

UNIVERSITY of TASMANIA



Institute for Marine and Antarctic Studies

REVIEW OF AUSTRALIA'S SMALL PELAGIC
FISHERIES: INSIGHTS TO INFORM THE
DEVELOPMENT OF A POTENTIAL NEW
TASMANIAN SARDINE FISHERY

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NON-TECHNICAL SUMMARY

Background and structure

This review of Australia's small pelagic fisheries was designed to provide insights to inform the development of a potential new fishery to utilise the Australian Sardine (*Sardinops sagax*, herein called Sardine) resource that occurs in waters off Tasmania (herein called the potential new Tasmanian Sardine Fishery). The review also evaluates the suitability for establishing the potential new fishery of key aspects of the developmental fishing program for Sardine instituted by the Tasmanian Government in 2015. The Department of Natural Resources and Environment Tasmania has indicated that the review should provide advice to address (but not be limited to) the following topics:

1. The operations of existing Australian small pelagic fisheries, especially the South Australian Sardine Fishery (SASF) and Commonwealth Small Pelagic Fishery (SPF)
2. The management regimes implemented in those fisheries
3. The histories and developmental processes of those fisheries and lessons learnt
4. Harvest strategy rules utilised and "best practice" that might be adopted
5. Issues relating to incidental capture of threatened species and minimisation strategies
6. Additional and ongoing research and assessment processes that may be required
7. Learnings, lessons and options from all the above that might be adopted/utilised a Tasmanian Sardine fishery
8. Advice/options on structural and operational issues for a Tasmanian fishery including limiting interactions with other user groups and stakeholders
9. Overview of licencing and access arrangements used in pelagic fisheries with an evaluation of implications for a Tasmanian Sardine fishery.

This review considers peer-reviewed scientific literature, as well as industry and government documents and reports relating to Australia's small pelagic fisheries. International literature on small pelagic fisheries is incorporated where it is relevant. The report provides electronic links to copies of key documents (e.g. Management Plans, Harvest Strategies, Codes of Practice).

The Results and Discussion section of the report is divided into nine sub-sections:

- Australia's small pelagic fisheries
- Target and limit reference points
- Examples of modern Harvest Strategies for small pelagic fishes
- Monitoring and assessing stock status
- Incidental capture of protected species
- Ecosystem considerations
- Social licence to operate
- Licensing and access arrangements
- Management structures.

Evaluation of the previous developmental fishing program for Australian Sardine

Many aspects of the previous developmental fishing program remain appropriate for the potential new Tasmanian Sardine Fishery, including:

- establishing separate small-scale and large-scale sectors,
- establishing two zones (i.e. Bass Strait and the East Coast) and spatial closures to reduce conflicts with other stakeholders and protect sensitive habitats/species
- using an exploitation rate of 20% to set annual catch limits
- establishing sampling programs to obtain biological information and monitor size/age structure of catches for both sectors
- requiring applications of the Daily Egg Production Method (DEPM) every five years to support the ongoing development of the large-scale sector

- requiring vessels to have a vessel monitoring system (VMS), approved codes of conduct for addressing interactions with protected species and an independent observer program with initial coverage of 20%.

Key aspects of the previous framework that may need to be reconsidered include:

- setting a total catch limit that reflects the recent finding that spawning biomass of the South-eastern Sardine stock is likely to be greater than 200,000 t
- balancing the need to provide sufficient certainty about duration of access to enable operators to invest capital against the constraint that granting of a permit does not provide entitlement to permanent access to any future fishery.

Management options for the potential new Tasmanian Sardine Fishery

- The Harvest Strategy established for the potential new Tasmanian Sardine Fishery should build on approaches that have been tested and established in the SASF and SPF.
- Building on what has been done these fisheries and addressing the Tasmanian Government's legislative requirements and policy position, a draft objective for the Harvest Strategy for the new fishery could be: *"A profitable commercial fishery that is ecologically sustainable, socially acceptable and delivers economic benefits to the Tasmanian community."*
- The Harvest Strategy for the new Tasmanian Sardine Fishery could include some aspects of the approaches used in the SASF but not in the SPF (e.g. applying the exploitation rate to a target reference point for spawning biomass rather than directly to the estimate of spawning biomass; and/or reducing the exploitation rates as the spawning biomass declines towards a point where recruitment may be impaired). Decision rules that are established in the new fishery should be tested using management strategy evaluations.
- The total catch for the fishery (large- and small-scale sectors combined) could be set at 30,000 t, which equates to 20% of the recommended Target Reference Point for spawning biomass of 150,000 t (i.e. 75% of the minimum likely spawning biomass of ~200,000 t).
- The total catch for small-scale sector could be set at 4,500 t to 7,500 t (i.e. 3-5% of the TRP of 150,000 t). Key management measures for the sector could include spatial controls to reduce interactions with other stakeholders and protect sensitive habitats/species.
- The total catch for large-scale sector could be set at 22,500 t to 25,500 t (i.e. 15-17% of 150,000 t). Key management measures could include a Total Allowable Catch, Individual Transferable Quotas and two zones (East Coast and Bass Strait), with most of the catch allocated to the Bass Strait Zone.
- The split of allocations between the small- and large-scale sectors could be established with clarity that the fractions would not be fixed and that decisions by Government to change the proportional split would occur with sufficient lead-time to enable businesses to adjust.

Research and Monitoring Stock Status

- Research and monitoring of the small-scale sector should include a catch sampling program to obtain biological information about the Sardine stock and monitor the size/age structure of the catch. Findings could be reported in Scalefish assessment reports.
- In addition to a catch sampling program, the large-scale sector would require the DEPM to be applied every five years. The DEPM survey would ideally cover the entire South-eastern Sardine Stock. Findings from both fishery-dependent and independent monitoring programs could be reported in annual fishery assessment reports.

Interactions with protected species, ecosystem considerations and social licence to operate

- An independent observer program with 20% initial coverage should be established to monitor interactions with protected species.

- Vessels should also be required to have a Vessel Monitoring System and a code of conduct for addressing interactions with protected species that meets guidelines or rules set by Government.
- Logbook and observer data on dolphin interactions should be reported annually. Increased observer coverage and electronic monitoring should be considered if dolphin mortalities are under-reported in logbooks.
- A formal ecological risk assessment should be conducted to inform the development of the potential new Tasmanian Sardine Fishery.
- Establishing research projects on the roles of Sardines in the pelagic ecosystems off Tasmania may provide new insights into the structure and function of the system and would help to build community confidence that the fishery is ecologically sustainable.

Management Structures

- The consultative structures that are established/adapted to support the new Tasmanian Sardine Fishery may need to include representatives of Aboriginal organisations (as a new opportunity), community groups (such as regional councils and tax-payer associations), recreational fishers, and non-government environmental organisations, as well specialist sardine fishers, and scientists with expertise in small pelagic fisheries, fisheries economics and social sciences.

1.0 BACKGROUND

1.1 South-eastern stock of Australian Sardine

A recent report by the institute for Marine and Antarctic Studies (IMAS, Ward et al. 2022) provided compelling evidence that in 2019 the spawning biomass of the eastern component of the South-eastern stock (Figure 1) of Australian Sardine (herein Sardine) was at least 185,000 tonnes (t). Combined with results of a previous study (Ward et al. 2015), the report also indicated that the spawning biomass of the entire stock, i.e. including waters west of the 2019 survey (Figure 2), was likely to be greater than 200,000 t, and potentially greater than 250,000 t. The egg distributions from three previous surveys (Figure 2) are indicative of the distribution of adult Sardine during the spawning season. These egg distributions show that most of the South-eastern spawning stock (Figure 1) is located in Bass Strait, with fewer spawning fish occurring along the east coasts of New South Wales, Victoria and Tasmania.

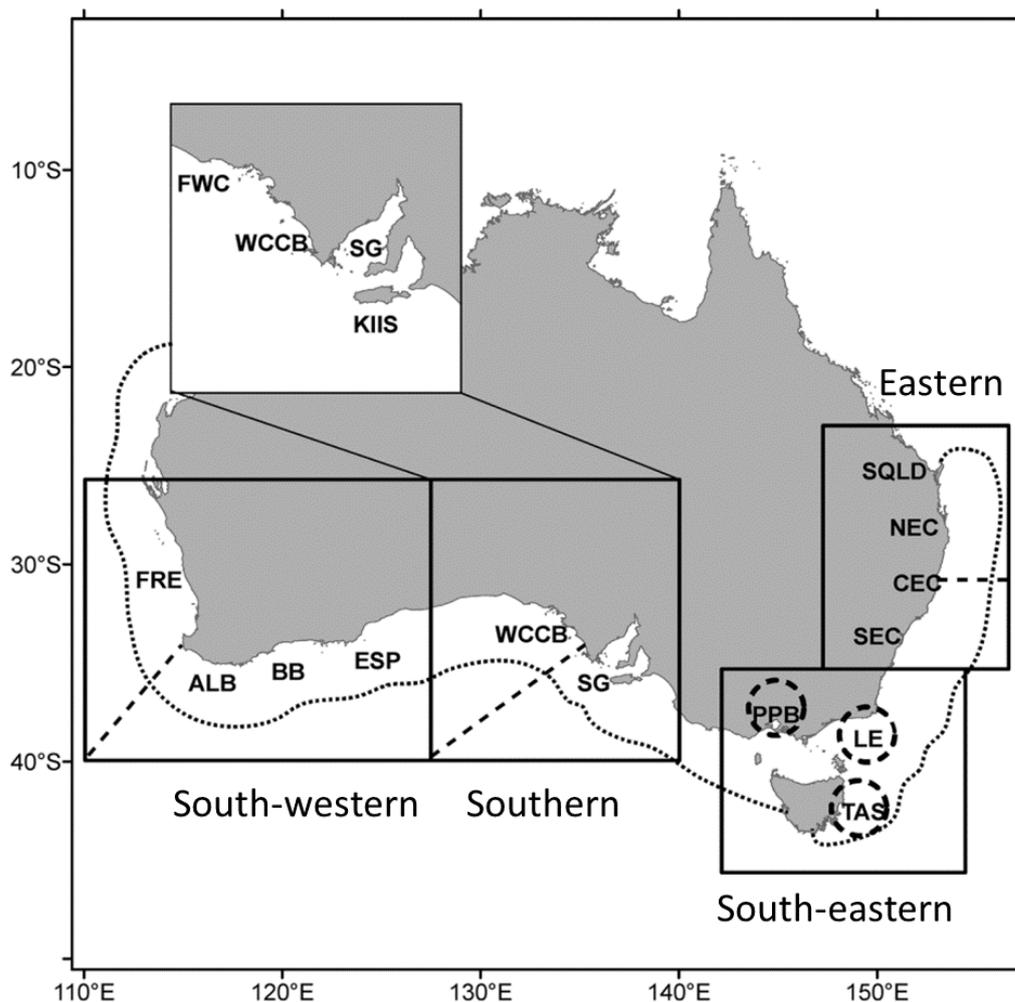


Figure 1. The four stocks of Sardine, *Sardinops sagax* found in Australian waters (South-western, Southern, South-eastern, Eastern). The dotted line is the approximate distribution of the meta-population. Regional codes show locations where data were available to use in the analysis: QLD Southern Queensland, NEC North East Coast, CEC Central East Coast, SEC Southern East Coast, LE Lakes Entrance, TAS Tasmania, PPB Port Philip Bay, SG Spencer Gulf, WCCB West Coast SA and Coffin Bay, ESP Esperance, BB Bremer Bay, ALB Albany, FRE Fremantle. The inset figure shows the key sardine fishing regions in South Australia; FWC Far West Coast, KIIS Kangaroo Island and Investigator Strait (Adapted from Izzo et al. 2017 with permission of Springer).

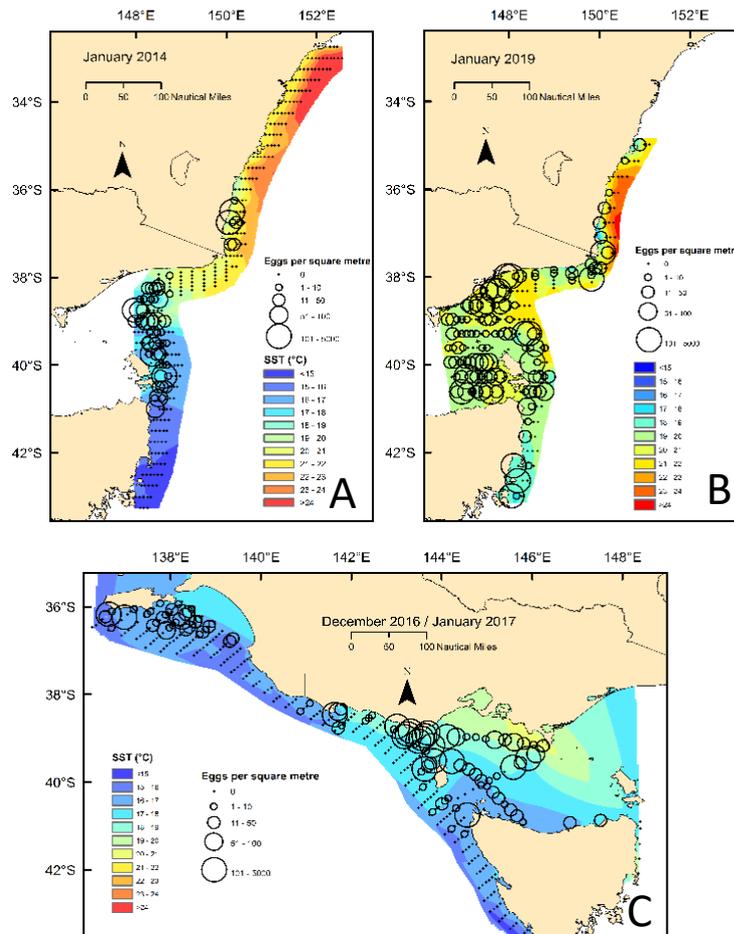


Figure 2. Sea surface temperatures and densities of sardine eggs at sites sampled in the ichthyoplankton surveys conducted in the eastern component of the South-eastern stock in 2014 and 2019 (A and B, respectively) and the western component in 2016/17 (B). Data from Ward et al. (2015; 2018, 2022) used to produce the images was provided by the South Australian Research and Development Institute.

