Graballs are used by both commercial and recreational sectors;
- *Banded Morwong* nets, which are usually 137–140 mm stretched mesh size and are used to target Banded Morwong for the live fish trade. These nets are made from lighter gauge mesh than traditional graballs;
- *Flounder* nets are similar to Banded Morwong nets but are designed to hang very loosely, which increases their effectiveness when targeting flounder;
- *Small mesh nets* include both recreational mullet nets (60–70 mm mesh size) and commercial small mesh nets (75–100 mm mesh size), use of the latter is restricted to the north coast. Mullet nets are predominantly used to target mullet, small mesh nets are used to target Shortfinned Pike, Blue Warehou, Rock and Bluespotted Flathead.

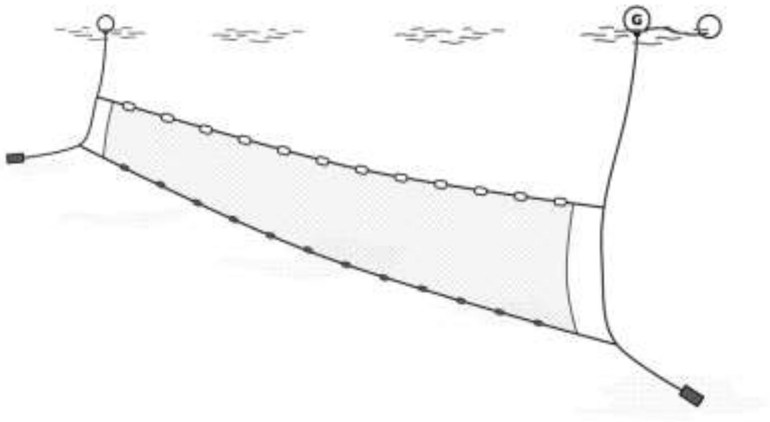

Figure 9. Graball net. Source: DPIPWE.

Risk Assessment

Gillnets were considered a medium to high risk activity for some target and non-target species (Table 15), these assessments were due to overfishing by Tasmanian and Commonwealth sectors (Blue Warehou), declining populations, the result of fishing and/or natural causes (Banded Morwong and Bastard Trumpeter), or general lack of information about stocks. In addition gillnetting was considered a medium to high risk activity for protected species, due to endangered status (Maugean Skate), and high rates of mortality when interactions with gear occur (seabirds). General ecosystem risks were assessed as very low to medium, the medium classification being based on the trophic impacts of the selective removal of target species.

A more comprehensive, semi-quantitative risk assessment based on the approach described by Hobday *et al*. (2011) is also provided for gillnetting in Appendix 2 for comparison. Both provide generally consistent results, although the semi-quantitative approach did flag several additional high risk species, generally due to the extent of spatial overlap between the fisheries and the species distribution or due to missing key information.

Table 15. Ecological risks identified for gillnets.

Gillnet	Hazardous event and potential impacts	Consequence	Likelihood	Risk ranking	Justification
Retained species					
Target species	Capture of Banded Morwong/ Potential change to populations	3	3	High	Banded Morwong are a major target species (average of 40 t over last five years), Tasmanian stocks are assessed to be in a transitional depleting state. As such the risk ranking is high but it should be noted this is a managed stock, with a total allowable catch (TAC) applying to the commercial sector. Current assessment suggests that rebuilding will be slow and gradual.
	Capture of Bastard Trumpeter/ Potential change to population	3	2	Medium	Commercial catches are at historically low levels (average of 11 t over last five years), influenced in part by reduced market demand and trip limits. Recreational catches now exceed commercial landings, however, an overall reduction in recreational netting effort has meant that recreational catches have also declined. The fishery targets juveniles, adults move offshore into deep water where they are subject to minimal fishing pressure. Population status is uncertain, if fishing pressure on juveniles is high then there is a possibility of growth overfishing.
	Capture of Blue Warehou/ Potential change to population	3	3	High	Blue Warehou stock is classified as overfished and despite a rebuilding strategy implemented by the Commonwealth, recovery appears to be very slow. Hence any fishing pressure (gillnets or Commonwealth trawl) poses a high risk at this stage. 2.5 – 35.7 t have been landed over the last five years, which is lower than historic catches but

					the capture of this species varies annually depending on local abundance.
	Capture of Mullet/ Potential change to population	1	2	Very low	Mullet are a key target for recreational fishers using mullet nets whereas the commercial fishery catch is very small due to low market demand in Tasmania. Recreational fishers landed 7.1 t in 2012/13. The low catch is not expected to adversely impact stocks.
Non-target by-product species	Capture of mixed fish/ Potential change to populations	3	2	Medium	By-product of the gillnet fishery includes a wide variety of fish species (average of 25 t over last 5 years), although most are taken in relatively small quantities. Since the population status of most of these minor species is uncertain, a medium risk ranking is assigned.
Non-retained species					
Protected /Special species	Capture of sea birds/ Potential change to populations	2	3	Medium	Cormorants, gannets, penguins and shearwaters will occasionally try and take meshed fish or become meshed in nets whilst pursuing fish underwater. Entanglements almost always result in drowning. Direct impacts on seabird populations from gillnet fishing are likely to represent a medium risk based on the low rate of interactions.
	Capture of Maugean Skate/ Potential change to population	3	3	High	Maugean skate have a restricted distribution and assumed small population size, the species is listed as endangered. The species is occasionally taken in gillnets in Macquarie Harbour and while most survive these encounters mortalities do occur. Given the species endangered status, any interactions that result in mortalities justify a high risk ranking.

		Capture of Syngnathids/ Potential change to populations	0	1	Negligible	Seahorses and Pipefish can attach to the meshes but are too small to become entangled. Few specimens are caught and most are released alive and unharmed, so this is not expected to lead to changes in populations.
		Capture of seals/ Potential change to population	0	1	Negligible	Seals regularly take fish meshed in gillnets but entanglements in gillnets is extremely rare.
General discard species		Discard of fish/ Potential change to populations	2	3	Medium	A wide range of by-catch is taken in gillnets, species such as Wrasse appear to have relatively poor post release survival whereas many other species appear to be quite robust. Recent management changes imposing maximum soak times plus the prohibition of night netting in most areas appears to have reduced wastage and enhanced the condition of released fish.
General ecosystem						
Ecosystem structure	*Ghost fishing*	Lost gear continuing to fish/ Potential impact on community structure	2	2	Low	Gillnets are occasionally lost and have the potential to ghost fish, In practice, however, they tend to roll up into tight balls relatively quickly and become ineffective.
	Discarding/provisioning	Discarded fish attracting wildlife/Habituation of marine mammals	1	1	Very Low	Seals often interact with the fishing operations. Interactions tend to be opportunistic although there is some evidence of habituation.
	Habitat/Benthic biota	Contact with seafloor/Changes to benthic composition	1	1	Very Low	Since ground lines make contact with the benthos some physical damage to sessile organisms as well as entanglement of macroalgae in meshes occurs. The risk level arising from these interactions on benthic composition is, however, very low.

	Community structure	Selective harvesting of Banded Morwong/ Changes to the trophic structure of ecosystem	2	3	Medium	Banded Morwong are a dominant component of the nearshore reef fish community, exhibiting a high degree of site attachment. They occupy an intermediate trophic level, ecosystem modelling suggests that as biomass declines there will be an increase in other functional groups (Metcalf, 2009) hence a medium risk is assessed.
		Selective harvesting of Bastard Trumpeter / Changes to the trophic structure of ecosystem	1	2	Very Low	Bastard Trumpeter are an intermediate trophic level predator species within the shelf ecosystem and thus unlikely to be a key trophic link. In any case relative biomass appears low compared with other species at similar trophic level.
		Selective harvesting of Blue Warehou / Changes to the trophic structure of ecosystem	1	1	Very Low	Blue Warehou are seasonally available in Tasmanian waters, they are a low trophic level species that is unlikely to be a key trophic link.
General environment	*Waste disposal*	Entanglement of marine species in debris/ Reduction of populations	2	2	Low	Loss of sections of gillnet mesh may occur and the mesh has the potential to entangle fish, birds or marine mammals. Being predominately monofilament, the meshes are unlikely to breakdown quickly. However, as noted above much of the debris is likely to ball up over time. Loss of ropes and buoys may also occur and there is potential for entanglements.

4.8 Hand collection

Hand collection is almost exclusively carried out at Eaglehawk Neck, where Maori Octopus (*Octopus maorum*) are collected with a hook in Eaglehawk Bay while they are attempting to migrate out into the ocean to spawn. Because of the physical land barrier these animals are not expected to reach their spawning grounds and will otherwise die.

Risk Assessment

Hand collection is considered to have negligible risk to target and by-product species (Table 16). Non-retained catch and the general ecosystem aspects are not applicable for this method.

Table 16. Ecological risks identified for hand collection.

Hand collection	Hazardous event and potential impacts	Consequence	Likelihood	Risk ranking	Justification
Retained species					
Target species	Capture of octopus/ Potential change to population	0	1	Negligible	As these octopus (*Octopus maorum)* expected to die of natural causes without contributing to the spawning potential of the population, no negative impact on the population/stock is likely. Further, only around 1 t is captured using this method annually.
	Capture of mixed fish/ Potential change to populations	0	1	Negligible	This is a very selective fishing method and there is no by-catch.

4.9 Hand line

Gear description

Commercially, fishing with hand lines, including rod and reel, is predominantly used to target Wrasse with some targeting of Striped Trumpeter and Sand Flathead. Recreational line fishers on the other hand target a wide variety of species although catches are dominated by relatively few species, principally Flathead and Australian Salmon, and these represent the focus of this assessment.

Risk Assessment

Hand line fishing was considered a medium risk activity for some target and non-target species (Table 17) mainly due to evidence that the populations are subject to heavy fishing pressure, whether mainly the result of this method (Sand Flathead) or the combined impact of this and other fishing methods (Striped Trumpeter). Impacts on communities and protected species were generally low or negligible although heavy fishing pressure on Sand Flathead populations in inshore and estuarine waters was considered to represent a medium risk to the trophic structure of these systems.

Table 17. Ecological risks identified for hand line.

Handline	Hazardous event and potential impacts	Consequence	Likelihood	Risk ranking	Justification
Retained species					
Target species	Capture of Wrasse/ Potential change to populations	2	2	Low	The shift from traps to handline means that Bluethroat Wrasse now dominate landings (annual average of 42.4 t over last 5 years). There is limited harvested catch by the recreational sector (most is released/discarded). Given that Wrasse have a very high degree of site fidelity, it is possible that this fishery could have localised impacts. Catch rates, however, remain high so there is no indication that these species, on the whole, are recruitment overfished.
	Capture of Striped Trumpeter/ Potential change to population	2	3	Medium	Commercial catches are at historically low levels (average of 6.3 t over last 5 years), influenced in part by trip limits. By contrast recreational catches appear to be growing - 36 t in 2011/12 – and now exceed those taken by the commercial sector. Following a period of poor recruitment (late 1990s to early 2000s) and decline in stock abundance there is now evidence of recovery in recruitment, the impact of the fishery on stocks is uncertain.
	Capture of Sand Flathead/ Potential change to population	2	3	Medium	Commercial catches of Sand Flathead are low compared to recreational catches, which was about 230 t in 2012/13. Recreational size and bag limits apply but evidence suggests that fishing pressure is high and abundances are declining.

	Capture of Australian Salmon/ Potential change to population	1	1	Very low	Line catches of this species are predominantly taken by the recreational sector, with an estimated catch of 63 t in 2012/13. Nevertheless, this species is broadly distributed and the recreational harvest is only around 20% of that typically taken by the commercial sector using other gears. The eastern Australian Salmon stock is considered sustainably fished (Flood *et al.*, 2014).
Non-target by-product species	Capture of mixed fish/ Potential change to populations	3	2	Medium	By-product of the line fishery for Wrasse fishery includes a variety of reef fishes; by-product of Striped Trumpeter fishing includes Jackass Morwong and Ocean Perch. A diverse range of species are taken by the recreational line fishery, though catches of individual species are less than 16 t. Since the population status of many of the minor species is uncertain, a medium risk ranking is assigned.
	Capture of Gummy Shark/ Potential change to populations	0	1	Negligible	Gummy Shark and School Shark are occasionally captured as a by-product of Striped Trumpeter fishing. Commercial trip and recreational bag limits are in place and catches are small. The impact of this method on the populations is assumed to be minimal.
Bait collection	Capture of mixed fish/ Potential change to populations	1	2	Very Low	Quantities of mixed species are used as bait, some will be by-catch of line fishing or other methods, including netting.
Non-retained species					
Protected /Special species	Capture of sea birds/ Potential change to populations	0	1	Negligible	Cormorants, albatrosses, gannets and shearwaters occasionally take hooked fish or dive on baits. Sea birds are occasionally hooked but the vast majority are released unharmed. Direct impacts on seabird populations are thus likely to be minimal.

		Capture of seal/ Potential change to population	0	1	Negligible	Seals will take hooked fish but rarely get hooked themselves. If hooked they are expected to break free from the lines. The impact on the welfare of affected animals is unknown.
General discard species		Discard of fish/ Potential change to populations	0	1	Negligible	Most discards of the Wrasse fishery are expected to be released alive. Discards from Striped Trumpeter fishing may suffer issues related to barotrauma, however, discard quantities are likely to be small reflecting the small size of the fishery. The majority of fish released/discarded when targeting Flathead and/or Australian Salmon are expected to survive if handled well and not deep-hooked.
General ecosystem						
Ecosystem structure	*Discarding/provisioning*	Discarded fish attracting wildlife/Habituation of marine mammals	1	1	Very Low	Seals can interact with the fishing operations. Interactions tend to be opportunistic and not expected to result in habituation.
	Habitat/Benthic biota	Contact with seafloor/Changes to benthic composition	0	1	Negligible	Only a small weight interacts with the benthos.
	Community structure	Selective harvesting of wrasse/ Changes to the trophic structure of ecosystem	2	2	Low	Wrasse are an important predator in coastal reef ecosystems. Given the Wrasse fishery is concentrated in certain areas of the east and south east coast, there is some possibility that localised depletions may occur. Implications for the reef ecosystem are unclear, although a relatively large minimum size limit will provide protection for a component of the populations.
		Selective harvesting of Striped Trumpeter / Changes to the trophic structure of ecosystem	1	2	Very Low	Striped Trumpeter represent one of many predator species within the shelf ecosystem and are thus unlikely to be a key trophic link. In any case relative biomass appears low compared with other species at a similar trophic level.