The South-eastern Sardine resource is shared by three jurisdictions: Tasmania, Victoria and NSW (Figure 1). The Status of Australian Fish Stocks Report 2021 indicates that catches from the stock over the previous decade have been less than 3,000 t per annum, with >95% taken off eastern Victoria and the rest taken off southern New South Wales (Ward et al. 2021). As Sardine in Australian waters can sustainably support exploitation rates of up to 33% of the spawning biomass (Smith et al. 2015), there is considerable potential to increase the catch being taken from this resource.

1.2 Sardine catches off Tasmania

The Tasmanian Government has jurisdiction over the management of finfish, including Sardine, in Tasmanian State waters and the area defined in the Offshore Constitutional Settlement with the Commonwealth of Australia (Figure 3, Commonwealth of Australia 1996). Although a large proportion of the South-eastern Sardine stock lies in waters under Tasmanian jurisdiction (Ward et al. 2022), this large resource is not currently harvested in significant quantities by the Tasmanian wild capture sector (Fraser et al. 2021). In the 1990s and 2000s, annual catches of up to ~15 t were occasionally taken by fishers targeting other small pelagic species, such as Jack Mackerel and Redbait (Fraser et al. 2021). The highest historical annual catch of ~33 t was taken in 2017/18 as part of a developmental fishing program for Australian Sardine established by the Tasmanian Government in

2015 (DPIPWE 2015a, Appendix 1). Two large-scale and two small-scale permits were issued under the program. All developmental permits have now expired (Fraser et al. 2021).

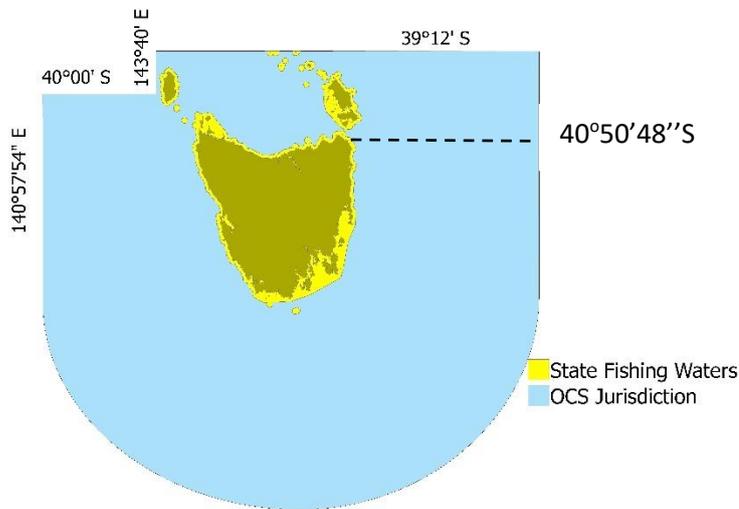


Figure 3. Map showing Tasmanian State waters and the area under Tasmanian jurisdiction for finfish under the Offshore Constitutional Settlement with the Commonwealth of Australia (1996). Dotted line is the line proposed to separate the Bass Strait and East Coast Zones. Source: NRE Tasmania.

The framework for the developmental fishing program previously established for Australian Sardine identified two sectors: a large-scale sector capable of handling individual catches of several tonnes or greater, and a small-scale sector taking individual catches of less than one tonne (DPIPWE 2015a, Appendix 1). Two zones were proposed: Bass Strait and the East Coast Zones. The main gear type was purse-seining (note: board trawling is banned in Tasmanian waters under Fisheries (Scalefish) Rules 2015). A total annual catch limit of 600 tonnes was established for the large-scale sector, with a maximum of 300 tonnes to be taken from Bass Strait and 300 tonnes from the East Coast. A 'soft cap limit' of 60 t per month was also established for the large-scale sector. A maximum catch of 50 tonnes was set for the small-scale sector.

Spatial closures were also established to minimise interactions with existing users and protect sensitive habitats and/or species (Appendix 1). Vessels in the large-scale sector were required to have a vessel monitoring system (VMS). Participants in this sector were also required to have an approved code of conduct that addressed interactions with protected species. An initial observer program (20% coverage) was envisaged. A stepwise research program that progressively obtained more information as the fishery grew was planned, with costs to be supported by permit fees. Information obtained during the research program were summarised by Fraser et al. (2021).

1.3 Developmental Fisheries Management Policy Document

The developmental fishing program for Australian Sardine was established under the Tasmanian Government's Developmental Fisheries Management Policy Document (DPIPWE 2015b, Appendix 2). The Policy Document indicates that developmental opportunities will be supported where it can be demonstrated that a long term, commercially profitable, environmentally sustainable and socially acceptable fishery can be developed. The policy recognises that there will be very few large-scale development opportunities, but that there may be more small-scale opportunities. A key objective of the policy is not to stimulate new investment in capital equipment, vessels and fishing gear that is totally reliant on the developmental fishing operation/activity.

The policy identifies two categories of fishery developments (1) completely novel fishing activities that are outside existing fishery management plans or regulations and (2) those which might be an adjunct to an existing fishery using methods/gears established under a prevailing fisheries management plan. For novel fishing activities (Category 1), the proponent will be invited to submit a developmental fishery plan in accordance with guidelines provided by DPIPW. For activities that may be an adjunct to an existing fishery (Category 2), the Minister will determine those licence holders to whom permits to participate in a developmental fishery will be issued. Permits under both categories will be granted for a maximum of one year. Importantly, the Policy Document explicitly states that the “granting of a permit to authorise a developmental fishing activity cannot provide any entitlement to long-term access to any future fishery.”

2.0 RATIONALE, AIMS AND OBJECTIVES

The existence of an under-utilised sardine resource off Tasmania provides a significant economic opportunity for the State. Given the potential economic value of the resource, as well as the ecological role of Sardines as a prey source for predatory fishes, seabirds and marine mammals (Bulman et al. 2011; Goldsworthy et al. 2013; Pikitch et al. 2014; Smith et al 2011; 2015;), it is important that development and management processes established for a potential Tasmanian Sardine Fishery take into account lessons learned through the development and management of other Australian fisheries for small pelagic species. It is also important that lessons learned from the previous Tasmanian developmental fishing program for Australian Sardine are considered when arrangements for any new fishery are being established.

The rationale underpinning this review is that the successes and failures of Australia's fisheries small pelagic species are likely to provide insights that should be considered during the establishment of a new Tasmanian Sardine Fishery. The Department of Natural Resources and Environment Tasmania (NRE Tasmania) commissioned this review because it considered that the management regimes established in these fisheries and the histories of how they were developed, would help to assess what form of sardine fishery might be established in Tasmania and how it should be developed and managed.

The aim of this review of Australia's small pelagic fisheries is to provide insights to inform the potential development and management of a Tasmanian fishery targeting the South-Eastern Australian Sardine stock. NRE Tasmania has indicated that the review should provide advice relating (but not be limited to) the following topics:

1. The operations of existing Australian small pelagic fisheries, especially the South Australian sardine fishery and Commonwealth Small Pelagic Fishery
2. The management regimes implemented in other Australian fisheries
3. The histories and developmental processes of those fisheries and lessons learnt
4. Harvest strategy rules and “best practice” options that might be adopted
5. Issues relating to incidental capture of threatened species and minimisation strategies
6. Additional and ongoing research and assessment processes that may be required
7. Learnings, lessons and options from all the above that might be adopted/utilised in a Tasmanian Sardine fishery
8. Advice/options on structural and operational issues for a Tasmanian fishery including limiting interactions with other user groups and stakeholders
9. Overview of licencing and access arrangements used in pelagic fisheries with an evaluation of implications for a Tasmanian Sardine fishery

3.0 METHODS

This review considers peer-reviewed scientific literature, as well as industry and government documents and reports relating to Australia's small pelagic fisheries. International literature on small pelagic fisheries is incorporated where it is relevant. The report provides electronic links to copies of key documents (e.g. Management Plans).

4.0 RESULTS AND DISCUSSION

4.1 Australia's small pelagic fisheries

There have been numerous attempts to establish fisheries for small pelagic species in Australia (e.g. see Kailoa et al. (1993) for an historical overview). The outcomes of these efforts have been variable. The two most notable success stories are the South Australian Sardine Fishery (SASF) and the Commonwealth Small Pelagic Fishery (SPF), which collectively take approximately 30% (>55,000 t, Ward et al. 2020; Ward and Grammer 2021) of the total Australian wild catch by weight (~180,000 t, ABARES 2020). Smaller Sardine fisheries, with contrasting histories also operate in waters off Western Australia, New South Wales and Victoria (Ward et al. 2021). Conversely, Sardine fishing was trialled and subsequently prohibited in Queensland in the 1990s; the Jack Mackerel Fishery off Tasmania rose and fell dramatically in the 1980s and 1990s (Expert Panel Report 2014) and has now been incorporated into the SPF; and attempts to establish a multi-species fishery for small pelagic species off the Northern Territory have been largely unsuccessful.

The contrasting histories and status of Australia's small pelagic fisheries (Table 1) provide several lessons for the development of a potential Tasmanian Sardine Fishery. Most importantly, the rise and fall of the Jack Mackerel Fishery (Expert Panel Report 2014) and parts of the Western Australian Sardine Fishery in the 1980s and 1990s (especially the collapse of the Albany fishery after 1989, Gaughan et al. 2008) demonstrate the importance of not allowing fisheries for small pelagic species to grow quickly before establishing 1) robust stock assessment procedures and/or 2) precautionary management arrangements that reflect levels of scientific uncertainty about stock status.

The successful growth of the SASF (see Grammer et al. 2021), and more recently the SPF (see Ward and Grammer 2019), which both have robust stock assessment procedures and precautionary management arrangements, also highlight the importance of these points. However, the rapid growth of the SASF and SPF also demonstrate the critical importance of having large reliable markets (i.e. for tuna feed and fish meal, respectively) to support the development of large volume fisheries. The contrasting small size and limited growth of the Sardine fisheries off Victorian and New South Wales (and in recent years Western Australia) reflect the difficulties of developing large fisheries for small pelagic species in Australia based solely on markets for human consumption, recreational bait and/or pet food.

Despite its recent growth, the history of the SPF also highlights the critical importance of social acceptance for ensuring the long-term success of pelagic fisheries (e.g. Tracey et al. 2013). Attempts to introduce a large factory-trawler into the SPF in 2012, met with strong resistance from conservation sector and recreational sectors, despite the fishery having well developed research and management frameworks (e.g. AFMA 2017). In response to an intense social media campaign, the Australian Government imposed a moratorium on large factory trawlers that overrode its own fisheries management objectives and process. Concurrently, the Government announced a comprehensive review of Australia's Commonwealth fisheries management legislation. The opposition to the introduction of a large factory-trawler into the SPF was particularly strong in Tasmania, in part because of the previous rise and fall of the Jack Mackerel Fishery.