		Selective harvesting of Sand Flathead / Changes to the trophic structure of ecosystem	2	3	Medium	Sand Flathead are a key predator species in the inshore ecosystem and current harvest rates (especially from the recreational sector) appear high, selective depletion may have flow on impact on ecosystem function.
General environment	*Waste disposal*	Entanglement of marine species in debris/ Reduction of populations	2	2	Low	Lines can be snapped and marine animals can become entangled, the likelihood of this occurring before the line itself becomes tangled up is assumed to be low. Rubbish generated by fishing (e.g. plastic bait bags) may pose a risk to seabirds and other animals.
	Direct land impacts	Launching of vessel from beach/Degradation of foreshores	0	1	Negligible	Beach launching is not a very common occurrence, impacts of shore habitats likely to be minor compared with other shore-based activities.

4.10 Octopus pot

Gear description

Octopus pots are used to target the Pale Octopus (*Octopus pallidus*). The bulk of the commercial catch is landed by a single operator who is licensed to use pots. Octopus are caught in unbaited plastic pots (approximately 3 litres in volume) that are attached to a demersal longline set at depths of 15–85 m. A maximum of 1000 pots are permitted on each line which is 3–4 km in length, with a maximum of 10,000 pots deployed at any one time. Octopus use these pots as refuge and the pots are hauled after 3–6 weeks.

Risk assessment

There was a medium risk that the pot fishery will affect octopus populations as the fishery does remove a large quantity of octopus over a relatively small geographic range. Octopus potting was considered a low risk activity with regards to the general ecosystem.

Table 18. Ecological risks identified for octopus pot

Octopus pot		**Hazardous event and potential impacts**	**Consequence**	**Likelihood**	**Risk ranking**	**Justification**
Retained species						
Target species		Capture of Pale Octopus/ Potential change to populations	2	3	Medium	Catch rates of Pale Octopus have declined in recent years (Emery and Hartmann, 2014). The catch in 2013/14 was 79 t and less than 2012/13 which was a historic high (nearly 120 t). Trends in catch and catch rate suggest recruitment overfishing may be occurring and the fishery is assessed as transitional depleting.
Non-target by-product species		Capture of other octopus species/ Potential change to population	0	1	Negligible	Catches of *Octopus maorum* and *O. tetricus* are low (< 1 t), and thus unlikely to impact stocks.
Non-retained species						
Protected /Special species		Entanglement of seal in pot lines/ Potential change to populations	0	1	Negligible	Seals take octopus from traps but there have been no reports of entanglement in the gear.
General ecosystem						
Ecosystem structure	*Habitat/Benthic biota*	Pots dragging on seafloor/Changes to benthic composition	1	1	Very Low	Gear is set on soft sediment, sponges and other sessile organisms may be impacted if the longlines drag across the bottom. Since longlines are anchored such impacts are likely to be minimal.
	Community structure	Capture of key species/ Changes to the trophic structure of ecosystem	2	2	Low	Octopus are voracious predators and important prey species, so there is potential that the fishery could alter community structure. Catch rates, although declining, remain relatively high suggesting that the biomass has not been heavily reduced.

4.11 Purse seine

Gear description

There are two very different scales of Purse Seine operations occurring in Tasmanian waters. There is large-scale pelagic purse seining for species such as Jack Mackerel, and small-scale operations based in shallow coastal waters designed to target a variety of species, including Garfish, Jack Mackerel and Australian Salmon all of which are taken in small quantities. Both scales of operations are similar in that they involve setting the seine in a circle and then drawing in a 'purse' rope to close off the bottom of the net, thereby preventing the escape of fish (Figure 10). Lampara nets are similar to purse seines in that they are used to encircle the fish, however, they do not have a purse on the bottom and rely on the fish being herded into a bag in the trailing end of the net. Lampara nets have been used occasionally in Tasmania.

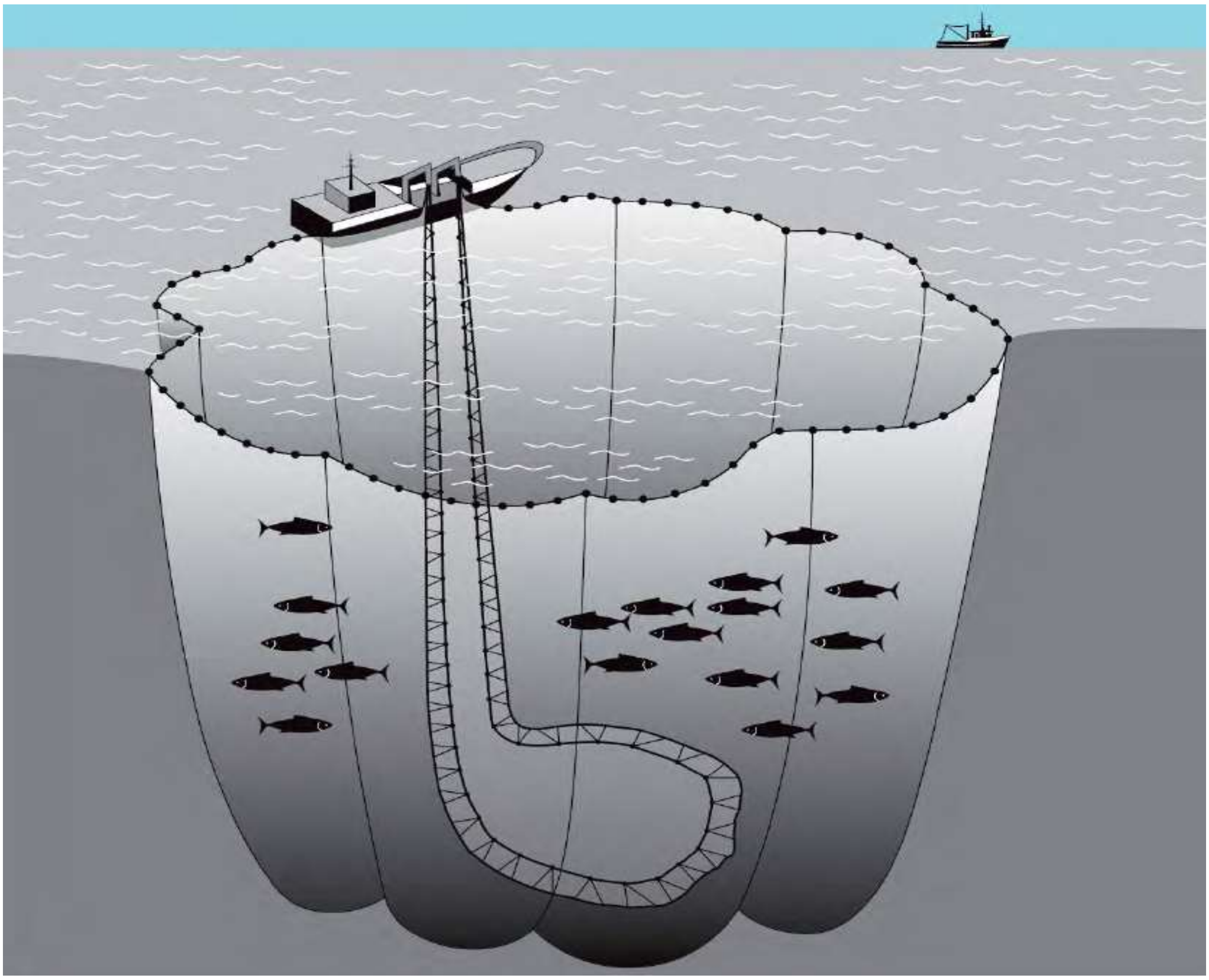

Figure 10. Purse seine used in offshore scenario. Source: Flood *et al.* (2014).

Risk assessment

Inshore purse seining has a low risk across all categories, as does large-scale pelagic purse seine operations (Table 19). However, this assessment is based on the fact that large-scale purse seine operators are currently inactive. The risks will need to be reassessed should this sector commence fishing activity.

Table 19. Ecological risks identified for purse seine.

Purse seine	Hazardous event and potential impacts	Consequence	Likelihood	Risk ranking	Justification
Retained species					
Target species	Capture of Jack Mackerel/ Potential change to population (offshore operations)	0	1	Negligible	This method has the potential to take large quantities of Jack Mackerel; however, since 2009/10 effort has been negligible (<1 t) or nil, and catches by all methods of this species has been minimal. Although catches are currently negligible, this issue will need to be revisited should large-scale operations commence.
	Capture of Redbait/ Potential change to population (offshore operations)	0	1	Negligible	This method has the potential to take large quantities of Redbait; however, since 2009/10 effort has been negligible (<1 t) or nil, and catches by all methods of this species has been minimal. Although catches are currently negligible, this issue will need to be revisited should large-scale operations commence.
	Capture of Australian Sardines/ Potential change to population	0	1	Negligible	Catches of Australian Sardines in Tasmania are currently limited by a restrictive trip limit (10 kg), and there was no catch in 2012/13. Under these arrangements any catches are extremely unlikely to have any detectible impact on the population.
Non-target by-product species	Capture of mixed fish/ Potential change to population (offshore operations)	0	1	Negligible	There is typically minimal by-product associated with purse seine operations since schools of fish can be selectively targeted. The fishery is non-active at present time, the issue will need to be revisited if large-scale operations commence.

	Capture of mixed fish/ Potential change to population (inshore operations)	1	1	Very low	By-product is high in inshore operations with the catch including Mullet, Jack Mackerel, Pike, Australian Salmon and other less frequently. Given the small scale of this fishery, and the fact that all of these species are widespread and not heavily fished by any other gears, the impacts are minor.
Non-retained species					
Protected /Special species	Capture of sea birds/ Potential change to populations	0	1	Negligible	A range of seabird species are attracted to the gear during hauling. This gear is open to the surface so birds are able to come and go as they please and are unlikely to become entangled in the net as meshes are visible and heavy gauge.
	Seals becoming entangled in net/ Potential change to population	0	1	Negligible	Seals are regularly attracted to the fishing operation but being agile and able to move in and out of the net, are rarely captured.
	Capture of dolphin/ Potential change to population	0	1	Negligible	There is potential for dolphin interactions, especially with the large-scale operations. Practices have been developed to minimise lethal interactions, e.g. South Australian Sardine Fishery code of practice. Although currently negligible, this issue will need to be revisited should large-scale operations commence.
General discard species	Discard of Fish/ Potential change to populations (inshore operations)	0	1	Negligible	Quantity-wise, discards are very limited in inshore purse seine operations, an exception being cobblers (*Gymnapistes marmoratus*). Industry suggest that occasionally up to 200 kg may be captured in a single deployment. However, the species is very abundant and not captured throughout much of its range. Fish that are meshed usually tend to be target species (e.g. garfish). By-catch removed by dip net most can generally be released alive, suggesting that the overall risk is negligible.

		Discard of Fish/ Potential change to populations (offshore operations)	0	1	Negligible	Based on large scale purse seine fishing off Tasmania during the 1980s and 1990s by-catch levels tended to be very low relative to the catch of target species. Although currently negligible, this issue will need to be revisited should large-scale operations commence.
General ecosystem						
Ecosystem structure	*Discarding/provisioning*	Discarded fish attracting wildlife/changes to feeding behaviour leading to habituation	1	2	Very Low	Fish are released alive but seabirds and seals are attracted to the activity and do feed on discards. The current scale of operations is, however, very small.
	Habitat/Benthic biota	Net dragging on the seafloor/Changes to seagrass habitat and benthic composition (inshore operations)	1	2	Very Low	The nets are designed either not to make contact with the substrate or if they do be as light as possible to avoid hook-ups and gear damage.
	Community structure	Capture of key species/ Changes to the trophic structure of ecosystem (inshore operations)	1	1	Very Low	A range of species are taken, although in small quantities. The potential for any impact on the trophic structure of ecosystem arise from the collective catch taken by all fishing methods (and sectors) rather than due to inshore purse seining alone.
		Capture of key species/ Changes to the trophic structure of ecosystem (offshore operations)	0	1	Negligible	The target species represent key forage species and play an important role in the functioning of the pelagic ecosystem. As a result, there is potential for adverse impacts on dependent species if catches are too high. Catches of small pelagic species by Tasmanian operators will need to be considered in the context of the Commonwealth Small Pelagic Fishery (SPF). The SPF has developed a harvest strategy to ensure that the fishery does not negatively impact on the sustainability of the target species nor the trophic structure of the ecosystem. Although currently negligible, this issue will need to be revisited if large-scale operations commence.

4.12 Spear

Gear description

Hand spears, in conjunction with submersible lights, are used to target flounder at night, with Greenback Flounder constituting the majority of the catch. Long-snouted Flounder are taken in lesser quantities along with a by-product of Southern Calamari and Flathead. Spears are also used to capture octopus, but in very small quantities.

Risk assessment

All aspects of this fishery were ranked as very low or negligible (Table 20). This is because this method has rarely been used in recent years and is highly selective, with fish sighted and captured individually. Although the recreational catch is relatively small, it is now more than three times larger than commercial landings.

Table 20. Ecological risks identified for spear.

Spear	Hazardous event and potential impacts	Consequence	Likelihood	Risk ranking	Justification
Retained species					
Target species	Capture of Flounder/ Potential change to population	1	1	Very Low	Catches (and effort) have declined considerably in recent years, mainly a result of reduced market demand more so than reduced availability. Only 2.2 t was landed by all gears in 2013/14. Catch per unit effort remains high indicating that current catches are not recruitment overfishing the population. Recreational fishers also participate in this fishery with an estimated harvest of 7.2 t in 2012/13.
	Capture of Southern Calamari/ Potential change to population	0	1	Negligible	Small quantities (<1 t annually) of Southern Calamari are taken opportunistically. Given the very low catch, the impact is negligible.
	Capture of Octopus/ Potential change to population	0	1	Negligible	Small quantities of octopus are speared in Eaglehawk Bay where they become trapped while attempting to migrate to the coast to spawn. These individuals are expected to die of natural causes without ever contributing to the spawning potential of the population, so no negative impact on the population/stock is likely
Non-target by-product species	Capture of mixed fish/ Potential change to population	0	1	Negligible	Fish, principally flathead, are opportunistically speared while floundering. Catches are very low (<1 t) so the impact assessed as negligible.

General ecosystem						
Ecosystem structure	*Community structure*	Capture of key species/ Changes to the trophic structure of ecosystem	0	1	Negligible	Overall, very small quantities of target species are taken using this method, catches are not expected to affect the ecosystem.
General environment	*Direct land impacts*	Launching of vessel from beach/Degradation of foreshores	0	1	Negligible	Beach launching is not common, impacts of shore habitats likely to be minor.

4.13 Squid jig

Gear description

Squid jigs are lures that are designed to catch squid, especially Southern Calamari, and are used in conjunction with either hand lines or rod and reel. Squid jigs are typically constructed of plastic and rather than a barbed hook, have concentric rows of sharp prongs on the bottom end of the jig. Jigs are weighted with lead to enable them to be fished at depth.

Risk assessment

The ecological risk to Southern Calamari due to jig fishing was considered to be medium due to increasing commercial and recreational catches coupled with fishery indicators that the stock is relatively heavily fished in Tasmania (Table 21). All other risks were considered negligible apart from changes to trophic structure which had a low risk. Although Southern Calamari are an important predator and their removal may impact other components of the ecosystem, natural variability in abundance of this annual species is likely to have a greater effect.

Table 21. Ecological risks identified for squid jig.

Squid jig	Hazardous event and potential impacts	Consequence	Likelihood	Risk ranking	Justification
Retained species					
Target species	Capture of Southern Calamari/ Potential change to populations	2	3	Medium	The catch of Southern Calamari rose from <10 t in the mid-1990s to around 50 t in recent years as market demand increased. The fishery has expanded throughout much of the state during this time, particularly in response to spawning closures introduced in the major spawning areas on the east coast. The recreational catch has also been growing rapidly since 2000 and was 63 t in 2012/13. There have been indicators that stocks are now subject to heavy fishing pressure, however catch rates remain high suggesting that recruitment overfishing is not taking place.
Non-target by-product species	Capture of Gould's Squid/ Potential change to populations	0	1	Negligible	Gould's squid are occasionally captured by this method, typically in very low quantities (generally <1 t). Gould's squid are distributed throughout southern Australia where the species is generally very abundant. Automatic jig machines represent the primary fishing method for this species, hand jigs have negligible impact on the stock.
Non-retained species					
Protected /Special species	Capture of sea birds/ Potential change to populations	0	1	Negligible	Cormorants, albatrosses, gannets, shearwaters and potentially others may attempt to capture a hooked Southern Calamari, or could potentially try and capture the squid jig. This would be exceedingly rare and would be actively avoided by fishers.

		Capture of seal/ Potential change to population	0	1	Negligible	Seals may take a hooked squid and become entangled in the gear. If this were to occur they would snap the fishing line. As squid jigs have no barbs the jig is expected to fall free and cause minimal impact.
General discard species		Discard of fish/ Potential change to populations	0	1	Negligible	Squid jigs are relatively selective, although fish will occasionally take squid jigs. By-catch are easily released and should survive.
General ecosystem						
Ecosystem structure	*Habitat/Benthic biota*	Anchoring on seagrass beds/Damage to the seagrass beds and change in benthic composition	0	1	Negligible	Given the wide distribution of seagrass beds and status in Tasmania, it is unlikely that the small area of damage caused by anchoring would have a significant impact. Much squid fishing is undertaken by drifting.
	Community structure	Capture of squid species/ Changes to the trophic structure of ecosystem	2	2	Low	Southern Calamari are likely an important component of near shore ecosystems and there is therefore potential for negative effects on ecosystem/community structure. Given that catch rates have remained relatively stable, and effort is spread throughout the state, it is unlikely that the fishery has reduced Southern Calamari abundances to levels that would affect community structure. Nevertheless, the fishery is probably operating at close to maximum production and further increases in effort could potentially impact other components of near shore ecosystem.
General environment	*Waste disposal*	Entanglement of marine species in debris/ Reduction of populations	0	1	Negligible	There is a possibility that lost squid jigs and any remaining fishing line could result in animals becoming entangled. However, this is unlikely to be a significant problem since the scale of lost gear is expected to be small.

	Direct land impacts	Launching of vessel from beach/Degradation of foreshore	0	1	Negligible	Beach launching is not a very common occurrence, impacts of shore habitats likely to be minor compared with other shore-based activities.

4.14 Trolling

Gear description

Trolling involves towing lures behind the vessel while under way at slow speed (Figure 11). This method was historically used to target Barracouta. Since demand for this species declined, the method is rarely used with only small catches of a variety of species being recorded. Recreational game fishers also use this method to target tunas; however, these species are wide ranging and managed by the Commonwealth in accordance with international treaties. As such they are considered outside the scope of the present assessment.

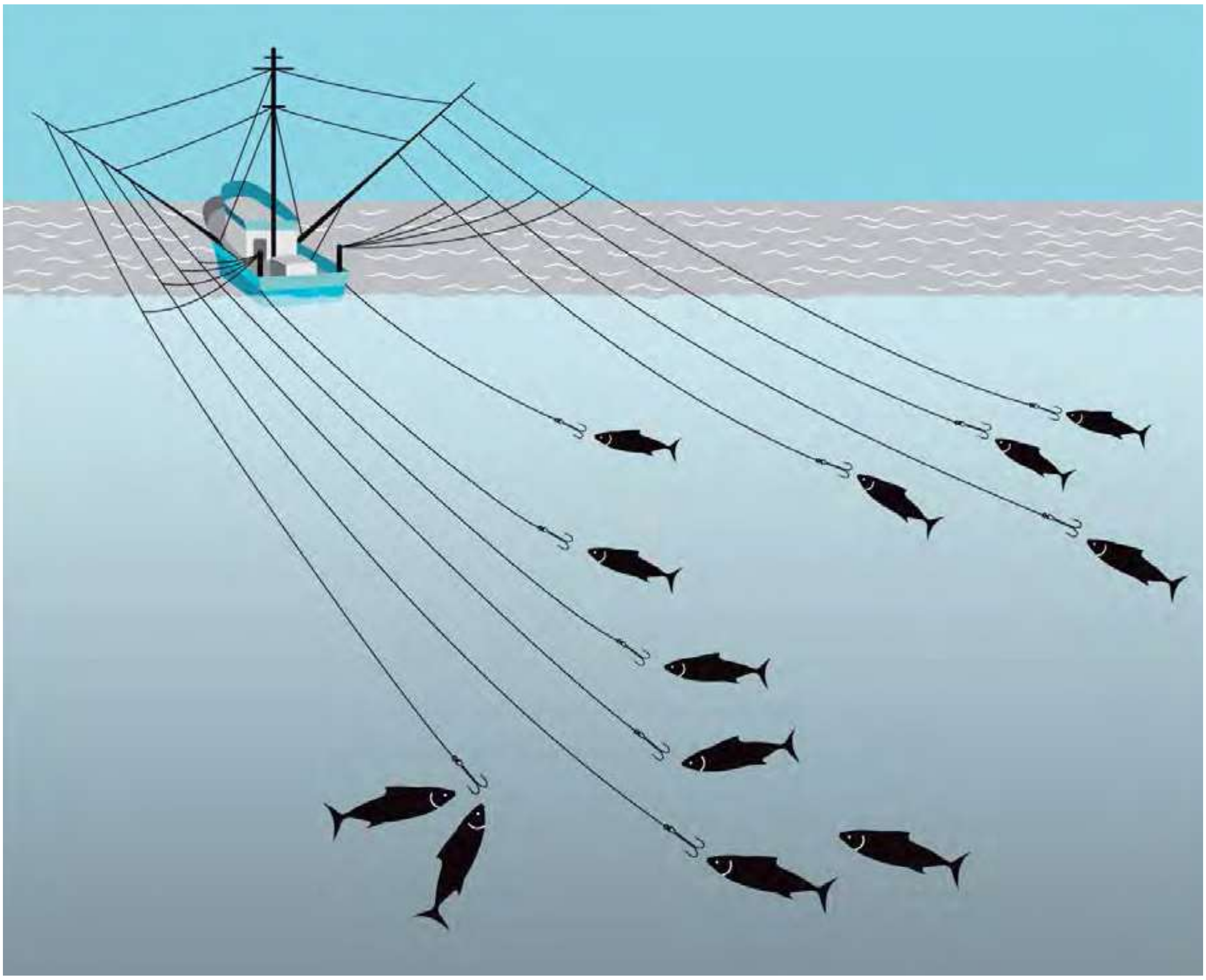

Figure 11. Trolling technique. Source: Flood *et al*. (2014).

Risk assessment

One target species (Pike) were considered to be at low risk, based on the combined catches of several gears (small mesh gillnet, beach seine) and since this species is only present in reasonably high numbers on the north coast where it is fished relatively heavily (Table 22). Trolling was considered a negligible risk activity with regards to non-and general ecosystems.

Table 22. Ecological risks identified for trolling.

Trolling	Hazardous event and potential impacts	Consequence	Likelihood	Risk ranking	Justification
Retained species					
Target species	Capture of Barracouta/ Potential change to populations	0	1	Negligible	The commercial troll catch is now so small (<1 t in 2012/13) it has no appreciable impact on Barracouta populations that have a broad distribution and are highly abundant.
	Capture of Australian Salmon/ Potential change to population	0	1	Negligible	The commercial troll catch is so small (<1 t in 2012/13) that it has no appreciable impact on Australian Salmon populations that have a broad distribution and are highly abundant.
	Capture of Pike/ Potential change to population	2	2	Low	The low catch (average of 5.0 t over last 5 years) would not alone impact Pike populations but, along with other fishing methods (e.g. small mesh gillnets, beach seine), the species is targeted throughout most of its Tasmanian range which is largely restricted to the north coast. Nevertheless, the combined catch is highly likely to be within sustainable levels.
Non-target by-product species	Capture of mixed fish/ Potential change to populations	0	1	Negligible	Capture of other species is minimal (<1 t average over the last 5 years). None of these are high risk species and none are at elevated risk from this fishing method.
Non-retained species					
Protected /Special species	Capture of sea birds/ Potential change to populations	0	1	Negligible	Cormorants, albatrosses, gannets, shearwaters, etc could become entangled by attempting to take fish or the lure directly. Such instances are

						extremely rare and the birds can usually be released with minimal damage.
		Capture of seal/ Potential change to population	0	1	Negligible	Seals will often take hooked fish but they are adept at removing fish without getting hooked themselves. If hooked, they snap the line and may be left with the lure attached. Presumably this will rust away in time and is unlikely to lethal. This level of interactions is unlikely to have any detectible impact on seal stocks.
General discard species		Discard of fish/ Potential change to populations	0	1	Negligible	Discards are minimal as by-catch can generally be released in good condition.
General ecosystem						
Ecosystem structure	*Community structure*	Capture of key species/ Changes to the trophic structure of ecosystem	0	1	Negligible	Australian Salmon, Barracouta and Pike are all important predators. Nevertheless, it is unlikely that any are currently fished heavily enough to impact the broader ecosystem or communities.
General environment	*Waste disposal*	Entanglement of marine species in debris/ Reduction of populations	0	1	Negligible	It is possible that lures and line can be lost and, although unlikely, animals may become entangled in the line.
	Direct land impacts	Launching of vessel from beach/Degradation of foreshore	0	1	Negligible	Beach launching is not a very common occurrence, impacts on shore habitats are likely to be minor compared with other shore-based activities.

5 General conclusions

While little is known of the specific impacts of many of the fisheries/gears that are utilised within the Tasmanian Scalefish Fishery, it was possible to rule out major risks in many cases based on low levels of effort and small catches in recent years. In many cases the target, by-product and by-catch species encountered by these gears/fisheries are widely distributed and fished through a small proportion of their range. Examples that did not have risk rankings of greater than low include automatic squid jig; beach seine, dip net, fish trap, hand collection, purse seine, spear, and trolling. Each of these fisheries were also assessed to have negligible to low negative impacts on protected species, the broader ecosystem or the physical habitats in which they operate. Recognising the above, however, there is considerable latent effort in the Scalefish Fishery and should the number of operators and/or effort increase dramatically, risk profiles could change and will need to be reassessed in accordance with developments in the fishery.