Fishery, Time period, Main target species	Key markets	Gear types, numbers of licenses or vessels	Location and zoning	Maximum Catch Catch trend Estimated Gross Value of Production in 2021	Assessment and Management Framework	Selected key References
Jack Mackerel Fishery 1979-2000 Mainly <i>Jack Mackerel</i>	Mainly fish meal plant off Triabuna, Tasmania	Multiple licenses and purse-seiners	Most catches taken off Tasmania. Four zones (from Geraldton, WA to NSW-Qld border) established in 1991	Peak ~42,000 t in 1986/87 High level of interannual variability in catches Lowest catches at end of the time-series GVP in 2021: NA	No dedicated ongoing stock assessment program No clearly defined process for setting catches	Bulman et al. (2008) Expert-panel-report-small-pelagic-fishery.pdf Ward et al. (2019)
Tasmanian Jack Mackerel Fishery 1997 to date Jack mackerel Blue mackerel Redbait Fishery has not been active since the 2012/13 season.	Mainly fish meal plant off Triabunna, Tasmania	Four Mackerel A licences and one Mackerel B licence up until 2020. Now only one Mackerel B licence. Purse seine only	Tasmanian State waters, primarily off the east coast.	Peak ~920 t in 2008/09 followed by 907 t in 2009/10 Catch declined after this (market driven) and company stopped fishing after the 2012/13 season. GVP in 2021: \$0	No dedicated ongoing stock assessment program. Bases annual TACs for jack mackerel, blue mackerel and redbait on the Commonwealth SPF Global TACs. Basing it on a third of the Global TAC divided by two. Legislative framework is the Fisheries (Mackerel) Rules 2019	Source: NRE Tasmania
Small Pelagic Fishery 2001-present Mainly <i>Jack Mackerel</i> , <i>Blue Mackerel</i> , <i>Redbait</i> Some <i>Sardine</i>	2017-present mainly fish meal plant(s) off southern NSW 2015-16 human consumption by freezer trawler	Multiple (~30) quota holders. One or two mid-water trawlers take most of the catch. Large freezer-trawler during 2015-16. Limited purse seining.	Two zones: East and West established in 2008 Most recent catches taken off southern NSW. Some fishing in West in 2015-16 by freezer trawler.	Peak ~14,000-16,000 t in 2019/20 and 2020/21 High level of interannual variability in catches. Low catches due to low effort Highest catches in most recent years GVP in 2021/22: Confidential	Daily egg production method (DEPM) applied to all stocks. Management Plan with Harvest Strategy established in 2008, with ongoing revisions, especially in 2014.	Small Pelagic Fishery DAWF; SPF-Harvest-Strategy AFMA , Smith et al. (2015). Ward et al. (2019)
South Australian Sardine Fishery 1991-present Mainly <i>Sardine</i>	Most >95% tuna feed Port Lincoln	14 licenses, multiple purse-seiners	SA Waters, Three zones trialed from 2012 onwards	Peaks ~40,000 in 2004 and 2017-21. Large reductions in catch during 1990s following	DEPM applied since 1995. Population modelling since 2014.	Grammer et al. (2021) SAFS Sardine 2021 SA Sardine Management Plan

	Some human consumption and recreational bait		and established in 2019	mass mortality events. Increasing trend. Highest catches recent years Estimated GVP in 2019/20: \$27M	Management Plans with Harvest Strategies established in 1995 and 2014,	Sardine Final Economic BDOs
Western Australian Sardine Fisheries 1991-present Mainly <i>Sardine</i> Also Tropical Sardine	Human consumption, recreational bait	Multiple licenses and purse-seiners	Two management units: West Coast and South Coast	Peak ~9,000 t in 1989 Large reductions in catch in 1990s before and after mortality events. Stocks recovered by mid-2000s. Low catches in recent years due to low effort	Dedicated research began in 1989. TACs were established in 1989. Management Advisory Committee established in 1990. DEPM and population modelling conducted in 1990s and 2000s. Exploitation rates less than 5% since mid-2000s.	SAFS Sardine 2021 WA South Coast Purse Seine Fishery Gaughan et al. (2002, 2004, 2008) Izzo et al. 2017
New South Wales Sardine Fishery	Human consumption	Multiple purse-seines		Peak ~2,000 t in 2008/09 Catches declined after fire destroyed processing factory in southern NSW in 2010. Remained low since then.	DEPM applied to eastern stock in 2004, 2014 and 2019.	Stewart et al (2010), Ward and Rogers (2007); Ward et al. (2019) SAFS Sardine 2021
Victorian Sardine Fishery 1991-present Mainly <i>Sardine</i>	Pet food	One purse-seine	Lakes Entrance Commercial fishing in Port Phillip Bay ceased.	Peaks of 2,628 t in 2010/11 and 2,344 t in 2016/17. Declined in recent years	No formal assessments or management framework. DEPM applied in 2014 and 2019.	SAFS Sardine 2021 VFA-Commercial-Fish-Production-2020~21 Ward et al. 2015, 2022

Table 1. Summary of the key features of existing Australian small pelagic fisheries. Species Jack Mackerel (*Trachurus declivis* and *T. murphyi*), Blue Mackerel (*Scomber australasicus*), Redbait (*Emmelichthys nitidus*), Sardine (*Sardinops sagax*), Tropical Sardine (*Sardinella lemuru*)

Implications for the potential Tasmanian Sardine Fishery

The framework for Tasmania's previous developmental Sardine fishery established separate small-scale and large-scale sectors. Information obtained in this review of Australia's small pelagic fisheries suggests that this approach was appropriate at the time and remains valid. The small-scale sector would presumably target markets for human consumption, recreational bait and/or pet food and could be established relatively quickly. However, it is important to note that the limited development of the Sardine fisheries off Victoria and New South Wales demonstrates the challenges associated with establishing successful small pelagic fisheries based entirely on these relatively small markets. This challenge is likely to be exacerbated in Tasmania where local markets are likely to be smaller than those in Victoria and New South Wales. If large markets (e.g. for tuna food or fish meal) can be identified for sardines taken off Tasmania, there may also be potential to establish a large (industrial) scale fishery targeting the South-eastern Sardine stock. However, a large-scale sector is likely to take more time to establish than the small-scale sector (e.g. due to the need for larger vessels and greater onshore infrastructure). The establishment of a small-scale sector would not need to be delayed while the potential to establish a larger fishery is further explored. The small-scale sector of the potential new Tasmanian Sardine Fishery is likely to be accepted more readily by the Tasmanian community than the large-scale sector.

4.2 Target and limit reference points

Several studies (e.g. Bulman et al. 2011; Goldsworthy et al. 2013; Smith et al. 2015) have shown that the marine food webs of south-eastern Australia are not as dependant on small pelagic fishes (i.e. Jack Mackerel, Redbait, Blue Mackerel and Sardine) as those off North and South America, southern Africa and elsewhere (e.g. Smith et al. 2011; Pikitch et al. 2014). In these other ecosystems, many predatory species, including fishes, seabirds and marine mammals, have a high level of dietary dependence on one or two small pelagic species (e.g. Cury et al. 2011; Smith et al. 2011; Pikitch et al. 2012). None of the key predators in south-eastern Australia, such as seals, penguins and tunas, has a high dietary dependence on small pelagic species (Bulman et al. 2011; Goldsworthy et al. 2013; Smith et al. 2015).

This reduced dependence of predators on small pelagic species in the marine ecosystems of south-eastern Australia means that the management frameworks do not need to be as precautionary as those elsewhere (e.g. Pikitch et al. 2012). Smith et al. (2015) suggested that from an ecosystem perspective the target reference point for SPF species (Jack Mackerel, Blue Mackerel, Redbait, Sardine) could be safely set at 50% virgin biomass (B_{50}) and the limit reference point could be safely set 20% virgin biomass (B_{20}). For species taken in the SPF and SASF, the exploitation rate to achieve a median depletion of 0.5 or B_{50} , while maintaining less than a 10% chance of falling below the suggested limit reference point of B_{20} are shown in Table 1

Table 2: Exploitation rates that achieve a median depletion of 0.5 or B_{50} , while maintaining less than a 10% chance of falling below the suggested limit reference point of B_{20} for stocks in the Commonwealth Small Pelagic Fishery and South Australian Sardine Fishery (Smith et al. (2015).

Species	East sub-area	West sub-area
Jack Mackerel, <i>Trachurus declivis</i> , <i>T. murphyi</i>	12%	12%
Blue Mackerel, <i>Scomber australasicus</i>	23%	23%
Redbait, <i>Emmelichthys nitidus</i>	9%	10%
Australian Sardine, <i>Sardinops sagax</i>	33%	33%

Implications for the potential Tasmanian Sardine Fishery

The framework for the previous Tasmanian developmental Sardine fishery established annual catch limits of 50 t and 600 t for the small-scale and large-scale sectors, respectively. However, these limits were established before evidence became available that indicated the spawning biomass of the South-eastern Sardine stock was likely to be greater than 200,000 t (Ward et al. 2022). As 1) stocks of Australia Sardine can safely sustain exploitation rates of up to 33% (Smith et al. 2015) and 2) current catches from this stock are less than 3,000 t per annum (Ward et al. 2021), there is considerable potential to establish catch limits for both the small-scale and large-scale sectors that are substantially higher than those envisaged under the previous developmental framework.

The new evidence available about the large size of the South-eastern Sardine stock suggests that potential new Tasmanian Sardine Fishery is one of the few large-scale development opportunities likely to be available to the Tasmanian fishing industry. The successful establishment of both small-scale and large-scale sectors of the potential Tasmanian Sardine Fishery will require significant investment. This requirement is not consistent with the objective of the Developmental Fisheries Management Policy Document that specifies that developmental fisheries should not stimulate new investment in capital equipment, vessels and fishing gear that is totally reliant on the developmental fishing operation/activity. It is difficult to envisage how the investment required to develop the potential Tasmanian Sardine Fishery could be made without concessions in the framework to provide access of sufficient duration to make the capital investment worthwhile.

4.3 Examples of modern Harvest Strategies for small pelagic fisheries

Commonwealth Small Pelagic Fishery

The objective of the Harvest Strategy for the SPF is: *“The sustainable and profitable utilisation of the Small Pelagic Fishery in perpetuity through the implementation of a harvest strategy that maintains key commercial stocks at ecologically sustainable levels and, within this context, maximises the net economic returns to the Australian community”* (AFMA 2017).

This objective involves enabling harvest to occur, within safe biological and ecological limits, and ensuring that maximum economic benefits flow to the Australian community. However, not all of these elements are addressed equally. Biological and ecological elements are strong but there is no explicit strategy for maximising economic benefit to the community.

The Commonwealth SPF Harvest Strategy applies to the each of three sub-areas (zones) of the SPF (Figure 3). It is used to develop advice on Recommended Biological Catches (RBCs) and Total Allowable Catches (TACs) for the four quota species: Jack Mackerel, Blue Mackerel, Redbait and Australian Sardine. Finer scale spatial management arrangements have also been implemented within zones. For example, some areas are closed to mid-water trawling, and sub-zones and catch grids have been established to help manage interactions with protected species and reduce the potential for localised depletion, respectively (Figure 4).

RBCs are based on estimates of spawning biomass obtained using the using the Daily Egg Production Method (DEPM, Parker, 1980; Lasker 1985; Ward et al. 2021) and species-specific harvest rates established in the Harvest Strategy. Fishery-dependent data such as catch, effort and size/age catch structure information are also considered. TACs are calculated by subtracting known sources of mortality from the RBCs.

The Harvest Strategy for the SPF has three tiers (Table 3). Each stock is allocated to a tier based upon how recently the estimate of spawning biomass was obtained using the DEPM. Stocks remain at Tier

1 for five seasons after a DEPM survey is completed and then revert to Tier 2. Stocks of Blue Mackerel and Sardine can remain at Tier 2 for up to five seasons whereas Redbait and Jack Mackerel stocks can remain at Tier 2 for up to ten seasons. All stocks remain at Tier 3 indefinitely.

The exploitation rates in the SPF Harvest Strategy provide a high likelihood that stocks will be maintained, on average, at the target reference point of B_{50} , with a less than a 10% chance over 50 years of falling below the limit reference point of B_{20} . More precautionary exploitation rates than those recommended by Smith et al. (2015) were established for Sardine (i.e. 20% rather than 33%) and Blue Mackerel (i.e. 15% rather than 23%) due to the high potential for fluctuations among years in the spawning biomass of these short-lived species, as well as significant uncertainties in existing knowledge of the growth rates and reproductive biology for Blue Mackerel. There are no explicit rules in the Harvest Strategy for the SPF for reducing exploitation rates as the spawning biomass is reduced towards the point where recruitment is likely to be impaired (Banks et al. 2019).

Table 3. Maximum exploitation rates and the number of years for each stock at each of the three tiers of the SPF Harvest Strategy (AFMA 2017).