Fisheries/gears with medium risk rankings include Danish seine, drop line, handline, octopus pot and squid jig, only the gillnet fishery had high risk rankings. In the majority instances medium to high risks were associated with target and/or by-product species. For handline and gillnet, medium risks to community structure due to harvesting of selected target species were also identified. As both Danish seine and gillnet methods can involve considerable levels of by-catch, impacts on discard species were ranked as medium risk, primarily due to limited information about the nature of the discards and impacts on the populations. Target species for which medium risk assessments were made include Striped Trumpeter, Bastard Trumpeter, Sand Flathead, Southern Calamari and Pale Octopus. High risk assessments were for Banded Morwong and Blue Warehou, the former is assessed as transitional depleting and the latter overfished (Andre *et al*. 2015). Medium or high levels of risk dictates that some level of specific management and/or monitoring is required (Fletcher *et al.*, 2002). Significantly, each of these species are currently monitored and managed to some degree. In terms of monitoring, catch, effort and catch rate trends are reported annually for the commercial sector (see André *et al.* 2015) and sporadically for the recreational sector (see Lyle *et al*., 2014) and there are on-going biological monitoring programs in place for Banded Morwong, Striped Trumpeter and Sand Flathead (Ewing et al., 2014; André *et al.* 2015). In terms of management, the Scalefish Fishery is limited entry and there are specific licences for certain gear types (e.g. Danish seine, purse seine, automatic squid jig) or the landing of specific species (i.e. Southern Calamari, Banded Morwong and Wrasse). Furthermore there are licences in place limiting the number of operators who can land large quantities of Jack Mackerel and/or Australian Salmon. In addition to conditions on licences or endorsements, there are a range of other management measures including legal minimum (and maximum for Banded Morwong) lengths, spatial closures, spawning closures (Banded Morwong, Southern Calamari, Striped Trumpeter, Southern Garfish) and general trip limits for all commercial operators (Striped Trumpeter, Bastard Trumpeter, Boarfish, Snapper and Yellowtail Kingfish) and specific trip limits for non-licenced operators (Wrasse, Southern Calamari).

Although many of the fishing methods involve some interactions with protected species, for the most part these present a very low risk. Exceptions included Danish Seine which was assessed to pose a medium risk to Spotted Handfish, and gillnetting which poses a medium risk to seabirds and a high risk to Maugean Skate. The rankings for the Spotted Handfish and Maugean Skate are based on the fact that both species are listed as endangered and have small population sizes and very restricted distributional ranges. In practice, most individuals are expected to survive should interactions occur but mortalities or habitat disturbance cannot be ruled out. In an extensive study of gillnetting in Tasmania, seabird entanglements were shown to be rare (0.5% of gillnet deployments) (Lyle *et al*. 2014a). In exceptional circumstances, however, entanglements may involve large numbers of individuals (especially shearwaters and penguins). The fact that a high proportion of entanglements result in drowning makes this a medium risk.

Apart from Danish seine, none of the other methods pose greater than very low risk to benthic biota, because when contact is made with the substrate the physical area of contact is either very small (e.g. drop line, fish trap, gillnet, hand line, octopus pot) or the gear passes lightly over the bottom (beach seine, purse seine). For Danish seine a medium risk was identified because the weighted ground ropes and net itself are dragged across the bottom. Fishing is, however, limited to soft substrates and fishing grounds tend to be very localised and are not widespread. Extensive areas closed to Danish seining exist around Tasmania, ensuring that they are not subject to disturbance from this method and hence the 'foot print' of the fishery is small relative to available habitat.

Semi-quantitative risk assessment for gillnet.

For comparative purposes, results of a semi-quantitative risk assessment of gillnetting focused on retained and non-retained species (Appendix 2) are summarised here. While this approach provided comparable results, there are a number of differences that mainly relate to how risk is assessed, in particular the semi-quantitative approach gives particular weight to uncertainty if key attributes are unknown while also recognising the role that management measures play in mitigating risk. A good example of such differences include Banded Morwong, which was rated as high risk for the qualitative approach, mainly due to the stock status being assessed as transitional depleting (André *et al.,* 2015), whereas the semi-quantitative approach rated the risk as medium, recognising that the current management arrangements (TAC and individual catch quotas) have the objective of gradually rebuilding biomass.

Species ranked as high risk include: Cormorants, Rock Flathead and Pike (Snook) for the small mesh fishery; Atlantic Salmon, Rainbow Trout, Maugean Skate and Whitespotted Dogfish for the Graball non-reef fishery; and, Bastard Trumpeter for the Graball reef fishery. No species was ranked as high risk for the Banded Morwong fishery, predominantly because the large mesh size means that by-catch is relatively low and all of the by-catch species have relatively high post release survival (Lyle *et al.*, 2014a). Further, this gear does not select for Bastard Trumpeter as well as do standard graball nets, which are a species of particular concern.

Cormorants were ranked as higher risk in small mesh fisheries as the encounter rate in this gear was higher than for other gillnets (Lyle *et al.*, 2014a). This may be due to the smaller mesh catching smaller fish that the Cormorants try to capture from the net and consequently become entangled themselves. It may also be because this gear tends to be deployed in shallower water where Cormorants are more likely to be encountered. Rock Flathead and Pike (Snook) were ranked as high risk because of the very high overlap of this fishery with their solely northern Tasmanian distribution. In reality, there has only been 8–10 active vessels in this fishery during the last 5 years and effort remains low so the actual overlap is far less and these species are probably at lower risk under current fishing practices than was identified in the assessment. Should effort increase considerably there may be a requirement for management intervention.

Bastard Trumpeter were only ranked as high risk in reef graball fisheries because this mesh size is particularly good at selecting this species, there is a long term decline in their abundance and the fishery almost solely targets juveniles. Declining Bastard Trumpeter abundance remains a major concern for this sector of the Scalefish Fishery and the various management measures introduced throughout the years (e.g. increased size limits, commercial trip limits, recreational bag limits, reduction in maximum soak time, reduction in the quantity of gear recreational fishers can use) do not appear to have been sufficient to enable the stock to recover. It is probable, however, that there has been poor recruitment in recent years, which has minimised the effectiveness of these management strategies.

The non-reef graball fishery has been particularly controversial throughout the years because of its high visibility in sheltered waters close to urban areas (e.g. D'Entrecasteaux Channel and the Tamar estuary). There has been concern expressed over many years regarding the by-catch of sharks from inshore waters that are known to represent important shark nurseries (Williams and Schaap, 1992). The recent implementation of a maximum permitted soak duration of two hours for gillnets set in designated Shark Refuge Areas is a management measure intended to reduce the level of shark by-catch from such areas. This measure is expected to decrease the incidental mortality of elasmobranchs (Lyle *et al.*, 2014a) and no species other than Maugean Skate and Whitespotted Dogfish were ranked as high risk. Maugean Skate are only found in Macquarie Harbour and Bathurst Harbour and, given the very limited distribution, high catchability, and occasional mortality (thoroughly investigated in Lyle et al. (2014a)), this species is ranked at high risk from gillnetting. Whitespotted Dogfish are widely distributed and are occasionally encountered in the D'Entrecasteaux Channel, but are very abundant in Macquarie Harbour, where they are occasionally captured in gillnets and have a moderately high mortality rate (Lyle *et al.*, 2014a). Recent tagging experiments indicate that the Macquarie Harbour population may be isolated, or partially isolated, from the oceanic population and, as this species has one of the most conservative life history strategies of any vertebrate, they are particularly vulnerable to the effects of fishing. This has seen several populations in the northern hemisphere listed as critically endangered by the International Union for the Conservation of Nature (http://www.iucnredlist.org/details/39326/0). Despite the above, Whitespotted Dogfish remain very abundant in Macquarie Harbour and fishers actively try to avoid them by deploying gillnets in shallow water (dogfish are particularly abundant in deep water) and avoiding areas where they are known to be abundant.

Atlantic Salmon and Rainbow Trout were ranked as high risk to the non-reef graball fishery as there is a high overlap with this fishery. However, these species are aquaculture escapees and their removal is desirable from an environmental viewpoint and does not represent a management issue.

In most gillnet sub-fisheries, a variety of sea birds, marine mammals and chondrichthyans were ranked as medium risk. This is because their life histories tend toward low productivity and they cannot withstand heavy fishing pressure. In particular, Cormorants and Little Penguins are captured occasionally (Lyle *et al.*, 2014a) and there are documented reports of encounters with large numbers of Short-tail Shearwaters.

The reason most teleost and invertebrates were ranked as medium risk was due to the weighting given to missing attributes. In reality, many of these species are likely to be relatively productive and at current catch levels, are likely to be at low risk. This is also true for many chondrichthyans that have high post release survival and/or are rarely encountered.

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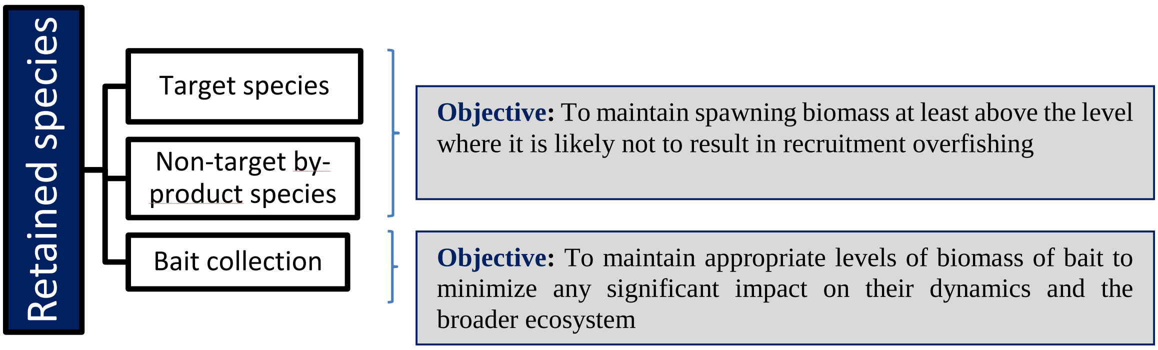
Appendix 1- Consequence tables

Retained species



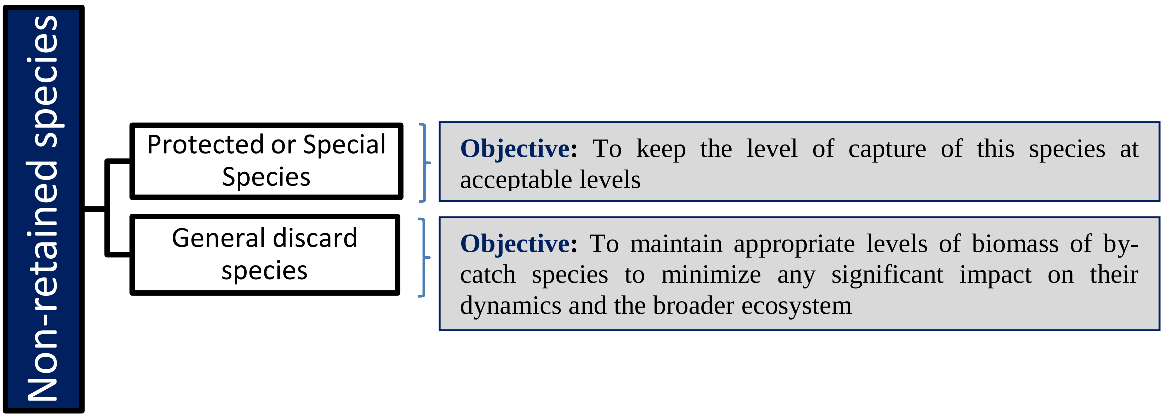
Target species & Non-target by-product species

Consequence level	Retained species (Target & Non-target by-product species)
Negligible (0)	No measureable decline
Minor (1)	Either not detectable against background variability for this population; or if detectable, minimal impact on population size and none on dynamics. Exploited Stock Abundance Range 100% to 70% unfished levels
Moderate (2)	Fishery operating at, or close to, the exploitation rate that will deliver MSY. Exploited Stock Abundance Range < 70% to > B_{msy}
Major (3)	Stock has been reduced to levels below MSY and may also be getting into the range where recruitment overfishing may occur. Exploited Stock Abundance Range < B_{msy} to > B_{rec}
Extreme (4)	Stock size or significant species range contraction > 50% have occurred and recruitment levels reduced affecting future recruitment and their capacity to increase from a depleted state (i.e. recruitment overfishing) Exploited Stock Abundance Range < B_{rec}

Bait collection

Consequence level	Retained species (Bait species)
Negligible (0)	Very few individuals are captured in relation to likely population size (<1%)
Minor (1)	Take in this fishery is small (< 10%), compared to total take by all fisheries and these species are covered explicitly elsewhere. Take and area of capture by this fishery is small, compared to known area of distribution (< 20%).
Moderate (2)	Relative area of, or susceptibility to capture is suspected to be less than 50% and species do not have vulnerable life history traits.
Major (3)	No information is available on the relative area or susceptibility to capture or on the vulnerability of life history traits of this type of species AND The relative levels of capture/susceptibility suspected/known to be greater than 50% and species should be examined explicitly
Extreme (4)	N/A Once a consequence reaches this point it should be examined using target species table.

Non-retained species



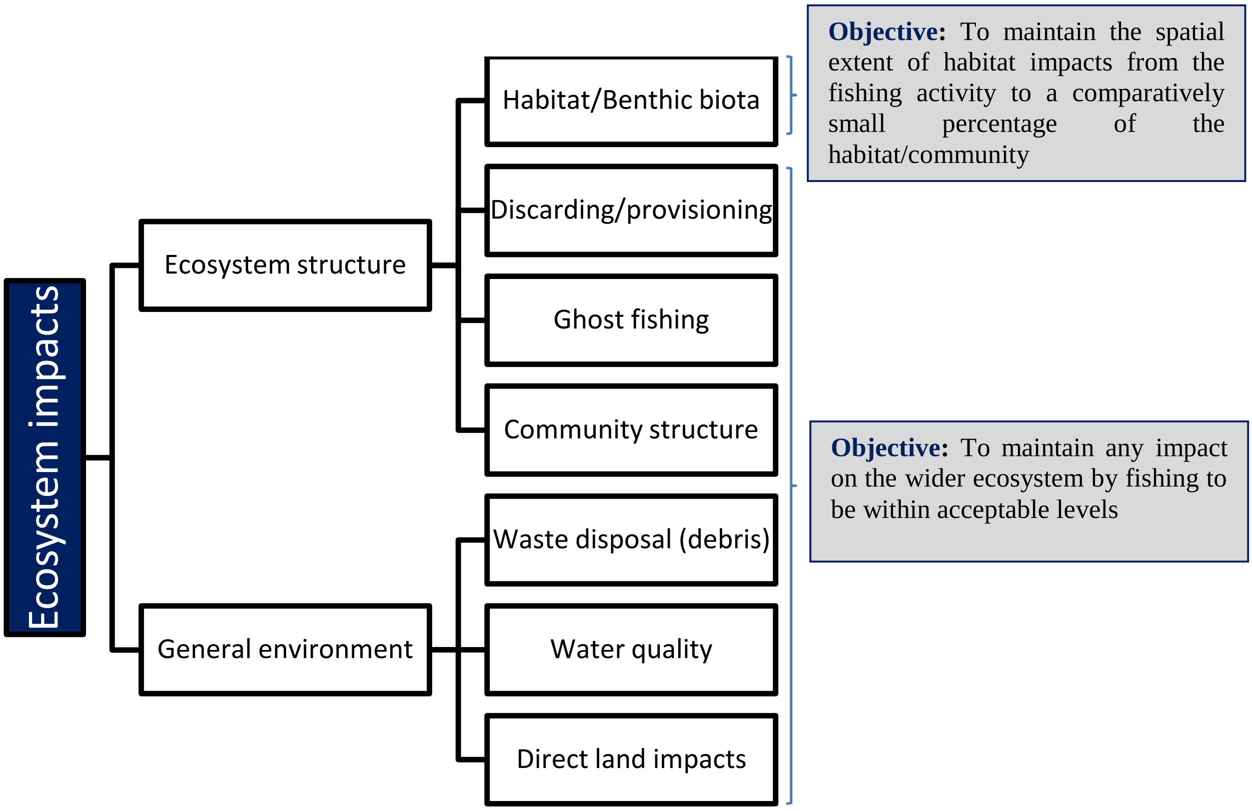
Protected/Special species

Consequence level	Non retained species (Protected/Special species by-catch)
Negligible (0)	Some level of interaction may occur but either no mortalities generated or extremely few are recorded at the time scale of years.
Minor (1)	Very few individuals of the protected species are directly impacted in most years, no general level of public concern
Moderate (2)	The fishery catches or impacts these species at the maximum level that is accepted
Major (3)	The catch or impact by the fishery on the protected species is above that accepted but there are few additional stock implications
Extreme (4)	The catch or impact is well above the acceptable level and this is having significant additional impacts on the already threatened status.

General discard species

Consequence level	Non retained species (General discard species)
Negligible (0)	Very few individuals are captured in relation to likely population size (<1%)
Minor (1)	Take in this fishery is small (< 10%), compared to total take by all fisheries and these species are covered explicitly elsewhere. Take and area of capture by this fishery is small, compared to known area of distribution (< 20%).
Moderate (2)	Relative area of, or susceptibility to capture is suspected to be less than 50% and species do not have vulnerable life history traits.
Major (3)	No information is available on the relative area or susceptibility to capture or on the vulnerability of life history traits of this type of species AND The relative levels of capture/susceptibility suspected/known to be greater than 50% and species should be examined explicitly
Extreme (4)	N/A Once a consequence reaches this point it should be examined using target species table.

General ecosystem



Ecosystem impacts (Habitat/Benthic biota)

Consequence level	**Ecosystem structure (Habitat)**
Negligible (0)	No measurable impact on the habitat would be possible.
Minor (1)	Barely measurable impacts on habitat(s) which are very localised compared to total habitat area.
Moderate (2)	There are likely to be more widespread impacts on the habitat but the levels are still considered acceptable given the percentage of area affected, the types of impact occurring and the recovery capacity of the habitat
Major (3)	The level of impact on habitats may be larger than is sensible to ensure that the habitat will not be able to recover adequately, or it will cause strong downstream effects from loss of function.
Extreme (4)	Too much of the habitat is being affected, which may endanger its long-term survival and result in severe changes to ecosystem function and the entire habitat is in danger of being affected in a major way/removed.

Ecosystem impacts (excl. Habitat/Benthic biota)

Consequence level	**Ecosystem structure (excl. Habitat) & General environment**
Negligible (0)	No measurable change in community structure would be possible against background variations
Minor (1)	Some relatively minor shifts in relative abundance may be occurring but it may be hard to identify any measurable changes at whole of trophic levels outside of natural variation.
Moderate (2)	Measurable changes to the ecosystem components without there being a major change in function. (i.e. no loss of components or real biodiversity), these changes are acceptable. None of the main captured species play a ‘true’ keystone role
Major (3)	Ecosystem function altered measurably and some function or components are locally missing/declining/increasing &/or allowed new species to appear. The level of change is not acceptable to enable one or more high level objective to be achieved. Recovery measured in many years to decadal.
Extreme (4)	An extreme change to ecosystem structure and function. Very different dynamics now occur with different species/groups now the major targets of capture and/or dominating the ecosystem. Could lead to a total collapse of ecosystem processes. Long-term recovery period may be greater than decades

Appendix 2- Semi-quantitative risk assessment: Gillnet

For the purpose of this assessment four sub-fisheries were identified based on the catch composition (target, by-product and by-catch) and fishing practices (Lyle *et al.*, 2014a). These categories were; (i) graball nets deployed on rocky reef habitats, (ii) graball nets deployed on soft sediment habitats, (iii) Small mesh nets including both north coast commercial small mesh nets and recreational mullet nets, and (iv) Banded Morwong nets.

As the gillnet sector is the most valuable scalefish fishery in Tasmania and has the highest number of operators, a greater quantity of information exists regarding catch composition (target, by-product and by-catch), fishing practices (specific gears, soak durations, fishing techniques), by-catch post release survival, interactions with habitat and interactions with threatened, endangered or protected species (Lyle *et al.*, 2014a). Thus, a previous study undertook a more detailed, semi-quantitative, ecological risk assessment for this sector. This analysis takes a precautionary approach to uncertainty and thus, if little is known of the life history, the species is more likely to be ranked as being at high risk. As a result, high risk species are often ranked as such because too little is known to classify them as being at low risk. The results of the productivity, susceptibility analysis are summarised below but for a detailed account of this assessment, including the initial scoping and scale, intensity and consequence analysis, see Lyle *et al.* (2014a). The scale, intensity and consequence analysis ruled out ecosystem and habitat effects so they are not considered herein. For a detailed account of that portion of the assessment see (Lyle *et al.*, 2014a).

Graball (reef) sub-fishery

Bastard Trumpeter was the only species to be ranked as high vulnerability within this sub-fishery (Table A1). This was due to the fishery operating through much of the species range, their high selectivity in the mesh sizes used and high rates of retention. It should be noted that although adult Bastard Trumpeter apparently inhabit deeper water, we chose to retain a high encounterability score as inshore reefs are the key nursery for this species and it is these (immature) individuals on which the fishery is focussed.

A total of 38 species had medium vulnerability rankings, which included most of the marine mammals, seabirds, chondrichthyans and a large number of teleosts (Table A1). This represents >30% of the species encountered in this sub-fishery and is considerably higher than for other fisheries. This is due to the broad spatial scale of the fishery, which encompasses much of the state, and is also due to the greater number of species selected by the mesh sizes commonly used. Of note is the presence of Longsnout Boarfish and Blue Warehou in the medium vulnerability category (target/by-product) and Draughtboard Shark and Herring Cale (common by-catch species).

Table A1. Graball (reef) sub-fishery Productivity, susceptibility analysis. The reason species ranked as high vulnerability are; 1. >3 missing attributes, 2. Low overlap, 3.High susceptibility (<1.5), low productivity (>2.5), 4. Missing spatial, 5. High still (Hobday *et al.*, 2011).

Species	Role in fishery	Missing > 3 attributes (Y/N)	Missing productivity attributes (out of 7)	Missing susceptibility attributes (out of 4)	Productivity (1- low, 3-high)	Susceptibility (1- low, 3-high)	Vulnerability value (low-high range = 1.41-4.24)	Susceptibility override used?	PSA rank	Reason for high ranking
Marine mammals										
New Zealand Fur-seal	TEP	N	0	0	2.43	1.20	2.71	Y	Med	
Southern Right Whale	TEP	N	0	0	2.71	1.05	2.91	Y	Med	
Humpback Whale	TEP	N	0	0	2.71	1.05	2.91	Y	Med	
Bottlenose Dolphin	TEP	N	0	0	2.86	1.13	3.07	Y	Med	
Australian Fur-seal	TEP	N	0	0	2.29	1.20	2.58	Y	Low	
Common Dolphin	TEP	N	0	0	2.29	1.13	2.55	Y	Low	
Seabirds										
Little Penguin	TEP	N	1	0	2.14	1.58	2.66	Y	Med	
Blackfaced Cormorant	TEP	N	1	0	2.57	1.58	3.02	Y	Med	
Great Cormorant	TEP	N	1	0	2.57	1.65	3.06	Y	Med	
Little Pied Cormorant	TEP	N	1	0	2.57	1.65	3.06	Y	Med	
Short-tailed Shearwater	TEP	N	1	0	2.43	1.43	2.82	Y	Med	
Chondrichthyans										
Broadnose Sevengill Shark	DI	N	0	0	2.57	1.05	2.78	Y	Med	
Thresher Shark	BP	N	0	0	2.57	1.05	2.78	Y	Med	
Draughtboard Shark	DI	N	2	0	2.57	1.43	2.94	Y	Med	
Bronze Whaler	BP	N	0	0	2.86	1.05	3.04	Y	Med	
Southern Sawshark	BP	N	0	0	2.14	2.33	3.16	Y	Med	
Australian Angel Shark	BP	N	0	0	2.57	1.65	3.06	Y	Med	
School Shark	TA	N	0	0	2.57	1.58	3.02	Y	Med	
Gummy Shark	TA	N	0	0	2.29	1.88	2.96	Y	Med	
Whitespotted Dogfish	DI	N	0	0	2.57	1.43	2.94	Y	Med	
Common Sawshark	BP	N	0	0	2.43	1.43	2.82	Y	Med	
Grey Nurse Shark	TEP	N	0	0	2.71	1.05	2.91	Y	Med	
Great White Shark	TEP	N	0	0	2.86	1.05	3.04	Y	Med	
Port Jackson Shark	DI	N	1	0	2.29	1.13	2.55	Y	Low	
Elephantfish	BP	N	0	0	1.71	1.88	2.54	Y	Low	
Rusty Catshark	DI	N	2	0	2.29	1.05	2.52	Y	Low	
Banded Stingaree	DI	N	0	0	1.71	1.43	2.23	Y	Low	
Southern Eagle Ray	DI	N	0	0	2.29	1.08	2.53	Y	Low	
Whitleys Skate	DI	Y	2	2	2.43	1.00	2.63	Y	Low	
Thornback Skate	DI	N	1	2	1.86	1.03	2.12	Y	Low	
Yellowstriped Leatherjacket	DI	Y	2	2	1.71	1.43	2.23	Y	Low	
Orange Spotted Catshark	DI	Y	2	2	1.71	1.43	2.23	Y	Low	
Maugean Skate	TEP	Y	2	2	2.29	1.20	2.58	Y	Low	
Teleosts										
Bastard Trumpeter	TA	N	0	0	1.71	3.00	3.46	Y	High	4
Bluespotted Flathead	BP	N	0	0	1.43	2.33	2.73	Y	Med	
Longfin Pike	BP	N	3	0	2.14	1.88	2.85	Y	Med	
Old Wife	DI	N	3	0	2.29	1.88	2.96	Y	Med	
Longsnout Boarfish	BP	N	3	0	2.00	2.33	3.07	Y	Med	