Species	East Sub-area			West sub-area		
	Tier 1	Tier 2	Tier 3	Tier 1	Tier 2	Tier 3
Jack Mackerel, <i>Trachurus declivis</i> , <i>T. murphyi</i>	12% 5 years	6% 10 years	3% indefinite	12% 5 years	6% 10 years	3% indefinite
Blue Mackerel, <i>Scomber australasicus</i>	15% 5 years	7.5% 5 years	3.75% indefinite	15% 5 years	7.5% 5 years	3.75% indefinite
Redbait, <i>Emmelichthys nitidus</i>	10% 5 years	5% 10 years	2.5 % indefinite	10% 5 years	5% 10 years	2.5 % indefinite
Australian Sardine, <i>Sardinops sagax</i>	20% 5 years	10% 5 years	5% indefinite	NA	NA	NA

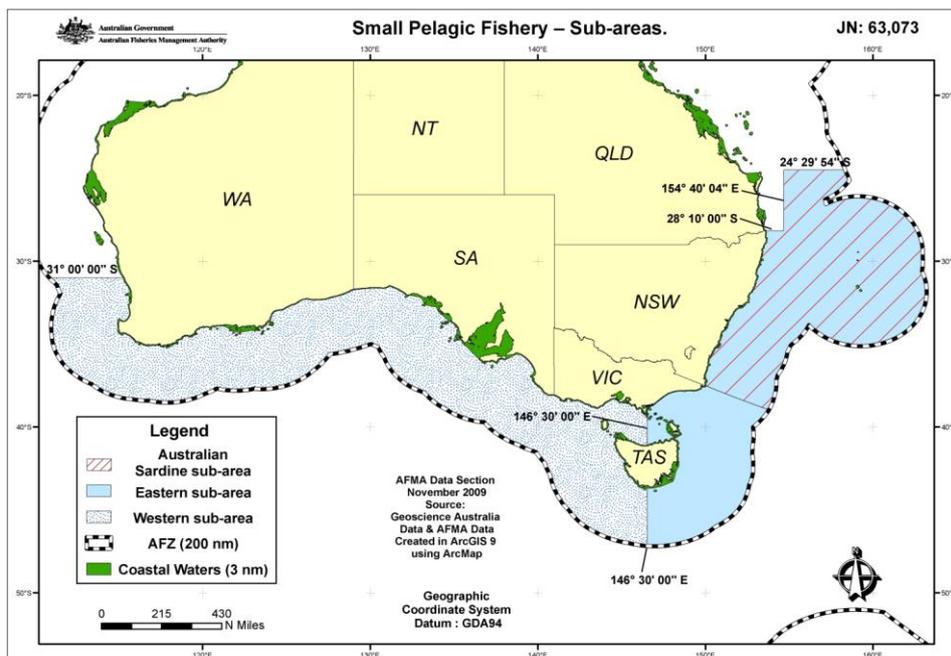


Figure 4. Management sub-areas of the Commonwealth Small Pelagic Fishery. (Source: AFMA 2017).

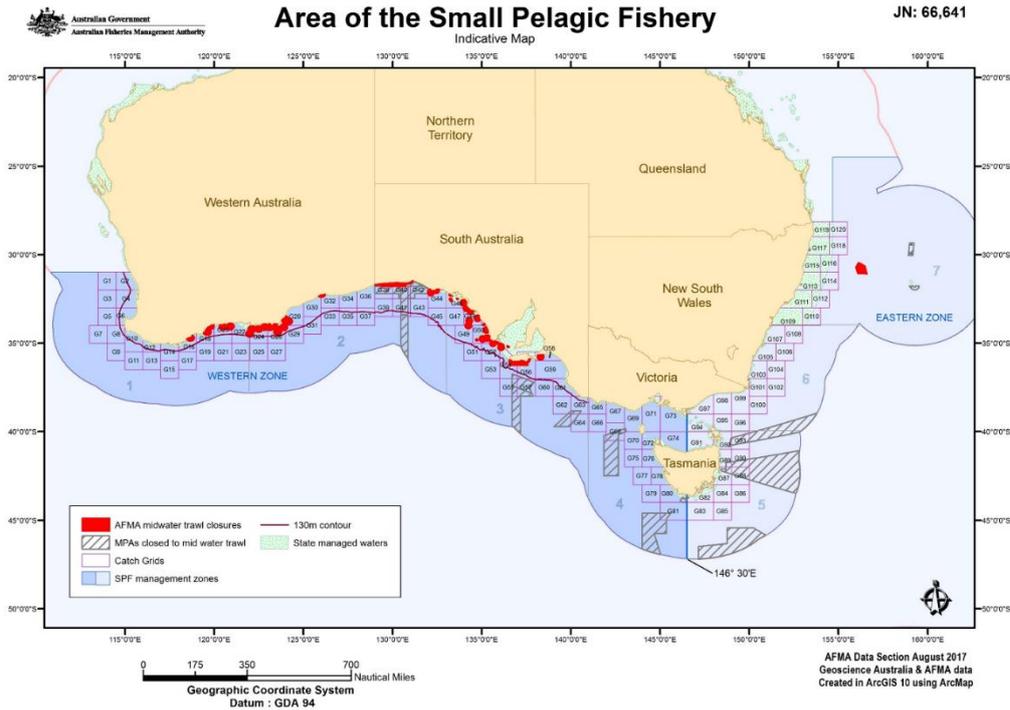


Figure 5. Sub-zones, catch grids and areas closed to mid-water trawling within management sub-areas of the Small Pelagic Fishery. (Source: AFMA 2017).

Implications for the potential Tasmanian Sardine Fishery

The objective of the Harvest Strategy for the SPF is consistent with Tasmanian Government’s policy position of providing opportunities for the development of long-term environmentally sustainable, commercially profitable and socially acceptable fisheries to deliver economic growth for the State (DPIPWE 2015b). Many aspects of the SPF Harvest Strategy could be adopted in the management arrangements established for the potential new Tasmanian Sardine Fishery. Additional elements, such as reducing the exploitation rates as the spawning biomass declines towards a point where recruitment may be impaired and establishing an explicit strategy for maximising economic benefit to the Tasmanian community, could also be considered.

Although management strategy evaluations undertaken to support the SPF have shown that exploitation rates of up to 33% are likely to be sustainable for Sardine, a more conservative maximum exploitation rate of 20% has been used to set TACs in the SPF. The framework for the previous developmental Sardine fishery also used a harvest rate of 20% to establish catch limits. This review of Australia’s small pelagic fisheries suggests that it would be prudent to use the conservative exploitation rate of 20% to establish catch limits for the potential new Tasmanian Sardine Fishery.

In the SPF, DEPM surveys must be undertaken every 5 years to stocks at Tier 1 (e.g. Ward et al. 2014, 2019). These surveys have provided valuable information about the size of the spawning biomass of the eastern component of the South-eastern stock of Australian Sardine (e.g. Ward et al. 2022, Figure 2). These surveys also have the potential to be used as the primary source information for ongoing management of fisheries that utilise the South-eastern Sardine stock, including the Tasmanian Sardine Fishery. The fact that DEPM surveys undertaken every five years are likely to be the primary source of information used to manage the potential new Tasmanian Sardine Fishery emphasizes the suitability of using an exploitation rate of 20% to establish catch limits.

The SPF also uses spatial management tools including zones, sub-zones, catch grids and closed areas to ensure the sustainability of the fishery. The framework for the previous developmental Tasmanian Sardine Fishery established two zones for the large-scale sector, i.e. Bass Strait and the East Coast, with boundary at Cape Naturaliste. As the majority of the spawning biomass is South-eastern Sardine stock is located in Bass Strait, there would be benefits in establishing Bass Strait and East Coast Zones in the potential new Tasmanian Sardine Fishery. This approach would provide a framework for controlling catches by the large-scale sector from the East Coast. It may even be appropriate to consider limiting access to the East Coast to the small-scale sector only.

In the SPF, parts of the fishery are closed to mid-water trawling. The framework for the previous developmental Sardine fishery established spatial closures to minimise interactions with existing users and sensitive habitats and/or species (Appendix 1). It would be appropriate to establish similar spatial closures in the potential new Tasmanian Sardine Fishery. In the SPF, fishers also communicate with other sectors (e.g. game-fishing tournaments) to minimise conflicts. This approach could also be adopted in the potential new fishery and NRE Tasmania could help to facilitate these discussions

South Australian Sardine Fishery

The objectives of the Harvest Strategy for the SASF (PIRSA 2014) are to:

- Maintain the sardine spawning biomass at a sustainable stock status
- Optimise economic returns within these sustainability imperatives.
- Provide certainty and stability for industry stakeholders.
- Establish a simple and practical guide for fishery managers, researchers and industry stakeholders.
- Ensure cost-effectiveness of management.

The Harvest Strategy is designed to support the ecologically sustainable management of the SASF by setting TACs (called Total Allowable Commercial Catches) by applying conservative exploitation rates to estimates of spawning biomass. The three-tiered Harvest Strategy aims to balance the risks associated with various exploitation rates with the amount of information provided by the monitoring and assessment program. The primary biological performance indicator is the estimate of spawning biomass obtained using the DEPM (Figure 1, Table 4). Supporting the DEPM assessment is a stock assessment report that uses an age-structured population model to synthesise fishery-independent and fishery-dependent information.

The TAC in the SASF is set by applying the exploitation rate target reference points rather than directly to the estimate of spawning biomass, which means that TAC is capped at each tier (i.e. 38,000 t at Tier 3 and 47,500 t at Tier 1, Figure 1, Table 4). The status of the SASF is considered to be: 1) sustainable if the spawning biomass is above the target reference point 150,000 t, 2) transitional if the spawning biomass is above the reference point of 75,000 t and below the target reference point of 150,000 t, and 3) over-fished if the spawning biomass is below the limit reference point of 75,000 t. As the unfished biomass appears to be approximately 310,000 t (Grammer et al. 2021), the target reference point of 190,000 (Figure 1, Table 4) equates approximately to B_{60} and the limit reference point of 75,000 equates approximately to B_{25}

The exploitation rates applied when the spawning biomass is above the target reference point range from 20% to 25 % (Figure 5, Table 4), depending on how often DEPM surveys and stock assessments are undertaken (i.e. either annually or biennially). When the spawning biomass is between the target and limit reference points, the exploitation rates range from 10% to 20 %. If the spawning biomass falls below the limit reference point the fishery is closed. Reducing the exploitation rates as spawning biomass falls towards a point at which recruitment may be impaired is an important

element of the Harvest Strategy for the SASF that is not part of the Harvest Strategy for the SPF (Banks et al. 2019).

The Harvest Strategy of the SASF also defines two zones: the Gulfs Zone (GZ) and the Outside Zone (OZ, Figure 6). Under this spatial management framework, no more than 30,000 t of sardines can be taken from the Gulf Zone in any single quota period (fishing season). The catch that can be taken from the Gulfs Zone is also determined by the mean size (Fork Length, FL) of Sardine taken in catches from that zone in the previous year (Table 2). If the mean size is above 142 mm FL, up to 30,000 t can be taken from the GZ; if it is between 135 mm and 142 mm FL the maximum catch is 27,000 t; if it is below 135 mm FL, the maximum catch is 24,000 t.

Implications for the potential Tasmanian Sardine Fishery

The objectives of the Harvest Strategy for the SASF are consistent with Tasmanian Government's policy position of providing opportunities for the development of long-term environmentally sustainable, commercially profitable and socially acceptable fisheries to deliver economic growth for the State. However, the SASF has the additional objective of providing certainty and stability for industry stakeholders. This objective is achieved by setting upper limits on the TAC, which is not how TACs are set in the SPF. The maximum TAC that can be established in the SASF cannot exceed 25% of the target reference point of 190,000, which approximately 60% of the unfished biomass of 31,000 t (see Grammer et al. 2021). In contrast, in the SPF the TAC is set by applying the exploitation rate directly to the estimate of spawning biomass and is therefore not capped.

The different approaches taken to using stock information to set catch limits in the SASF and SPF are examples of many possible approaches. Most importantly, both fisheries have a direct and objective link (i.e. decision rules) for using scientific stock information and to set catches. How the catch setting rules behave under a range of possible scenarios, such as changing recruitment from climate change, can and has been tested (especially in the SPF) by conducting management strategy evaluations (e.g. Smith et al 2015). This modelling can be repeated as the fishery develops so that the decision rules can be refined/improved over time.

The maximum exploitation rate in the SASF of 25% is lower than the 33% that is considered to be sustainable for this species (Smith et al. 2015) and can only be applied when DEPM surveys are done annually. As DEPM surveys may only be conducted for the South-eastern Sardine stock every five years (as outlined in the SPF Harvest Strategy), an exploitation rate of less 25% (e.g. 20% as in the SPF) may be appropriate for the potential new Tasmanian Sardine Fishery. As noted above, this was also exploitation rate used to establish catch limits in the previous developmental Tasmanian Sardine fishery.

The zones established in the SASF were designed to limit the proportion of the TAC that could be taken from the Gulfs Zone, especially southern Spencer Gulf where the home port for the fleet of Port Lincoln, and the tuna farms they service, are located. One of the reasons for this spatial management was to pro-actively control the potential ecological interactions of the fishery.

Spatial management arrangements (zones) could be used to divide the potential new Tasmanian Sardine Fishery into separate components. For example, a zone or zones for fishers targeting small quantities of high-quality sardine for human consumption, recreational bait and/or pet food could be established close to ports with large populations and processing/storage facilities (e.g. East Coast). A zone for industrial scale fishing could be established in locations further away from these ports and near the main areas where most of the resource occurs (e.g. Bass Strait, Figure 2).