Species	Role in fishery	Missing > 3 attributes (Y/N)	Missing productivity attributes (out of 7)	Missing susceptibility attributes (out of 4)	Productivity (1- low, 3-high)	Susceptibility (1- low, 3-high)	Vulnerability value (low-high range = 1.41-4.24)	Susceptibility override used?	PSA rank	Reason for high ranking
Blue Warehou	TA	N	0	0	1.29	2.33	2.66	Y	Med	
Smooth Stingray	DI	Y	3	2	2.86	1.08	3.05	Y	Med	
Red Velvet Fish	DI	Y	4	2	2.43	1.65	2.94	Y	Med	
Zebra Fish	DI	N	1	2	1.43	2.33	2.73	Y	Med	
Snook	BP	N	1	2	2.00	1.88	2.74	Y	Med	
Senator Wrasse	DI	N	3	0	1.86	2.33	2.98	Y	Med	
Herring Cale	DI	Y	3	2	2.14	1.65	2.70	Y	Med	
Ornate Cowfish	DI	Y	4	2	2.14	2.33	3.16	Y	Med	
Globefish	DI	Y	4	2	2.14	1.88	2.85	Y	Med	
Southern Conger Eel	DI	Y	2	2	2.29	1.88	2.96	Y	Med	
Ruddy Gurnard Perch	BP	N	3	0	2.14	1.43	2.57	Y	Low	
Southern Sand Flathead	BP	N	0	0	1.43	1.05	1.77	Y	Low	
Rock Flathead	BP	N	0	0	1.14	1.28	1.71	Y	Low	
Yellowtail Kingfish	BP	N	0	0	1.71	1.13	2.05	Y	Low	
Silver Trevally	BP	N	0	0	1.57	1.88	2.45	Y	Low	
Australian Salmon	TA	N	0	0	1.57	1.58	2.22	Y	Low	
Snapper	BP	N	0	0	1.71	1.13	2.05	Y	Low	
Black Bream	DI	N	0	0	1.29	1.08	1.68	Y	Low	
Bluelined Goatfish	BP	N	0	0	1.14	1.18	1.64	Y	Low	
Bluethroat Wrasse	BP	N	0	0	1.29	1.58	2.03	Y	Low	
Common Stargazer	DI	N	1	0	1.86	1.43	2.34	Y	Low	
Blue Mackerel	DI	N	0	0	1.29	1.05	1.66	Y	Low	
Silver Dory	BP	N	0	0	1.29	1.20	1.76	Y	Low	
Latchet	BP	N	0	0	1.29	1.13	1.71	Y	Low	
Sea Sweep	BP	N	0	0	1.14	2.33	2.59	Y	Low	
Magpie Perch	BP	N	0	0	1.29	1.28	1.81	Y	Low	
Dusky Morwong	BP	N	0	0	1.43	1.88	2.36	Y	Low	
Banded Morwong	DI	N	0	0	1.43	1.43	2.02	Y	Low	
Atlantic Salmon	BP	N	0	0	1.71	1.20	2.09	Y	Low	
Bearded Rock Cod	BP	N	2	0	1.86	1.58	2.44	Y	Low	
Rock Ling	BP	N	1	0	2.00	1.58	2.55	Y	Low	
Pink Ling	BP	N	1	0	2.14	1.20	2.46	Y	Low	
Striped Trumpeter	TA	N	0	0	1.86	1.58	2.44	Y	Low	
Jackass Morwong	TA	N	0	0	1.43	1.28	1.91	Y	Low	
Spotted Warehou	BP	N	0	0	1.43	1.43	2.02	Y	Low	
Barracouta	BP	N	0	0	1.57	1.28	2.02	Y	Low	
Jack Mackerel	DI	N	0	0	1.29	1.13	1.71	Y	Low	
Brown Trout	BP	N	0	1	1.71	1.13	2.05	Y	Low	
Rainbow Trout	BP	N	0	2	1.71	1.43	2.23	Y	Low	
Thetis Fish	DI	N	0	0	1.29	1.18	1.74	Y	Low	
Spiny Gurnard	DI	N	0	0	1.29	1.43	1.92	Y	Low	
King George Whiting	BP	N	0	1	1.43	1.28	1.91	Y	Low	
Red Bait	DI	Y	2	2	1.57	1.05	1.89	Y	Low	
Silverbelly	DI	Y	2	2	1.57	1.43	2.12	Y	Low	

Species	Role in fishery	Missing > 3 attributes (Y/N)	Missing productivity attributes (out of 7)	Missing susceptibility attributes (out of 4)	Productivity (1- low, 3-high)	Susceptibility (1- low, 3-high)	Vulnerability value (low-high range = 1.41-4.24)	Susceptibility override used?	PSA rank	Reason for high ranking
Common Bullseye	DI	N	2	1	1.57	1.65	2.28	Y	Low	
Black Drummer	BP	N	1	1	1.43	1.88	2.36	Y	Low	
Marblefish	DI	Y	3	2	2.00	1.65	2.59	Y	Low	
Yelloweye Mullet	BP	N	0	2	1.00	1.28	1.62	Y	Low	
Purple Wrasse	BP	N	1	0	1.71	1.43	2.23	Y	Low	
Rosy Wrasse	DI	N	2	0	1.57	1.88	2.45	Y	Low	
Southern Maori Wrasse	DI	N	1	2	1.71	1.58	2.33	Y	Low	
Rainbow Cale	DI	N	1	2	1.29	1.43	1.92	Y	Low	
Longsnouted Flounder	BP	N	1	2	1.57	1.43	2.12	Y	Low	
Greenback Flounder	BP	Y	2	2	1.71	1.43	2.23	Y	Low	
Toothbrush Leatherjacket	BP	N	1	2	1.43	1.58	2.13	Y	Low	
Horseshoe Leatherjacket	BP	Y	2	2	1.71	1.43	2.23	Y	Low	
Velvet Leatherjacket	DI	N	1	2	1.57	1.28	2.02	Y	Low	
Brownstriped Leatherjacket	DI	Y	2	2	1.71	1.58	2.33	Y	Low	
Six-spined Leatherjacket	BP	Y	2	2	1.71	1.58	2.33	Y	Low	
Shaw's Cowfish	DI	Y	4	2	2.14	1.18	2.44	Y	Low	
Ringed Toadfish	DI	Y	2	2	1.57	1.13	1.93	Y	Low	
Albacore	BP	N	0	0	1.71	1.05	2.01	Y	Low	
Garfish	BP	N	0	2	1.14	1.13	1.60	Y	Low	
Gunn's Leatherjacket	DI	Y	2	2	1.71	1.28	2.14	Y	Low	
Luderick	BP	N	0	2	1.14	1.43	1.83	Y	Low	
Mirror Dory	BP	N	0	0	1.43	1.20	1.87	Y	Low	
Ocean Perch	BP	N	0	0	1.86	1.43	2.34	Y	Low	
Real Bastard Trumpeter	DI	N	1	2	1.57	1.88	2.45	Y	Low	
School Whiting	BP	N	0	2	1.29	1.28	1.81	Y	Low	
Sea Mullet	BP	N	1	2	1.43	1.88	2.36	Y	Low	
Skipjack Tuna	BP	N	0	0	1.57	1.20	1.98	Y	Low	
Tailor	BP	N	0	0	1.43	1.43	2.02	Y	Low	
Common Seadragon	TEP	N	0	0	1.57	1.28	2.02	Y	Low	
Spotted Pipefish	TEP	N	0	0	1.43	1.13	1.82	Y	Low	
Bigbellied seahorse	TEP	N	0	0	1.43	1.13	1.82	Y	Low	
Crustaceans										
Spider Crab	DI	Y	6	2	2.71	1.18	2.96	Y	Med	
Piecrust Crab	DI	Y	6	2	2.71	1.08	2.92	Y	Med	
Speedy Crab	DI	Y	6	3	2.71	1.65	3.18	Y	Med	
Southern Rock Lobster	DI	N	1	1	1.57	1.18	1.96	Y	Low	
Eleven-arm Seastar	DI	N	2	1	2.00	1.08	2.27	Y	Low	
Southern Calamari	BP	N	0	0	1.43	1.43	2.02	Y	Low	
Molluscs										
Gould's Squid	BP	N	1	1	1.71	1.03	2.00	Y	Low	
Maori Octopus	BP	N	0	1	1.57	1.13	1.93	Y	Low	
Blacklip Abalone	DI	N	0	1	1.14	1.20	1.66	Y	Low	

Graball (Banded Morwong) sub-fishery

No species achieved a ranking of high vulnerability within the Banded Morwong fishery (Table A2). This occurred for several reasons: first, there is minimal gillnet effort on the west coast and many of the species encountered by the fishery are distributed around the entire coastline of state; second, the fishery predominantly operates in depths of <25 m and many of species inhabit greater depths; third, many of the smaller species are not selected well by the larger mesh sizes used by the fishery; and finally, post release survival for many of the key by-catch species is high (Lyle et al., 2014a).

Species of medium vulnerability include most of the marine mammals and seabirds, several chondrichthyans (including Great White and Grey Nurse Sharks) and invertebrates, and the teleosts, Banded Morwong, Longsnout Boarfish, Red Velvet Fish and Globefish (Table A2). The ranking of the marine mammals, seabirds and chondrichthyans was due to their low productivity, whereas the invertebrates, Red Velvet Fish and Globefish were ranked as such due to missing attributes. Banded Morwong and Longsnout Boarfish are both caught throughout a large proportion of their range by this fishery and are highly selected by the gear and retained when of legal size.

Table A2. Graball (Banded Morwong) sub-fishery productivity, susceptibility analysis. The reason species ranked as high vulnerability are; 1. >3 missing attributes, 2. Low overlap, 3.High susceptibility (<1.5), low productivity (>2.5), 4. Missing spatial, 5. High still (Hobday *et al.*, 2011).

Species	Role in fishery	Missing > 3 attributes (Y/N)	Missing productivity attributes (out of 7)	Missing susceptibility attributes (out of 4)	Productivity (1- low, 3- high)	Susceptibility (1- low, 3- high)	Vulnerability value (low- high range = 1.41-4.24)	Susceptibility override used?	PSA rank	Reason for high ranking
Marine mammal										
New Zealand Fur-seal	TEP	N	0	0	2.43	1.20	2.71	Y	Med	
Southern Right Whale	TEP	N	0	0	2.71	1.05	2.91	Y	Med	
Humpback Whale	TEP	N	0	0	2.71	1.05	2.91	Y	Med	
Bottlenose Dolphin	TEP	N	0	0	2.86	1.13	3.07	Y	Med	
Australian Fur-seal	TEP	N	0	0	2.29	1.20	2.58	Y	Low	
Common Dolphin	TEP	N	0	0	2.29	1.13	2.55	Y	Low	
Seabirds										
Blackfaced Cormorant	TEP	N	1	0	2.57	1.28	2.87	Y	Med	
Great Cormorant	TEP	N	1	0	2.57	1.65	3.06	Y	Med	
Little Pied Cormorant	TEP	N	1	0	2.57	1.65	3.06	Y	Med	
Short-tailed Shearwater	TEP	N	1	0	2.43	1.43	2.82	Y	Med	
Little Penguin	TEP	N	1	0	2.14	1.28	2.49	Y	Low	
Chondrichthyans										
Broadnose Sevengill Shark	DI	N	0	0	2.57	1.05	2.78	Y	Med	
Thresher Shark	BP	N	0	0	2.57	1.05	2.78	Y	Med	
Draughtboard Shark	DI	N	2	0	2.57	1.28	2.87	Y	Med	
Australian Angel Shark	BP	N	0	0	2.57	1.43	2.94	Y	Med	
School Shark	BP	N	0	0	2.57	1.58	3.02	Y	Med	
Gummy Shark	BP	N	0	0	2.29	1.43	2.69	Y	Med	
Common Sawshark	BP	N	0	0	2.43	1.43	2.82	Y	Med	
Grey Nurse Shark	TEP	N	0	0	2.71	1.05	2.91	Y	Med	

Species	Role in fishery	Missing > 3 attributes (Y/N)	Missing productivity attributes (out of 7)	Missing susceptibility attributes (out of 4)	Productivity (1- low, 3- high)	Susceptibility (1- low, 3- high)	Vulnerability value (low-high range = 1.41-4.24)	Susceptibility override used?	PSA rank	Reason for high ranking
Great White Shark	TEP	N	0	0	2.86	1.13	3.07	Y	Med	
Smooth Stingray	DI	Y	3	2	2.86	1.08	3.05	Y	Med	
Port Jackson Shark	DI	N	1	0	2.29	1.13	2.55	Y	Low	
Elephantfish	BP	N	0	0	1.71	1.43	2.23	Y	Low	
Southern Sawshark	BP	N	0	0	2.14	1.43	2.57	Y	Low	
Banded Stingaree	DI	N	0	0	1.71	1.43	2.23	Y	Low	
Southern Eagle Ray	DI	N	0	0	2.29	1.08	2.53	Y	Low	
Whitleys Skate	DI	Y	2	2	2.43	1.00	2.63	Y	Low	
Maugean Skate	TEP	Y	2	2	2.29	1.20	2.58	Y	Low	
Teleosts										
Longsnout Boarfish	BP	N	3	0	2.00	2.33	3.07	Y	Med	
Banded Morwong	TA	N	0	0	1.43	2.33	2.73	Y	Med	
Red Velvet Fish	BP	Y	4	2	2.43	1.43	2.82	Y	Med	
Globefish	DI	Y	4	2	2.14	1.88	2.85	Y	Med	
Ruddy Gurnard Perch	BP	N	3	0	2.14	1.43	2.57	Y	Low	
Southern Red Scorpion Fish	BP	N	1	0	1.43	1.43	2.02	Y	Low	
Southern Sand Flathead	BP	N	0	0	1.43	1.05	1.77	Y	Low	
Longfinned Pike	BP	N	3	0	2.14	1.43	2.57	Y	Low	
Yellowtail Kingfish	BP	N	0	0	1.71	1.13	2.05	Y	Low	
Silver Trevally	BP	N	0	0	1.57	1.43	2.12	Y	Low	
Australian Salmon	BP	N	0	0	1.57	1.28	2.02	Y	Low	
Old Wife	DI	N	3	0	2.29	1.20	2.58	Y	Low	
Grey Morwong	BP	N	0	0	1.29	1.20	1.76	Y	Low	
Bastard Trumpeter	BP	N	0	0	1.71	1.88	2.54	Y	Low	
Bluethroat Wrasse	BP	N	0	0	1.29	1.38	1.88	Y	Low	
Common Stargazer	DI	N	1	0	1.86	1.20	2.21	Y	Low	
Blue Mackerel	DI	N	0	0	1.29	1.05	1.66	Y	Low	
Silver Dory	BP	N	0	0	1.29	1.20	1.76	Y	Low	
Sea Sweep	BP	N	0	0	1.14	1.58	1.95	Y	Low	
Magpie Perch	DI	N	0	0	1.29	1.18	1.74	Y	Low	
Dusky Morwong	BP	N	0	0	1.43	1.88	2.36	Y	Low	
Bearded Rock Cod	DI	N	2	0	1.86	1.58	2.44	Y	Low	
Rock Ling	BP	N	1	0	2.00	1.58	2.55	Y	Low	
Striped Trumpeter	BP	N	0	0	1.86	1.58	2.44	Y	Low	
Jackass Morwong	BP	N	0	0	1.43	1.18	1.85	Y	Low	
Blue Warehou	BP	N	0	0	1.29	1.58	2.03	Y	Low	
Jack Mackerel	DI	N	0	0	1.29	1.13	1.71	Y	Low	
Thetis Fish	DI	N	0	0	1.29	1.08	1.68	Y	Low	
Barber Perch	DI	Y	2	2	1.57	1.05	1.89	Y	Low	
Common Bullseye	DI	N	2	1	1.57	1.43	2.12	Y	Low	
Marblefish	DI	Y	3	2	2.00	1.20	2.33	Y	Low	
Yelloweye Mullet	DI	N	0	2	1.00	1.05	1.45	Y	Low	
Snook	BP	N	1	2	2.00	1.13	2.29	Y	Low	
Senator Wrasse	DI	N	3	0	1.86	1.20	2.21	Y	Low	
Purple Wrasse	BP	N	1	0	1.71	1.13	2.05	Y	Low	
Rosy Wrasse	DI	N	2	0	1.57	1.28	2.02	Y	Low	

Species	Role in fishery	Missing > 3 attributes (Y/N)	Missing productivity attributes (out of 7)	Missing susceptibility attributes (out of 4)	Productivity (1- low, 3- high)	Susceptibility (1- low, 3- high)	Vulnerability value (low- high range = 1.41-4.24)	Susceptibility override used?	PSA rank	Reason for high ranking
Herring Cale	DI	Y	3	2	2.14	1.43	2.57	Y	Low	
Rainbow Cale	DI	N	1	2	1.29	1.13	1.71	Y	Low	
Greenback Flounder	BP	Y	2	2	1.71	1.20	2.09	Y	Low	
Toothbrush Leatherjacket	DI	N	1	2	1.43	1.18	1.85	Y	Low	
Mosaic Leatherjacket	DI	Y	2	2	1.71	1.13	2.05	Y	Low	
Velvet Leatherjacket	DI	N	1	2	1.57	1.18	1.96	Y	Low	
Brownstriped Leatherjacket	DI	Y	2	2	1.71	1.18	2.08	Y	Low	
Six-spined Leatherjacket	DI	Y	2	2	1.71	1.08	2.02	Y	Low	
Shaw's Cowfish	DI	Y	4	2	2.14	1.08	2.40	Y	Low	
Albacore	BP	N	0	0	1.71	1.05	2.01	Y	Low	
Australian Bonito	BP	N	0	0	1.57	1.05	1.89	Y	Low	
Degen's Leatherjacket	DI	Y	2	2	1.71	1.08	2.02	Y	Low	
Gunn's Leatherjacket	DI	Y	2	2	1.71	1.18	2.08	Y	Low	
John Dory	BP	N	0	0	1.43	1.28	1.91	Y	Low	
Johnston's Weedfish	DI	Y	4	2	2.14	1.13	2.42	Y	Low	
Luderick	BP	N	0	2	1.14	1.43	1.83	Y	Low	
Mirror Dory	BP	N	0	0	1.43	1.20	1.87	Y	Low	
Real Bastard Trumpeter	DI	N	1	2	1.57	1.88	2.45	Y	Low	
Rough Leatherjacket	DI	Y	2	2	1.71	1.08	2.02	Y	Low	
White-ear	DI	N	1	2	1.29	1.03	1.64	Y	Low	
Common Seadragon	TEP	N	0	0	1.57	1.13	1.93	Y	Low	
Spotted Pipefish	TEP	N	0	0	1.43	1.05	1.77	Y	Low	
Bigbellied seahorse	TEP	N	0	0	1.43	1.05	1.77	Y	Low	
Crustaceans										
Piecrust Crab	DI	Y	6	2	2.71	1.03	2.90	Y	Med	
Speedy Crab	DI	Y	6	3	2.71	1.43	3.07	Y	Med	
Southern Rock Lobster	DI	N	1	1	1.57	1.18	1.96	Y	Low	
Eastern Rocklobster	DI	N	1	1	1.57	1.18	1.96	Y	Low	
Echinoderms										
Longspine Sea Urchin	DI	Y	6	3	2.71	1.13	2.94	Y	Med	
Molluscs										
Gould’s Squid	BP	N	1	1	1.71	1.03	2.00	Y	Low	
Southern Calamari	BP	N	0	0	1.43	1.13	1.82	Y	Low	
Blacklip Abalone	DI	N	0	1	1.14	1.13	1.60	Y	Low	

Graball (non-reef) sub-fishery

Species to obtain a high vulnerability rating in the graball (non-reef) sub-fishery included Atlantic Salmon, Rainbow Trout, Maugean Skate and Whitespotted Dogfish (Table A3). The salmonids were ranked as such because they are believed to be largely restricted to areas related to the location of aquaculture farms, are well selected for by graball nets and are retained when caught. Maugean Skate predominantly obtained this ranking due to missing biological attributes in addition to restricted distribution (Macquarie Harbour and Bathurst Harbour). Whitespotted Dogfish are more widespread but have particularly conservative life history characteristics.

Species of medium vulnerability include seabirds (Cormorant species and Short-tailed Shearwaters), marine mammals (fur seals, whales and dolphins), several chondrichthyan species (Tasmanian Numbfish, Southern Eagle Ray and Broadnose Sevengill, Great White, Gummy, Draughtboard and School Sharks) and several teleosts (Longfin Pike, Blue Warehou, Greenback Flounder, Longsnouted Flounder and Globefish) (Table A3). In the case of the seabirds, this ranking was due to the relatively high encounter rate and the high mortality of individuals when entangled. Marine mammals have very conservative life histories and were assigned medium vulnerability despite low distributional overlap with the fishery and the low probability of entanglement. Similarly, the chondrichthyans were generally ranked as medium risk due to their conservative life histories; however, Draughtboard Shark were assigned a medium ranking due to precautionary defaults that arose from missing biological attributes. This was also the reason the majority of teleosts were ranked medium, though the number was few (n=5).

Table A3. Graball (non-reef) sub-fishery PSA. The reason species ranked as high vulnerability are; 1. >3 missing attributes, 2. Low overlap, 3.High susceptibility (<1.5), low productivity (>2.5), 4. Missing spatial, 5. High still (Hobday *et al.*, 2011).

Species	Role in fishery	Missing > 3 attributes (Y/N)	Missing productivity attributes (out of 7)	Missing susceptibility attributes (out of 4)	Productivity (1- low, 3- high)	Susceptibility (1- low, 3- high)	Vulnerability value (low-high range = 1.41-4.24)	Susceptibility override used?	PSA ranking	Reason for high ranking
Marine mammals										
New Zealand Fur-seal	TEP	N	0	0	2.43	1.20	2.71	Y	Med	
Southern Right Whale	TEP	N	0	0	2.71	1.05	2.91	Y	Med	
Humpback Whale	TEP	N	0	0	2.71	1.05	2.91	Y	Med	
Bottlenose Dolphin	TEP	N	0	0	2.86	1.13	3.07	Y	Med	
Australian Fur-seal	TEP	N	0	0	2.29	1.20	2.58	Y	Low	
Common Dolphin	TEP	N	0	0	2.29	1.13	2.55	Y	Low	
Seabirds										
Little Penguin	TEP	N	1	0	2.14	1.58	2.66	Y	Med	
Blackfaced Cormorant	TEP	N	1	0	2.57	1.58	3.02	Y	Med	
Great Cormorant	TEP	N	1	0	2.57	1.65	3.06	Y	Med	
Little Pied Cormorant	TEP	N	1	0	2.57	1.65	3.06	Y	Med	
Short-tailed Shearwater	TEP	N	1	0	2.43	1.43	2.82	Y	Med	
Chondrichthyans										
Whitespotted Dogfish	DI	N	0	0	2.57	1.88	3.18	Y	High	4
Maugean Skate	TEP	Y	2	2	2.29	2.33	3.26	Y	High	1
Broadnose Sevengill Shark	DI	N	0	0	2.57	1.05	2.78	Y	Med	
Draughtboard Shark	DI	N	2	0	2.57	1.08	2.79	Y	Med	
Southern Eagle Ray	DI	N	0	0	2.29	1.43	2.69	Y	Med	
School Shark	DI	N	0	0	2.57	1.58	3.02	Y	Med	
Gummy Shark	DI	N	0	0	2.29	1.88	2.96	Y	Med	
Tasmanian Numbfish	DI	Y	3	2	2.43	1.18	2.70	Y	Med	

Species	Role in fishery	Missing > 3 attributes (Y/N)	Missing productivity attributes (out of 7)	Missing susceptibility attributes (out of 4)	Productivity (1- low, 3- high)	Susceptibility (1- low, 3- high)	Vulnerability value (low- high range = 1.41-4.24)	Susceptibility override used?	PSA ranking	Reason for high ranking
Common Sawshark	DI	N	0	0	2.43	1.43	2.82	Y	Med	
Grey Nurse Shark	TEP	N	0	0	2.71	1.05	2.91	Y	Med	
Great White Shark	TEP	N	0	0	2.86	1.05	3.04	Y	Med	
Port Jackson Shark	DI	N	1	0	2.29	1.13	2.55	Y	Low	
Elephantfish	TA	N	0	0	1.71	1.88	2.54	Y	Low	
Southern Sawshark	BP	N	0	0	2.14	1.43	2.57	Y	Low	
Banded Stingaree	DI	N	0	0	1.71	1.43	2.23	Y	Low	
Whitespotted Skate	DI	Y	2	2	1.86	1.00	2.11	Y	Low	
Whitleys Skate	DI	Y	2	2	2.43	1.03	2.64	Y	Low	
Thornback Skate	DI	N	1	2	1.86	1.03	2.12	Y	Low	
Teleosts										
Atlantic Salmon	TA	N	0	0	1.71	3.00	3.46	Y	High	4
Rainbow Trout	TA	N	0	2	1.71	3.00	3.46	Y	High	4
Longfin Pike	BP	N	3	0	2.14	1.88	2.85	Y	Med	
Blue Warehou	TA	N	0	0	1.29	2.33	2.66	Y	Med	
Longsnouted Flounder	TA	N	1	2	1.57	2.33	2.81	Y	Med	
Greenback Flounder	TA	Y	2	2	1.71	2.33	2.89	Y	Med	
Globefish	DI	Y	4	2	2.14	1.88	2.85	Y	Med	
Ruddy Gurnard Perch	BP	N	3	0	2.14	1.43	2.57	Y	Low	
Southern Sand Flathead	BP	N	0	0	1.43	1.05	1.77	Y	Low	
Yellowtail Kingfish	BP	N	0	0	1.71	1.13	2.05	Y	Low	
Silver Trevally	BP	N	0	0	1.57	1.88	2.45	Y	Low	
Australian Salmon	BP	N	0	0	1.57	1.88	2.45	Y	Low	
Snapper	BP	N	0	0	1.71	1.13	2.05	Y	Low	
Black Bream	DI	N	0	0	1.29	1.18	1.74	Y	Low	
Bluelined Goatfish	BP	N	0	0	1.14	1.28	1.71	Y	Low	
Old Wife	DI	N	3	0	2.29	1.13	2.55	Y	Low	
Longsnout Boarfish	BP	N	3	0	2.00	1.20	2.33	Y	Low	
Bastard Trumpeter	BP	N	0	0	1.71	1.28	2.14	Y	Low	
Bluethroat Wrasse	BP	N	0	0	1.29	1.38	1.88	Y	Low	
Common Stargazer	DI	N	1	0	1.86	1.88	2.64	Y	Low	
Blue Mackerel	DI	N	0	0	1.29	1.05	1.66	Y	Low	
Latchet	BP	N	0	0	1.29	1.13	1.71	Y	Low	
Sea Sweep	BP	N	0	0	1.14	1.43	1.83	Y	Low	
Magpie Perch	BP	N	0	0	1.29	1.13	1.71	Y	Low	
Dusky Morwong	BP	N	0	0	1.43	1.88	2.36	Y	Low	
Banded Morwong	DI	N	0	0	1.43	1.13	1.82	Y	Low	
Bearded Rock Cod	DI	N	2	0	1.86	1.58	2.44	Y	Low	
Rock Ling	BP	N	1	0	2.00	1.58	2.55	Y	Low	

Species	Role in fishery	Missing > 3 attributes (Y/N)	Missing productivity attributes (out of 7)	Missing susceptibility attributes (out of 4)	Productivity (1- low, 3- high)	Susceptibility (1- low, 3- high)	Vulnerability value (low-high range = 1.41-4.24)	Susceptibility override used?	PSA ranking	Reason for high ranking
Pink Ling	BP	N	1	0	2.14	1.20	2.46	Y	Low	
Striped Trumpeter	BP	N	0	0	1.86	1.13	2.17	Y	Low	
Blue Grenadier	DI	N	0	0	1.71	1.28	2.14	Y	Low	
Jackass Morwong	BP	N	0	0	1.43	1.05	1.77	Y	Low	
Barracouta	BP	N	0	0	1.57	1.28	2.02	Y	Low	
Jack Mackerel	DI	N	0	0	1.29	1.13	1.71	Y	Low	
Brown Trout	BP	N	0	1	1.71	1.58	2.33	Y	Low	
Southern Shortfin Eel	BP	N	0	2	2.00	1.05	2.26	Y	Low	
Spiny Gurnard	DI	N	0	0	1.29	1.43	1.92	Y	Low	
King George Whiting	BP	N	0	1	1.43	1.28	1.91	Y	Low	
Marblefish	DI	Y	3	2	2.00	1.13	2.29	Y	Low	
Yelloweye Mullet	DI	N	0	2	1.00	1.43	1.74	Y	Low	
Purple Wrasse	BP	N	1	0	1.71	1.03	2.00	Y	Low	
Herring Cale	DI	Y	3	2	2.14	1.05	2.39	Y	Low	
Toothbrush Leatherjacket	BP	N	1	2	1.43	1.18	1.85	Y	Low	
Brownstriped Leatherjacket	DI	Y	2	2	1.71	1.18	2.08	Y	Low	
Six-spined Leatherjacket	BP	Y	2	2	1.71	1.18	2.08	Y	Low	
Shaw's Cowfish	DI	Y	4	2	2.14	1.18	2.44	Y	Low	
Prickly Toadfish	DI	Y	3	2	1.86	1.43	2.34	Y	Low	
Garfish	BP	N	0	2	1.14	1.13	1.60	Y	Low	
Luderick	BP	N	0	2	1.14	1.43	1.83	Y	Low	
Mirror Dory	BP	N	0	0	1.43	1.20	1.87	Y	Low	
School Whiting	BP	N	0	2	1.29	1.13	1.71	Y	Low	
Skipjack Tuna	BP	N	0	0	1.57	1.20	1.98	Y	Low	
Tailor	BP	N	0	0	1.43	1.43	2.02	Y	Low	
Common Seadragon	TEP	N	0	0	1.57	1.28	2.02	Y	Low	
Spotted Pipefish	TEP	N	0	0	1.43	1.13	1.82	Y	Low	
Bigbellied seahorse	TEP	N	0	0	1.43	1.13	1.82	Y	Low	
Crustaceans										
Spider Crab	DI	Y	6	2	2.71	1.38	3.04	Y	Med	
Piecrust Crab	DI	Y	6	2	2.71	1.00	2.89	Y	Med	
Southern Rock Lobster	DI	N	1	1	1.57	1.03	1.88	Y	Low	
Molluscs										
Gould's Squid	BP	N	1	1	1.71	1.03	2.00	Y	Low	
Maori Octopus	BP	N	0	1	1.57	1.03	1.88	Y	Low	
Southern Calamari	BP	N	0	0	1.43	1.43	2.02	Y	Low	
Echinoderms										
Eleven-arm Seastar	DI	N	2	1	2.00	1.08	2.27	Y	Low	

Small mesh sub-fishery

Within the small mesh sub-fishery (north coast commercial mesh and recreational mullet net), three species were ranked as having high vulnerability to the effects of fishing (Table A4): Rock Flathead and Snook due to both species only being abundant on the north coast, both species inhabiting inshore areas where the fishery is concentrated, both species being highly selected by the mesh size used and both species being retained the majority of the time. Great Cormorants were ranked as high due to their low biological productivity and low survival when they encounter the gear.