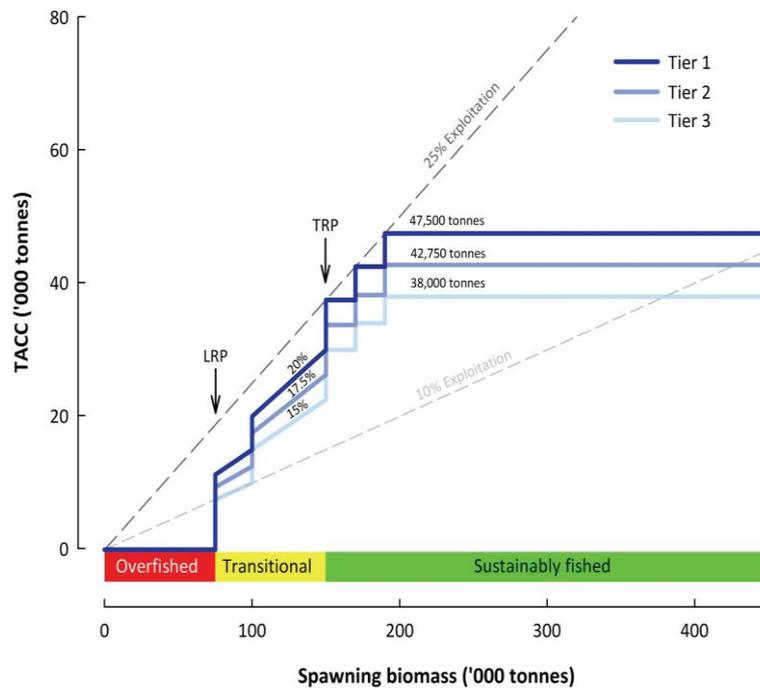


Figure 6. The relationship between spawning biomass, stock status, exploitation rates and Total Allowable Commercial Catch (TACC) at each tier of the SASF Harvest Strategy (Source PIRSA 2014).

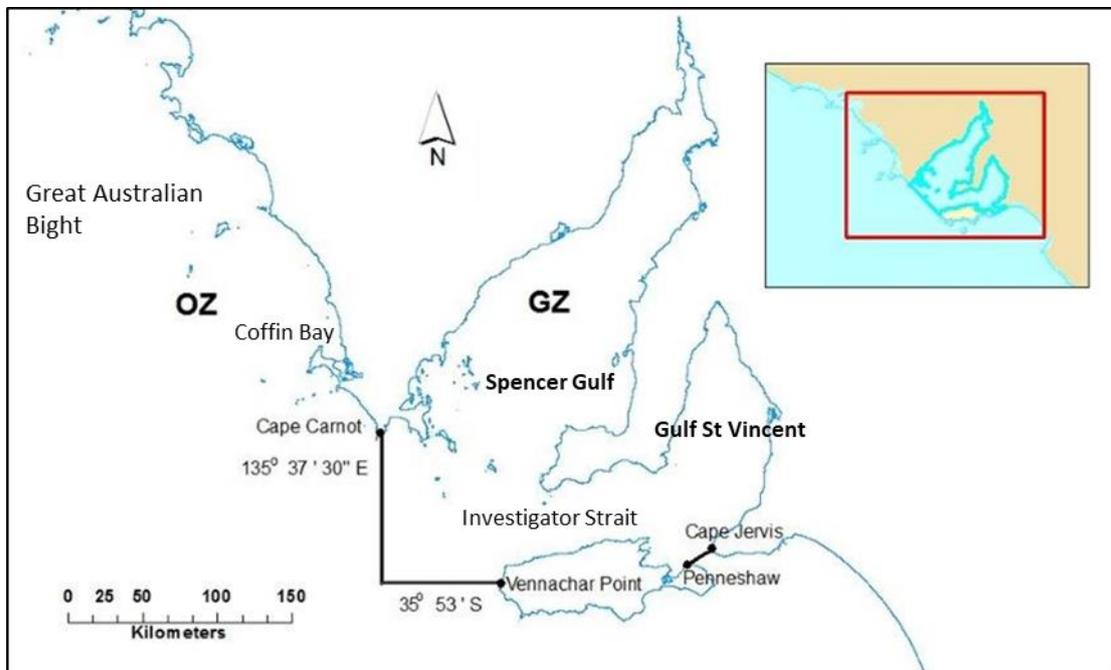


Figure 7 The two spatial management zones defined in the Harvest Strategy for the SASF. Abbreviations: OZ, Outside Zone; GZ, Gulfs Zone (Source PIRSA 2014).

Table 4. Decision rule table for Harvest Strategy of the South Australian Sardine Fishery, showing target and limit reference points for spawning biomass (SpB), exploitation rates at various levels of spawning biomass and the tiers. The table also shows the frequency of Daily Egg Production Method (DEPM) surveys and stock assessments undertaken at each tier (PIRSA 2014).

Spawning Biomass			Reference Points	Stock Status	Tier 1				Tier 2				Tier 3			
					TACC (t)	Maximum Exploitation	DEPM Survey	Stock Assessment	TACC (t)	Maximum Exploitation	DEPM Survey	Stock Assessment	TACC (t)	Maximum Exploitation	DEPM Survey	Stock Assessment
190000 t <	SpB		>TRP	Sustainable	47,500 t	25%	Annual	Annual	42,750 t	22.5%	Annual	Biennial	38,000 t	20%	Biennial	Biennial
170000 t <	SpB	≤190000 t	>TRP	Sustainable	42,500 t	25%	Annual	Annual	38,250 t	22.5%	Annual	Biennial	34,000 t	20%	Biennial	Biennial
150000 t <	SpB	≤170000 t	>TRP	Sustainable	37,500 t	25%	Annual	Annual	33,750 t	22.5%	Annual	Biennial	30,000 t	20%	Biennial	Biennial
100000 t <	SpB	≤150000 t	LRP - TRP	Transitional	20% of SpB	20%	Annual	Annual	17.5% of SpB	17.5%	Annual	Biennial	15% of SpB	15%	Biennial	Biennial
75,000 t <	SpB	≤100000 t	LRP - TRP	Transitional	15% of SpB	15%	Annual	Annual	12.5% of SpB	12.5%	Annual	Biennial	10% of SpB	10%	Biennial	Biennial
	SpB	≤75000 t	<LRP	Overfished	Closed	0%	Annual	Annual	Closed	0%	Annual	Biennial	Closed	0%	Biennial	Biennial

Table 5 Catch allocation decision table for the harvest strategy for the SASF to guide the maximum TACC allowed from the Gulfs Zone (GZ) (PIRSA 2014).

Mean size of Sardines (MSS, mm Fork Length) in GZ	Maximum catch limits for GZ
142 mm < MSS	30,000 t
135 mm < MSS ≤ 142 mm	27,000 t
MSS ≤ 135 mm	24,000 t

4.4 Monitoring and assessing stock status

The monitoring and assessment programs for SPF and SASF are similar; both are based on the DEPM, and both involve Fisheries Assessment Reports that collate and synthesize fishery-independent and fishery-dependent data. Both fisheries have ongoing catch sampling programs and have developed otolith-based protocols for ageing fish collected. In the SASF, the DEPM and Fishery Assessment Reports are done annually or biennially, depending on which tier (i.e. which level of research and monitoring) fishers choose to adopt for the fishery. In the SPF, for stocks to remain at Tier 1 (where exploitation rates are highest) the DEPM must be applied every five years. SPF Fishery Assessment Reports are done every year at both Tier 1 and Tier 2. In both fisheries, the Fisheries Assessment Reports document spatial and temporal patterns in catch and effort data and changes in the size/age structure of catches. An age structured population model is used routinely in the SASF. Similar models have been developed for some stocks in the SPF but are not used routinely due to the limited time-series of data available for the fishery.

The smaller Sardine fisheries off Western Australia, Victoria and New South Wales do not have dedicated monitoring and assessment programs and undertake assessments of stock status using the framework established for Status of Australian Fish Stocks ([Australian Sardine 2020](#)). The assessment of the Sardine catch by purse-seine vessels in the NSW Ocean Haul Fishery have been based on the DEPM assessments of the Eastern stock of Sardine undertaken for AFMA (e.g. Ward et al. 2014, 2019).

Implications for the potential Tasmanian Sardine Fishery

The stepwise research program that progressively obtained more information as the fishery grew that was outlined in the framework for the previous Tasmanian developmental Sardine fishery remains valid. The stock assessment program established for the potential new Tasmanian Sardine Fishery should match the scale of the fishery and the risk to the stock. If only the small-scale-sector with exploitation rate of less than 5% of the spawning biomass is established, the fishery could be assessed under the framework established for the Status of Australian Fish Stocks, as is done for the fisheries off Western Australia, Victoria and New South Wales. A catch sampling program could be established to provide biological information about the stock and the size/age structure of catches. This information could be presented in Scalefish assessments reports such as Fraser et al. (2021).

If a larger fishery is established (e.g. with an exploitation rate of 20%), stock assessment should be based on application of the DEPM at least every five years. Ideally, the Sardine DEPMS would be done in conjunction with application of the DEPM to Jack Mackerel by AFMA (see Ward et al. 2022) and cover the entire South-easter stock. A catch sampling program should be instigated at the start of the large-scale sector. Cost-benefits of otolith-based ageing of fish could be evaluated explicitly over the first five years of the fishery. Fishery reports could be done annually and after five years involve the adoption of the population model used in the SASF. Fishery assessment reports for the large-scale sector would incorporate information from both sectors.

4.5 Incidental capture of protected species

Small pelagic fisheries are known to interact with small cetaceans, mainly dolphins and porpoises (Family Delphinidae), sometimes with lethal consequences for the animals (FAO 2018; 2020; Ward et al. 2018). For example, dolphins are sometimes encircled and/or entangled in purse-seine nets used in the SASF (Ward et al. 2018) and captured in the mid-water trawl nets used in the SPF (Lyle and Wilcox 2008).

Commonwealth Small Pelagic Fishery

AFMA has established a Dolphin Mitigation Strategy to minimise interactions with dolphins in the mid-water trawl sector of the SPF (AFMA 2019). The strategy is consistent with AFMA's bycatch management principles for Commonwealth fisheries, which include: management responses should be proportionate to the conservation status of affected species; incentives should encourage industry-led solutions, approaches should account for the cumulative impacts of Commonwealth fisheries and monitoring and reporting arrangements should be consistent across fisheries.

The Dolphin Mitigation Strategy identifies the mix of observer coverage (historically up to 100%, currently 20%, Table 2) and electronic monitoring that is required for monitoring interactions with dolphins in the SPF and documents best practice options for mitigating interactions (e.g. trawling only in daylight hours, net bindings on deployment, acoustic pingers in the net). Daily fishing logbooks in the SPF include a form for reporting interactions with Listed Marine and Threatened Species. Fishers must complete a Dolphin Interaction Evaluation Report for each interaction with dolphins. Each trawl vessel must have an approved Dolphin Mitigation Plan. AFMA will only approve plans that include actions in fishing practices (e.g. only setting gear during daylight hours), gear set up (e.g. net bindings) and mitigation devices. The strategy includes incentives for individual fishers to minimise interactions with dolphins.

The SPF Dolphin Mitigation Strategy establishes a Maximum Interaction Rate (i.e. one dolphin per 50 trawl sets in the six-month review period) as a Performance Indicator. If the interaction rate is exceeded in one review period, the Dolphin Mitigation Plan must be reviewed. If the interaction rate is exceeded in two consecutive review periods, the individual vessel is excluded from an area (i.e. the East and West zones of the SPF) for six months. If the interaction rate is exceeded for three consecutive periods, the vessel is excluded from fishery for six months. There are also caps on numbers of interactions (1, 3 and 6 dolphins) per set or review period. The number of interactions with protected species is posted on the AFMA website each quarter. Reported numbers of dolphin mortalities are relatively low; suggesting that mitigation actions may be successful. However, no reports have been published on the observer and electronic monitoring programs nor the effectiveness of the various mitigation measures identified in the Dolphin Mitigation Strategy.

Implications for the potential Tasmanian Sardine Fishery

If it is developed, the potential new Tasmanian Sardine Fishery will use purse-seine gear because board trawling is banned in Tasmanian waters (Fisheries (Scalefish) Rules 2015). The framework for the developmental fishing program previously established for Australian Sardine required purse-seine vessels to have a vessel monitoring system (VMS) and approved an approved code of conduct that addressed interactions with protected species. The initial observer program (20% coverage) that was envisaged is consistent with the approach taken in the SPF. However, the previous developmental fishing program did not specify the need for electronic monitoring which is a key feature of the SPF.

South Australia Sardine Fishery

Interactions of the SASF with dolphins are monitored using the South Australian Sardine Fishery Research Logbook which must be completed for each net-set and Wildlife Interaction Forms which must be completed when there are interactions with wildlife. An independent observer program has been undertaken since 2004/05. Observer coverage is set annually and has ranged from 3.9% in 2004/05 to 25.2% in 2008-09 with baseline level of 10% (Kirkwood et al. 2020, Table 1). Annual scientific reports based on the logbook and observer programs are published that evaluate the effectiveness of the Wildlife Interaction Code of Practice (CoP) in mitigating interactions with

dolphins. These reports are used by fishery managers to set the level of observer coverage for the following year. Management responses to high rates of observed mortality and large discrepancies between rates of dolphin mortality reported in logbooks and by observers have been implemented across the entire fishery, rather than on individual vessels. For example, in 2007/08 to 2009/10 target observer coverage was increased to 30% following high mortality rates and large discrepancies between observer and logbook data in the preceding year.

The CoP (SASIA 2021) was established by the South Australian Sardine Industry Association (SASIA) in 2005. It documents how interactions with protected species, especially dolphins, should be mitigated in the SASF.