Species assigned a rank of medium include the remaining seabirds, most of the marine mammals, several teleosts that are either limited to, or most abundant on, the north coast (King George Whiting, Bluespotted Flathead, Blue Rock Whiting and Blue-lined Goatfish) and several chondrichthyans (School Shark, Draughtboard Shark, Grey Nurse Shark and Australian Angel Shark) (Table A4). The marine mammals, seabirds and chondrichthyans are ranked as medium due to their relatively low productivity and tendency toward low survival if captured. The teleosts ranking was a result of the high overlap between the sub-fishery and the core distribution of each species. Grey Nurse Sharks were included due to vague and unsubstantiated reports of them inhabiting the north coast and being caught by 'fishers', although there is no firm evidence that this species inhabits Tasmanian waters. Spider Crabs were also ranked as medium in terms of vulnerability but this is due to the species lacking six biological attributes: it is not envisioned that this sub-fishery is of any real threat to this species.

Table 25. Small mesh net sub-fishery PSA. The reason species ranked as high vulnerability are; 1. >3 missing attributes, 2. Low overlap, 3.High susceptibility (<1.5), low productivity (>2.5), 4. Missing spatial, 5. High still (Hobday *et al.*, 2011).

Species	Role in fishery	Missing > 3 attributes (Y/N)	Missing productivity attributes (out of 7)	Missing susceptibility attributes (out of 4)	Productivity (1- low, 3- high)	Susceptibility (1- low, 3- high)	Vulnerability value (low- high range = 1.41-4.24)	Susceptibility override used?	PSA rank	Reason for high ranking
Marine mammals										
New Zealand Fur-seal	TEP	N	0	0	2.43	1.05	2.65	Y	Med	
Southern Right Whale	TEP	N	0	0	2.71	1.13	2.94	Y	Med	
Humpback Whale	TEP	N	0	0	2.71	1.13	2.94	Y	Med	
Australian Fur-seal	TEP	N	0	0	2.29	1.13	2.55	Y	Low	
Bottlenose Dolphin	TEP	N	0	0	2.86	1.20	0.00	Y	Low	
Common Dolphin	TEP	N	0	0	2.29	1.20	0.00	Y	Low	
Seabirds										
Great Cormorant	TEP	N	1	0	2.57	2.33	3.47	Y	High	4
Little Penguin	TEP	N	1	0	2.14	1.65	2.70	Y	Med	
Blackfaced Cormorant	TEP	N	1	0	2.57	1.65	3.06	Y	Med	
Little Pied Cormorant	TEP	N	1	0	2.57	1.43	2.94	Y	Med	
Short-tailed Shearwater	TEP	N	1	0	2.43	1.43	0.00	Y	Low	
Chondrichthyans										
Draughtboard Shark	DI	N	2	0	2.57	1.00	2.76	Y	Med	
Australian Angel Shark	BP	N	0	0	2.57	1.28	2.87	Y	Med	
School Shark	BP	N	0	0	2.57	1.13	2.81	Y	Med	
Grey Nurse Shark	TEP	N	0	0	2.71	1.20	2.97	Y	Med	
Elephantfish	BP	N	0	0	1.71	1.03	2.00	Y	Low	

Species	Role in fishery	Missing > 3 attributes (Y/N)	Missing productivity attributes (out of 7)	Missing susceptibility attributes (out of 4)	Productivity (1- low, 3- high)	Susceptibility (1- low, 3- high)	Vulnerability value (low- high range = 1.41-4.24)	Susceptibility override used?	PSA rank	Reason for high ranking
Rusty Catshark	DI	N	2	0	2.29	1.03	2.51	Y	Low	
Southern Sawshark	BP	N	0	0	2.14	1.20	2.46	Y	Low	
Southern Eagle Ray	DI	N	0	0	2.29	1.28	2.62	Y	Low	
Gummy Shark	BP	N	0	0	2.29	1.13	2.55	Y	Low	
Whitleys Skate	DI	Y	2	2	2.43	1.00	2.63	Y	Low	
Yellowstriped Leatherjacket	DI	Y	2	2	1.71	1.28	2.14	Y	Low	
Maugean Skate	TEP	Y	2	2	2.29	1.00	2.49	Y	Low	
Great White Shark	TEP	N	0	0	2.86	1.13	0.00	Y	Low	
Teleosts										
Rock Flathead	BP	N	0	0	1.14	3.00	3.21	Y	High	4
Snook	TA	N	1	2	2.00	3.00	3.61	Y	High	4
Bluespotted Flathead	BP	N	0	0	1.43	2.33	2.73	Y	Med	
Old Wife	DI	N	3	0	2.29	1.88	2.96	Y	Med	
King George Whiting	TA	N	0	1	1.43	2.33	2.73	Y	Med	
Blue Rock Whiting	BP	N	1	2	1.43	2.33	2.73	Y	Med	
Common Seadragon	TEP	N	0	0	1.57	2.33	2.81	Y	Med	
Bigbellied seahorse	TEP	N	0	0	1.43	2.33	2.73	Y	Med	
Ruddy Gurnard Perch	BP	N	3	0	2.14	1.13	2.42	Y	Low	
Southern Sand Flathead	BP	N	0	0	1.43	1.58	2.13	Y	Low	
Longfin Pike	TA	N	3	0	2.14	1.20	2.46	Y	Low	
Yellowtail Kingfish	BP	N	0	0	1.71	1.43	2.23	Y	Low	
Silver Trevally	BP	N	0	0	1.57	1.28	2.02	Y	Low	
Australian Salmon	BP	N	0	0	1.57	1.88	2.45	Y	Low	
Snapper	BP	N	0	0	1.71	1.13	2.05	Y	Low	
Bluelined Goatfish	BP	N	0	0	1.14	2.33	2.59	Y	Low	
Longsnout Boarfish	BP	N	3	0	2.00	0.98	2.23	Y	Low	
Grey Morwong	BP	N	0	0	1.29	1.13	1.71	Y	Low	
Bastard Trumpeter	BP	N	0	0	1.71	1.00	1.98	Y	Low	
Bluethroat Wrasse	BP	N	0	0	1.29	1.18	1.74	Y	Low	
Blue Mackerel	BP	N	0	0	1.29	1.13	1.71	Y	Low	
Silver Dory	BP	N	0	0	1.29	1.05	1.66	Y	Low	
Latchet	BP	N	0	0	1.29	1.20	1.76	Y	Low	
Sea Sweep	BP	N	0	0	1.14	1.88	2.20	Y	Low	
Magpie Perch	BP	N	0	0	1.29	1.03	1.64	Y	Low	
Dusky Morwong	BP	N	0	0	1.43	1.88	2.36	Y	Low	
Banded Morwong	DI	N	0	0	1.43	1.05	1.77	Y	Low	
Atlantic Salmon	BP	N	0	0	1.71	1.05	2.01	Y	Low	
Sergeant Baker	DI	N	3	0	2.14	1.43	2.57	Y	Low	
Bearded Rock Cod	DI	N	2	0	1.86	1.43	2.34	Y	Low	
Rock Ling	BP	N	1	0	2.00	1.28	2.37	Y	Low	
Pink Ling	BP	N	1	0	2.14	1.13	2.42	Y	Low	
Striped Trumpeter	BP	N	0	0	1.86	1.05	2.13	Y	Low	
Jackass Morwong	BP	N	0	0	1.43	1.13	1.82	Y	Low	
Blue Warehou	TA	N	0	0	1.29	1.28	1.81	Y	Low	
Spotted Warehou	BP	N	0	0	1.43	1.28	1.91	Y	Low	
Barracouta	BP	N	0	0	1.57	1.43	2.12	Y	Low	

Species	Role in fishery	Missing > 3 attributes (Y/N)	Missing productivity attributes (out of 7)	Missing susceptibility attributes (out of 4)	Productivity (1- low, 3- high)	Susceptibility (1- low, 3- high)	Vulnerability value (low-high range = 1.41-4.24)	Susceptibility override used?	PSA rank	Reason for high ranking
Jack Mackerel	BP	N	0	0	1.29	1.05	1.66	Y	Low	
Rainbow Trout	BP	N	0	2	1.71	1.13	2.05	Y	Low	
Barber Perch	DI	Y	2	2	1.57	1.13	1.93	Y	Low	
Silverbelly	DI	Y	2	2	1.57	1.28	2.02	Y	Low	
Common Bullseye	DI	N	2	1	1.57	1.13	1.93	Y	Low	
Zebra Fish	DI	N	1	2	1.43	1.13	1.82	Y	Low	
Victorian Scalyfin	DI	N	1	2	1.43	1.43	2.02	Y	Low	
Marblefish	DI	Y	3	2	2.00	1.03	2.25	Y	Low	
Yelloweye Mullet	TA	N	0	2	1.00	1.43	1.74	Y	Low	
Senator Wrasse	DI	N	3	0	1.86	1.20	2.21	Y	Low	
Purple Wrasse	BP	N	1	0	1.71	1.08	2.02	Y	Low	
Rosy Wrasse	DI	N	2	0	1.57	1.20	1.98	Y	Low	
Herring Cale	DI	Y	3	2	2.14	1.13	2.42	Y	Low	
Butterfly Mackerel	DI	Y	2	2	2.00	1.05	2.26	Y	Low	
Greenback Flounder	BP	Y	2	2	1.71	1.05	2.01	Y	Low	
Toothbrush Leatherjacket	BP	N	1	2	1.43	1.05	1.77	Y	Low	
Mosaic Leatherjacket	BP	Y	2	2	1.71	1.18	2.08	Y	Low	
Horseshoe Leatherjacket	BP	Y	2	2	1.71	1.28	2.14	Y	Low	
Velvet Leatherjacket	DI	N	1	2	1.57	1.03	1.88	Y	Low	
Brownstriped Leatherjacket	DI	Y	2	2	1.71	1.08	2.02	Y	Low	
Six-spined Leatherjacket	BP	Y	2	2	1.71	1.13	2.05	Y	Low	
Stars and Stripes Leatherjacket	DI	Y	2	2	1.57	1.28	2.02	Y	Low	
Shaw's Cowfish	DI	Y	4	2	2.14	1.43	2.57	Y	Low	
Prickly Toadfish	DI	Y	3	2	1.86	1.28	2.25	Y	Low	
Globefish	DI	Y	4	2	2.14	1.43	2.57	Y	Low	
Crested Weedfish	DI	Y	3	2	2.14	1.20	2.46	Y	Low	
Garfish	BP	N	0	2	1.14	1.13	1.60	Y	Low	
Luderick	BP	N	0	2	1.14	1.43	1.83	Y	Low	
Ocean Perch	BP	N	0	0	1.86	1.43	2.34	Y	Low	
Real Bastard Trumpeter	DI	N	1	2	1.57	1.43	2.12	Y	Low	
School Whiting	BP	N	0	2	1.29	1.05	1.66	Y	Low	
Sea Mullet	BP	N	1	2	1.43	1.43	2.02	Y	Low	
Southern Conger Eel	DI	Y	2	2	2.29	1.05	2.52	Y	Low	
Tailor	BP	N	0	0	1.43	1.43	2.02	Y	Low	
Spotted Pipefish	TEP	N	0	0	1.43	1.20	1.87	Y	Low	
Crustaceans										
Spider Crab	DI	Y	6	2	2.71	1.18	2.96	Y	Med	
Southern Rock Lobster	DI	N	1	1	1.57	1.13	1.93	Y	Low	
Echinodermata										
Eleven-arm Seastar	DI	N	2	1	2.00	1.00	2.24	Y	Low	
Molluscs										
Gould's Squid	BP	N	1	1	1.71	1.03	2.00	Y	Low	
Maori Octopus	BP	N	0	1	1.57	1.03	1.88	Y	Low	
Southern Calamari	BP	N	0	0	1.43	1.13	1.82	Y	Low	