Key elements of the CoP include:

- industry commitment to continuous improvement and preventing dolphin mortalities
- training and education processes for skippers and crew, including annual inductions, skippers' meetings and vessel specific plans for search and release procedures
- avoidance (search and delay) procedures designed to prevent encirclement dolphins
- release procedures designed to prevent the mortality of encircled dolphins
- a Wildlife Interaction Working Group (which includes South Australian Department of Environment and Water and other stakeholders) that meets quarterly, and after mortality events, and is responsible for ongoing review and refinement of the CoP
- at sea communication among skippers and the "real-time" program for monitoring wildlife interaction conducted by industry that was implemented in 2011/12.

Recent studies show that observed interaction rates with dolphins in the SASF are relatively low compared to other fisheries and that the CoP is effective in reducing encirclement and mortality rates when an observer is present (Ward et al. 2018; Kirkwood et al. 2020). Ongoing discrepancies between dolphin mortality rates reported in logbooks and by observers suggest that dolphin mortalities are under-reported in logbooks. It is not known how well the CoP is applied when an observer is not present. It has been noted elsewhere (e.g. Kirkwood et al. 2020) that electronic monitoring using fixed cameras on vessels may provide a cost-effective option for reducing under-reporting of wildlife interactions in logbooks and evaluating how well the CoP is applied when an observer is not present.

Implications for the potential Tasmanian Sardine Fishery

The previous developmental fishery program recommended that fishers should adopt/adapt the CoP for the SASF from the outset of the fishery. This approach remains appropriate for the potential new fishery, but consideration should also be given to establishing regulations that make key aspects of the CoP legally enforceable (e.g. when dolphins are encircled in the purse-seine net, the net-set must be aborted as soon as practicable). Experience in the SASF and the SPF suggest that the new Tasmanian Sardine Fishery should require annual reports that assess the effectiveness of the CoP and compare data on dolphin interactions reported in logbooks and by observers. If under-reporting of dolphin mortalities in logbooks is detected, consideration should be given to increasing observer coverage and/or establishing an electronic monitoring program to evaluate how well the CoP is applied in the absence of an observer.

4.6 Ecosystem considerations

Extensive studies have been conducted on the roles of pelagic fishes in the marine ecosystems of south-eastern Australia (e.g. Bulman et al. 2010, Smith et al 2011, 2015), especially Sardines off

South Australia (e.g. Ward et al. 2005; Goldsworthy et al. 2011, 2013). The research done off the Australian east coast has been built on a large body of ecological work done by CSIRO (e.g. Bulman et al. 2001; Young et al. 2010; Smith et al. 2011). The studies done off South Australia have been built around large projects funded by FRDC and industry and have involved a suite of inter-related projects done by post-graduate students (see Goldsworthy et al. 2011 for a list of projects). The key finding of these research programs, i.e. that none of the key predators in the marine ecosystems off south-eastern Australia has a high dietary dependence on small pelagic species, is reflected in the target and limit reference points for spawning biomass that have been established in the SPF and SASF (see Section 2.4 of this report for a detailed explanation).

Ecological risk assessments have been undertaken for both the SPF (e.g. Bulman et al. 2017) and SASF (e.g. PIRSA 2014). In the SPF, this was last done by Bulman et al. (2017) using a hierarchical framework that assesses risks on five ecological components: key commercial species; by-product and bycatch species; protected species; habitats; and (ecological) communities (Hobday et al. 2011). This framework is called the “Ecological Risk Assessment for Effects of Fishing” and was developed jointly by CSIRO and AFMA. The latest ecological risk assessment for the SPF did not identify any current risks. In the SASF, the last ecological risk assessment (PIRSA 2014) was done using the National Ecologically Sustainable Development Reporting Framework for Australian Fisheries (Fletcher et al. 2002). An excerpt from this risk assessment for the SASF is shown in Table 6. The table shows risks that were identified as medium or high and for which specific management goals, objectives and strategies were developed (PIRSA 2014). The goals, objectives and strategies developed in response to those risks formed the basis of the Management Plan (PIRSA 2014).

Implications for the potential Tasmanian Sardine Fishery

Previous studies (e.g. Bulman et al. 2011; Goldsworthy et al. 2013; Smith et al. 2015) suggest that key marine predators off Tasmania are unlikely to have a high dietary dependence on individual species, including Sardine. While this means that detailed studies of the roles of Sardines in the pelagic ecosystems off Tasmania may not be essential for the future management of the Tasmanian Sardine Fishery, projects related to this topic may provide important new insights into the structure and function of this ecosystem and would provide excellent training opportunities for students and. Dedicated studies of the role of Sardine in the marine ecosystem off Tasmania would also help to build community confidence that the fishery is developed and managed within a framework of ecological sustainability. It is recommended that a formal ecological risk assessment is done to support the development and management of the new potential Tasmanian Sardine Fishery.

4.7 Social license to operate

Australia’s fisheries for small pelagic species, especially the SPF, have come under public scrutiny because of the perceived ecological importance of the target species and their interactions with protected species, especially dolphins, as well as for their potential impacts on recreational fisheries. Conservation groups and recreational fishing bodies have been particularly vocal in expressing their concerns about pelagic fisheries (e.g. Tracey et al. 2013). For example, the Conservation Council of South Australia (CCSA) and Australian Marine Conservation Society have written on numerous occasions to the Commonwealth Department of Agriculture, Fisheries and Forestry and the South Australian Department of Primary Industries expressing their concerns about the under-reporting of dolphin mortalities in the SASF. Conservation groups and recreational fishers also conducted an intense social media campaign against the SPF when a major quota holder attempted to introduce a large factory trawler into the fishery (Tracey et al. 2013).

Table 6. Risk assessment of ecological components of the SASF (PIRSA 2014). This table shows risks identified as medium or high.

Component	Risk/issue	Description	Risk/importance
Retained species	Australian Sardines	Risk of fishery impacts on SpB of sardines – primary species	Medium
Non-retained species	Common dolphin– social	Risk to the fishery from social acceptance to impacts with common dolphins –threatened, endangered and protected species	Medium
General ecosystem impacts of fishing	Water quality – brine discharge	Risk of the fishery from brine discharge - water quality	High
General community	Work, health and safety	Risk to the fishery from work, health and safety legislative changes and accidents – fishing industry	Medium
	Market	Risk to the fishery from lack of market demand	Medium
	Infrastructure – Port Lincoln	Risk to the fishery from lack of infrastructure	Medium
	Infrastructure – western Eyre Peninsula	Risk to the fishery from lack of infrastructure	High
	Social value – public acceptance	Risk to the fishery from the lack of public acceptance of fishing	High
Governance	Policy and management – compliance	Risk to the fishery through lack of compliance	High
	Legal framework – allocation/Offshore Constitutional Settlement	Explicit allocation of resource	Medium
	Other agencies –Department of Planning, Transport and Infrastructure	Risk to the fishery from lack of infrastructure	Medium
	Other agencies – Australian Fisheries Management Authority/DAFF (catch sharing)	Risk to the fishery from Commonwealth catches	Medium
	Others –social licence to operate	Risk to the fishery from not having a social licence to operate	Medium
External factors affecting the performance of the fishery	Ecological impacts– biological	Risk to the fishery from biological diseases	Medium
	Economic – market forces/demand	Risk to the fishery from a lack of Southern Bluefin Tuna quota being set by the Commonwealth and high Australian dollar	Medium
	Access – unload facilities – west coast	Risk to the fishery from a lack of infrastructure and unloading facilities on the west coast of Eyre Peninsula	High

The concerns of recreational fishers about the SPF have included the potential impacts on the distribution and behaviour of small pelagic fishes on key game-fishing grounds and the subsequent effects on the distribution and availability of predatory fish species, especially tunas and marlins. To address these concerns, operators in the SPF have liaised with recreational fishers, especially the organisers of game-fishing tournaments, to identify ways to alleviate mitigate these potential impacts.

Both the SPF (Banks et al. 2019) and SASF (<https://fisheries.msc.org/en/fisheries/south-australia-sardine-fishery/@assessments>) have sought accreditation from the Marine Stewardship Council to help refine their management arrangements and attempt to address the issue of social license to operate. The SASF remains certified by the Marine Stewardship Council while the SPF has currently withdrawn from the program.

Implications for the potential Tasmanian Sardine Fishery

The potential new Tasmanian Sardine Fishery will be best placed to establish and maintain a social licence to operate if 1) the management arrangements that are established for the fishery are precautionary and explicitly account for the role of Sardine in the ecosystem and 2) interactions with protected species, especially dolphins, are monitored independently, reported transparently and mitigated effectively. It would also be beneficial to establish a suite of projects, including by studies done by postgraduate students, to explicitly examine the role of Sardine in the marine ecosystems off Tasmania. It would also be appropriate for NRE Tasmania and operators in the new fishery to develop strategies to mitigate potential interactions with recreation fishers.

4.8 Licensing and access arrangements

Commonwealth Small Pelagic Fishery

The SPF was initially established in 2001 as a limited entry fishery with 73 permits held by 33 concession holders. Few permits were active and there was a high level of latent effort. In 2003, AFMA made a policy commitment to complete fisheries management plans for all major fisheries and implement Statutory Fishing Rights (SFRs). AFMA also committed to retaining output controls in the form of Individual Transferable Quotas (ITQs) as the preferred management approach. In 2009, a Statutory Management Plan was established for the SPF (AFMA 2009). The plan indicated that to fish in the SPF, operators must hold Quota SFRs that allow fishers to take a percentage the TAC for each target species. SFR's granted under the Management Plan may be transferred, leased, surrendered or cancelled. In 2010, an independent Allocation Advisory Panel (IAAP) was established to advise AFMA on a method for the allocation of SFRs. In May 2022, 30 entities held SFRs in the SPF (five for Sardine; 11 for Blue Mackerel East; 10 for Jack Mackerel East; 15 for Redbait East; 17 for Blue Mackerel West; 17 for Jack Mackerel West and 21 for Redbait West).

The Australian Government's cost recovery policy is that non-government recipients of specific government activities should be charged some or all of the costs of those activities. AFMA's Cost Recovery Implementation Statement (CRIS) outlines the cost recoverable activities that AFMA provides and how they are implemented in managing Commonwealth fisheries (AFMA 2022). AFMA charges the Commonwealth commercial fishing industry for costs directly attributable to the industry, while the Australian Government pays for activities directly benefiting the broader community. Costs recovered activities include fisheries management, data collection and management, licensing administration and revenue collection, fisheries compliance, research and policy (AFMA 2022).

The recent economic performance of the SPF is poorly understood because this information is confidential due to the small number of operators in the fishery (Noriega and Dylewski 2021). For example, the Gross Value of Production of the SPF is unknown. However, the increasing TACs over the past decade, combined with lower levels of latent efforts suggest that the fishery is likely to be generating positive net economic returns. As most of the large (>16,000 t) catch is processed onshore the fishery is also likely to generate a significant indirect employment.

The SPF Harvest Strategy has not delivered against its objective of providing maximum economic benefit to the Australian community and has no explicit strategy to achieve this goal. Even though, the total annual catch has always been below the combined TACs, no mechanisms have been established to address this problem. In comparable industries, such as mining or forestry, if a resource is not used for maximum benefit the Government typically retains the power to reallocate access after a reasonable period of time. For example, mining leases are issued for a sufficient duration to allow prospecting to occur and mining to operate, but if the lessee fails to explore and develop the resource then the lease is cancelled. This creates an incentive for operators to either invest in the resource or lose access to it. As is the case in other Commonwealth fisheries, the SPF also has no explicit mechanism for delivering direct economic benefits to the community. This issue was raised in the public debate about the introduction of factory trawler into the fishery 2012, with concerns expressed that the economic benefit would flow largely to foreign companies. Economic benefits to the community from Commonwealth fisheries, such as the SPF, could potentially be maximised by establishing a system for the payment of royalties.

AFMA has a Developmental Fisheries Policy (AFMA Development Fisheries Policy) that sets out processes for the exploration and development of new, unallocated or unexploited Commonwealth fisheries resources. It provides information on the rights and obligations of fishers wishing to establish and/or gain access to a developing fishery. The policy "recognises there are risks and costs associated with developmental fishing and aims to balance these with the potential rewards" and that by "doing so, the exploration and development of new resources is not unnecessarily limited".

South Australian Sardine Fishery

The SASF was established in the 1990s to provide Sardines to feed Southern Bluefin Tuna in the mariculture industry off Port Lincoln. In 1991, the South Australian Department of Fisheries (now PIRSA Fisheries and Aquaculture) sought expressions of interest in establishing a purse-seine fishery for Australian Sardine from licence holders in the Marine Scalefish Fishery who held a net endorsement (PIRSA 2014). As a result, 20 licence holders were granted access to sardines using a purse-seine net. Catches among the initial 20 licence holders were low as few took up sardine fishing full-time or purchased purpose-built gear. In 1993, access arrangements were reviewed. Permit holders were eligible to apply for entry into the fishery if they had a catch history of at least 30 t or had made significant financial investment in a purse-seine vessel. As a result of these new access arrangements, seven MSF licence holders and seven fishers previously nominated by the Australian Tuna Boat Owners Association (ATBOA) were granted access to sardines. In 2000, a Pilchard Fishery Independent Advisory Allocation Panel was established. Following the panel's advice, the Minister determined that the 14 fishers should maintain their access to sardine. From the outset, the Sardine Fishery was managed using a combination of input and output controls. The fishery was initially managed through an ITQ system with no provision for permanent transfer of quota. The annual TAC was divided equally among the 14 licence holders. In 2021, the South Australian Sardine Fishery was established as separate entity, independent of the Marine Scalefish Fishery. The regulations for the new fishery provide for permanent transfer of ITQs.

The South Australian Government has operated a cost-recovery policy for over 20 years (see KPMG 2018). Under this policy, commercial fishers accessing publicly owned fisheries resources, contribute on a cost-recovery basis for services provided by government, including management, compliance, leasing, licencing, scientific research and other activities required to manage and ensure the sustainability of the State's fisheries resources.

The economic performance of the SASF has been monitored in detail over the last 20 years (BDO Econsearch 2021). This analysis shows that fishery is large volume, stable and profitable. The GVP in 2019/20 was ~\$27M with direct employment of 84 Full Time Employees (FTEs) and indirect employment of 103 FTEs (BDO Econsearch, 2021). As is the case in other South Australian fisheries, operators in the SASF do not pay for access to the State's Sardine resource other than cost recovery for government services. South Australia does not have a fisheries royalty system. Even profitable fisheries such as the SASF (net economic rent of ~\$4 M, BDO Econsearch 2021) have limited capacity to provide an access payment to the community.

Western Pacific Tuna

The large pelagic (tuna) fisheries in the western Pacific Ocean provide a good example of how fisheries can be managed to deliver maximum economic benefits to communities (Pacific Islands Forum 2015). Because of the importance of these fish resources to many Pacific countries, careful and sophisticated consideration has been given to how licencing arrangements have been established. In many cases, tunas are the most valuable natural resource in the region and there has been a strong imperative to ensure these fisheries were managed to the benefit of local communities (Pacific Islands Forum 2015).

Targets for the tuna fisheries are routine in terms of biological sustainability but unusual in their emphasis of community benefit, including through employment and food supply. Key elements of these arrangements include:

- Enhanced resource sustainability as a prerequisite for greater benefits, including agreed objectives (i.e. 'target reference points') for minimum stock sizes (biomass), that ensure progress towards growth/maintenance of stocks sizes within 10 years, particularly for rebuilding over-fished stocks.
- Enhanced economic value of the tuna fisheries without increased production, by reducing harvests and oversupply to the markets, increasing fishery productivity and profitability (and therefore the value of access) and targeting higher value products and markets, resulting in a doubling of the value of the region's tuna catch within 10 years.
- Increased Pacific Island employment in tuna fisheries, through additional processing in the region (e.g. Melanesia), as well as increased Pacific Island crew for fishing vessels, resulting in 18,000 new jobs over the next 10 years.
- Enhanced Pacific Islands food security, through increased small-scale catch of tuna, local processing and supply, and utilization of incidental catch (i.e. 'bycatch') of non-targeted species, resulting in 40,000 tons of additional tuna supplied for Pacific Island consumption in over 10 years.

These approaches have established a framework that provides: i) sufficient security for firms to invest capital; ii) sufficient flexibility for the government to reallocate the resource in the future to prevent under-use; and iii) maximise the return to the community owners of the natural resource. The solution has been simple and effective. It has provided access to private companies for a sufficient period of time to encourage capital investment, but not permanent access. Access to the

resource has been provided through market processes, including negotiated tenders where companies may pay lower royalties in return for a commitment to contribute in other ways, such as construction of processing facilities. In these situations, governments may choose to forego income that could be used for public services in return for greater employment in processing facilities.

Implications for the potential Tasmanian Sardine Fishery

Lessons from other fisheries include:

- Capital investment is required for vessels/gear and to develop markets. This investment only occurs if companies have confidence that they will have access to the resource for sufficient duration to generate an adequate return on investment.
- The risk of the potential new Tasmanian Fishery not being developed to its full potential would be increased by the allocation of permanent catch shares. This risk could be alleviated by the Government retaining the power to reallocate access if existing operators fail to invest and/or harvest (as occurred in the early development of the SASF).
- Economic yield is likely to be zero for the initial development phase of the new fishery. Community benefit during this period is likely to be provided through employment.

Consideration should be given to establishing mechanisms to ensure that the potential new Sardine Fishery will deliver significant economic benefits to the Tasmanian community. These mechanisms could include incentives to ensure that the TAC is taken and an option for establishing royalty payments if the fishery is developed successfully.

4.9 Management Structures

The consultative arrangements for the SPF involve the South East Management Advisory Committee (SEMAC) and the Small Pelagic Fishery Resource Assessment Group (SPFRAG). The SPFRAG provides advice on the status of SPF stocks and impact of fishing on the marine environment to SEMAC and the AFMA Commission. TACs are set by the AFMA Commission following consideration of advice from SPFRAG, SEMAC and AFMA. Other administrative structures (i.e. an Independent Scientific Panel, Stakeholder Forums) were trialed (2015-19) as an alternative to the RAG structure but have been abandoned in favour of the more traditional model.

South Australia has adopted a system of co-management whereby management responsibilities and obligations are negotiated, shared and delegated between government and key stakeholders (PIRSA 2013). The South Australian Sardine Industry Association (SASIA) is recognised by PIRSA as the peak representative industry body for the commercial Sardine fishery. The Minister has oversight of the management of the fishery under the Management Plan (PIRSA 2014). Day-to-day management is conducted by PIRSA in consultation with SASIA. PIRSA administers fisheries legislation and makes decisions on fisheries management through consultative processes with fishers and other key stakeholders. Fisheries management decisions are discussed and debated through SASIA. SASIA has established a Research and Management Committee, which involves representatives from industry, PIRSA Fisheries and Aquaculture and the South Australian Research and Development Institute (SARDI). SASIA also chairs a Wildlife Interaction Working Group which also includes representatives from the South Australian Department of Environment and Water and the Conservation Council of South Australia. Critical meetings, e.g. where TACs and levels of observer coverage for monitoring interactions with protected species are set, are chaired by PIRSA Fisheries and Aquaculture.

Implications for the potential Tasmanian Sardine Fishery

The consultative structures established to support the management of the SPF and SASF include industry representatives with expertise in pelagic fisheries, representatives of government

departments and non-government organisations with a focus on environmental issues, especially the conservation of protected species, as well as scientists with expertise in small pelagic fisheries and resource economics. The consultative structures that are adapted/developed to support the potential new Tasmanian Sardine Fishery should include a similar representation and expertise.

5.0 SYNTHESIS AND CONCLUSIONS

5.1 Previous developmental fishing program

Many aspects of the framework to support Tasmania's previous developmental fishing program for Australian Sardines (DPIPWE 2015a, Appendix 1) remain appropriate for the current opportunity to develop a new Tasmanian Sardine Fishery. For example, it would still be suitable to:

- establish separate small-scale and large-scale sectors
- establish spatial management arrangements that include two zones (i.e. Bass Strait and the East Coast) and spatial closures to reduce interactions with other stakeholders and protect sensitive habitats/species
- use conservative maximum exploitation rate of 20% to set annual catch limits
- establish a stepwise research program that progressively obtains more information as the fishery grows, with sampling programs to obtain biological information and monitor size/age structure of catches established from the outset of both sectors, and applications of the DEPM required to support the ongoing development of the large-scale sector.
- require operators to have a vessel monitoring system (VMS), approved codes of conduct for addressing interactions with protected species, and an independent observer program with initial coverage of 20%.

Key aspects of the previous framework that will need to be reconsidered to maximise the opportunity for the successful development of a new Tasmanian Sardine Fishery include:

- setting a catch limit for the fishery (and each sector) that reflects the recent finding that the spawning biomass of the South-eastern Sardine stock is likely to be greater than 200,000 t
- balancing the need to provide sufficient certainty about duration of access to enable operators to invest capital against the constraint that granting of a permit does not provide entitlement to permanent access to any future fishery.

The second point is important because the successful establishment of both the small-scale and large-scale sectors of the new Tasmanian Sardine Fishery will require significant investment. At the same time, the Developmental Fisheries Management Policy Document (DPIPWE 2015b) makes it clear that initial access through permits does not entitle operators to future permanent and exclusive access to the fishery.

The need to provide incentives for private investment without giving away public assets or benefits in perpetuity is a common challenge in other parts of the economy and usually resolved by providing access security for a fixed term. In the case of the potential new Tasmanian Sardine Fishery, successful development of the resource will require the provision of access for a sufficient time period to warrant investment, provided that criteria such as a minimum catch threshold are met.

5.2 Harvest Strategy

The objectives of the Harvest Strategies for both the SPF and SASF are consistent with: (1) the requirements of the *Marine Living Resources Management Act 1995* for the sustainable

development of living resources that take into account the community's needs and interests, and (2) the Tasmanian Government's policy of providing opportunities for developing long-term environmentally sustainable, commercially profitable and socially acceptable fisheries to deliver economic growth for the State.

The Harvest Strategy established for the potential new Tasmanian Sardine Fishery should build on approaches that have been tested and established in the SASF and SPF. Building on the Harvest Strategies for the SPF and SASF and addressing the Tasmanian Government's legislative requirements and policy position, a draft objective of the Harvest Strategy for the Tasmanian Sardine Fishery could be: *"A profitable commercial fishery that is ecologically sustainable, socially acceptable and delivers economic benefits to the Tasmanian community."*

The Harvest Strategy for the new Tasmanian Sardine Fishery could also include some aspects of the approach used in the SASF but not in the SPF (e.g. applying the exploitation rate to reference points for spawning biomass rather than directly to the estimate of spawning biomass; and/or reducing the exploitation rates as the spawning biomass declines towards a point where recruitment may be impaired). Decision rules that are established in the new fishery should be tested using management strategy evaluations.

The total catch for the (i.e. the large-scale and small-scale sectors combined) could be set at 30,000 t (i.e. 20% of the Target Reference Point of 150,000 t, which is ~75% of the minimum likely spawning biomass of ~200,000 t).

A proportion of the total catch (e.g. 3-5% of 150,000 t = 4,500 t to 7,500 t) could be allocated to the small-scale sector. Spatial management arrangements for the small-scale sector could include closures to reduce conflicts with other stakeholders and protect sensitive habitats/species but may not need to involve zoning.

The remainder of the total catch for fishery (i.e. 15-17% of 150,000 t = 22,500 t to 25,500 t) could be allocated to the large-scale sector. It may be appropriate to establish TACs and ITQs for the large-scale-sector. Zoning (e.g. East Coast and Bass Strait) would be required. Most of the catch of the large-scale-sector would need to be allocated to the Bass Strait Zone.

The initial split of allocations between the small- and large-scale sectors could be established with clear advice that the fractions would not be fixed and that decisions by Government to change the proportional split would occur with sufficient lead-time to enable businesses to adjust.

5.3 Research and Monitoring Stock Status

The monitoring and assessment program established for the potential new Tasmanian Sardine Fishery should vary according to the scale of the fishery. If only the small-scale sector is established, a catch sampling program could be conducted to provide biological information about the stock and the size/age structure of catches. This information could be presented in Scalefish assessments reports such as Fraser et al. (2021).

If a large-scale sector is also established (e.g. so the total exploitation rate could reach 20%), stock assessment should be based on application of the DEPM at least every five years. The DEPM survey would ideally cover the entire South-eastern Sardine Stock (Figure 1). A catch sampling program would need to be instigated at the start of the large-scale sector. Fishery assessment reports could be done annually and incorporate information from both sectors. The population model used in the SASF could be adopted/adapted for the Tasmanian Sardine Fishery.

5.4 Interactions with protected species

An independent observer program with 20% initial coverage should be established for both sectors. Vessels operating in the fishery should also be required to have a VMS and approved an approved code of conduct to mitigate interactions with protected species. Consideration should be given to establishing regulations that make key aspects of the code legally enforceable (e.g. when dolphins are encircled in the purse-seine net, the net-set must be aborted as soon as practicable). Annual reports should be produced that assess the effectiveness of the mitigation measures and compare data obtained in logbooks and by observers. If under-reporting of dolphin mortalities in logbooks is detected, observer coverage should be increased and the potential benefits of establishing an electronic monitoring program should be evaluated.

5.5 Ecosystem considerations and social licence to operate

It is recommended that a formal ecological risk assessment is done to support the development of the new potential Tasmanian Sardine Fishery. Establishing research projects on the roles of Sardines in the pelagic ecosystems off Tasmania may provide new insights into the structure and function of the system and help to build community confidence that the fishery is ecologically sustainable.

5.6 Management Structures

The consultative structures and management processes that are established/adapted to support the new Tasmanian Sardine Fishery will require input from representatives of a diverse range of stakeholder groups and experts in variety of disciplines. This may include, but not be limited to, representatives of Aboriginal organisations (as a new opportunity), community groups (such as regional councils and tax-payer associations), recreational fishers and non-government environmental organisations, as well specialist sardine fishers, and scientists with expertise in small pelagic fisheries, fisheries economics and social sciences.

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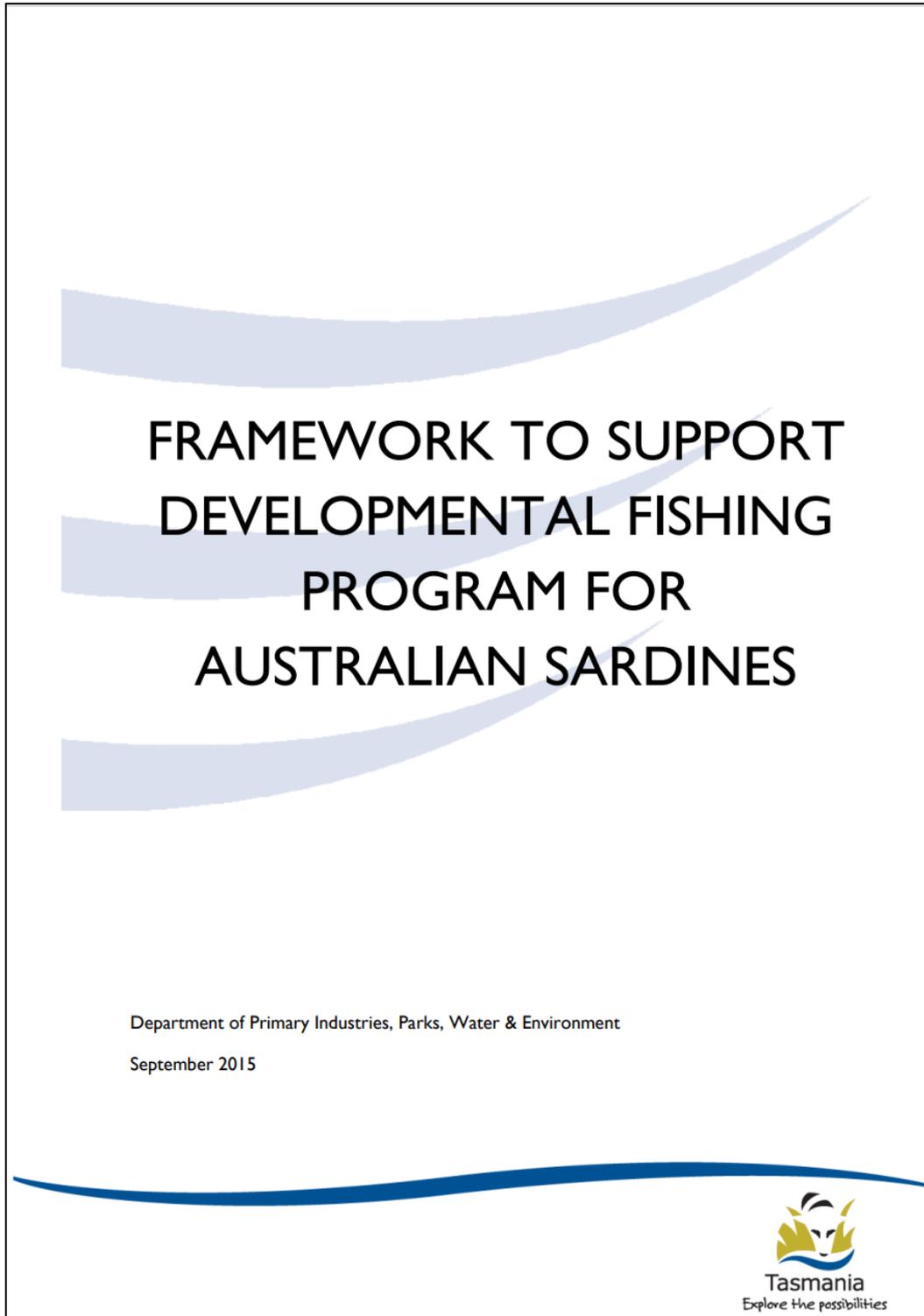
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Appendix 1. Framework to support the developmental fishing program for Australian Sardines
(DPIPWE 2015)



FRAMEWORK TO SUPPORT DEVELOPMENTAL FISHING PROGRAM FOR AUSTRALIAN SARDINES

Background

The Government has committed to 'encourage the progression of more developmental fisheries in order to allow a broader range of options for commercial fishers, particularly in the area of value adding to low value species'.

The Minister has released a policy (Developmental Fisheries Management Policy Document) to provide a coherent and structured framework for progressing developmental fishing activities in Tasmanian waters.

Supporting developmental fisheries (fisheries which are not provided for in any existing fisheries management plan or regulations) can be resource intensive. To maximise the benefits of an investment in developmental fisheries the Government has adopted the following policy position -

The Tasmanian Government supports providing opportunities for the development of long term environmentally sustainable, commercially profitable and socially acceptable fisheries to deliver economic growth for the State.

Developmental fishery opportunities will be supported by the Minister only where it can be satisfactorily demonstrated by a proponent that a long term, commercially profitable, environmentally sustainable and socially acceptable fishery can be developed.

This requires a level of information to provide the necessary confidence that a particular fishing activity will not result in an unacceptable environmental or social impact. Where information is absent, unreliable, inadequate or uncertain, a risk based approach to fisheries development is necessary to ensure that there is an acceptable risk with respect to detriment of resources, the environment and or to other stakeholders.

Where scientific understanding is such that an acceptable level of risk cannot be demonstrated, there will be a cost in acquiring that understanding. This cost may prove to be a barrier in advancing a developmental fishery proposal. Proponents will be required to meet that cost and to assist where they reasonably can to the collection of data to support a scientific understanding.

One of the potential species for developmental fishing is Australian sardines (*Sardinops sagax*).

The Minister for Primary Industries and Water – the Hon Jeremy Rockliff MP - has now approved that a developmental fishing program should be undertaken for Australian sardines.

A process will be implemented to facilitate a limited developmental fishing program to investigate the feasibility of an ongoing sardine fishery. The purpose of this paper is to outline processes to support this program.

It is envisaged that the process will develop in an adaptive manner as fishery and scientific information becomes available and that future management decisions made on the basis of that information. The developmental plan will run for two years, after which time a full review would be undertaken in the third year and possible long term formal management arrangements considered/implemented.

Participation

The *Living Marine Resources Management Act 1995* (the Act) provides for the issuing of permits to undertake activities that would otherwise not be permitted. One of the purposes explicitly provided for is 'the development of fisheries'. Fishing for sardines within a prescribed regime will now be provided for under such permits.

With the release of the developmental fisheries policy, applications for candidate species are now being received. Applications have been received for sardines and those applications have been assessed to determine who will participate on the developmental process.

No further participants will be approved under this developmental process.

The Act stipulates that the Minister must consult with relevant fishing bodies in considering permit applications for fisheries development. In considering these applications the following groups were consulted:

- the Tasmanian Seafood Industry Council (TSIC);
- the Tasmanian Association for Recreational Fishing (TARFish); and,
- the Institute for Marine and Antarctic Studies (IMAS).

The assessment of applications is made in reference to the objectives of the Act, the Developmental Fisheries Management Policy document, and the Developmental Fisheries Management Policy Advice for applications and supporting documents.

The Minister has stated that he will be supporting the strongest applications that align best with the policies developed which are most likely to see the successful development of long term environmentally sustainable, commercially profitable and socially acceptable fisheries. The granting of permits is not a "right" for applicants, but must be considered with regard to the broad context of fisheries management in Tasmania.

One of the objectives of the policy is to support activities that will provide information to support long term management decisions, but in manner that does not require a significant investment in gear and equipment for the developmental process itself, with corresponding reliance on long term access.

The granting of a permit to authorise a developmental fishing activity can provide no entitlement to long term access to any future fishery managed under an amended fishery management plan. The amendment of a fishery management plan is the process by which access to a fishery will be determined.

The participants will be broken into two categories, nominally the small and large scale. Different provisions will apply to these two sectors including in terms of catch allowances and spatial management.

Catch limits

There have been a number of recent studies relevant to a potential sardine fishery.

A daily egg production method (DEPM) biomass assessment of the spawning biomass of Australian sardine off eastern and north eastern Tasmania in January 2014 has been completed (Ward et al. 2015). This survey estimated that the biomass was in the range of 8,000 – 15,000 tonnes. It was also noted that the actual spawning area was likely to be larger than surveyed (possibly extending into Bass Strait and off northern Tasmania), implying that the estimate may be negatively biased.

In relation to recommended harvest rates, Smith et. al. (2015) has recommended a conservative harvest rate of 24-27%. Other researchers in this area suggest that a more appropriate and conservative harvest rate would be 20%, taking into account that very little is known about the dynamics of the sardine stocks off eastern Australia, including recruitment variability.

Applying a harvest rate of 20% to the 2014 biomass estimate suggests that the stock (some of which occurs outside of Tasmanian waters) could support catches in the range of 1600-3000 tonnes p.a. It should be noted that this is a shared stock at least in Victoria where a fishery already operates.

For this developmental process, the catch limit for the large scale sector will begin at 600 tonnes.

The 600 tonnes will be split into two portions, a maximum of 300 tonnes to be taken from Bass Strait and 300 tonnes from the east coast. The boundary between the east coast and Bass Strait is at Cape Naturaliste (40° 50' 48"). Furthermore, a 'soft cap limit' of 60 tonnes per month in each area will be set, these measures are intended to reduce the potential for fishing effort to be concentrated both in space and time (and to maximise the collection of data spatially and temporally).

Any changes to catch limits will need to be supported by appropriate rigorous research to support decisions. Potential development of the fishery will require information to support management decisions consistent with best practice for small pelagic fish stocks. An adaptive process to assess the potential for a sardine fishery, with appropriate catch limits is envisaged.

It is not envisaged that any increase to the 600 tonnes for the large scale sector will be considered in the absence of a targeted DEPM assessment.

Through the assessment process, two applicants have been approved to operate in the large scale sector. The 600 tonnes will be equally shared between the two, negotiations will be conducted as to how the share might be split spatially.

For the small scale sector, the total limit will be 50 tonnes, with amounts allocated to individual permit holders. Two applications have been approved through the assessment process.

Spatial management

There are a range of potential interactions with other user groups and sectors that should not be exacerbated by the developmental fishing program – minimising such interactions with existing users is an explicit objective. Additionally, there are a range of sensitive habitats or species utilising certain habitat that will also be protected through spatial management measures. There are already a range of closures in place for other fishing operations including purse seine.

Therefore, a range of spatial closures for areas that will not be accessed under this permit process will be instituted. Some different measures will be put in place for the large and small scale sectors.

Areas that will not be open to any fishing for sardines (both small and large scale) under permit are:

- areas where nets are not permitted under the scalefish fishery management plan;
- areas where purse seine nets are not permitted under the scalefish fishery management plan (including the D'Entrecasteaux Channel);
- River Derwent (Dennes Point to Cape Direction);
- River Tamar;
- One nautical mile from Diamond Island;
- One nautical mile from Lillico Beach penguin viewing platform;
- Brid River and waters of Anderson Bay south of an imaginary straight line from the eastern extremity of Barnbogle Beach to the boat ramp at the southern end of Old Pier Beach and the old wharf piles;
- 1,000 metres from the Hippolyte Rocks;
- Adventure Bay west of a line from Cape Queen Elizabeth to Penguin Island;
- within 500 metres of the low-water mark at Swimcart Beach between Cosy Corner and Round Hill Point between 1 December in one year and 31 March in the following year.
- 1,000 metres from Waterhouse Island;
- 1,000 metres from Ninth Island.

Areas that will not be open to any large scale fishing for sardines under permit are:

- shark refuge areas (as defined in the scalefish rules);

- River Derwent and Storm Bay north of a line from Cape Queen Elizabeth to Cape Raoul;
- west and north of imaginary straight lines from Cape Degerando to Cape Baudin, from Cape Faure to Ile des Phoques, from Ile des Phoques to Cape Boullanger and from Cape Bernier to Cape Peron.

Catch monitoring (including protected species)

Vessels in the large scale sector will require a vessel monitoring system (VMS). This provides for real time monitoring of the position of each vessel.

Real time monitoring of the catch will not be required to limit catches as amounts will be allocated to individual operators. However additional reporting will be required to ensure catch information is timely and up to date.

Fishers will be required to continue to complete the *Commercial Catch, Effort and Disposal Record Book* for catch effort information as currently utilised in the scalefish fishery. In addition, a catch/effort report will need to be emailed to WFM within 24 hours of each landing of sardines (*Sardine catch log and reporting form*).

Due to the nature of schooling pelagic fish species, and the fishing method for their capture, there is a risk of by-catch of protected species including seals, dolphins and seabirds. Appropriate record keeping documenting any interactions is required through a mandatory Wildlife Interaction Record log.

An industry Code of Practice must be implemented and permit holders must support that code. The South Australian sardine fishery code of conduct has been developed over time and forms a useful guide. Participants in the large scale sector must provide the Department with a copy of their code of conduct, which must then be approved by the Department, before any fishing is undertaken by that operator.

A level of observer coverage will be required to monitor interactions and supplement data collection envisaged at 20% for year one.

Research and fishing program

It is expected that the developmental fishery will be supported by a research and monitoring program to maximise the information collected from the fishery. It is expected that this will involve a cooperative approach between fishers, researchers and managers to maximise the potential utility of information about the fishery and stocks. This will require a genuine commitment from permit holders to assist in the research processes ensuring that information is collected in a cost effective manner.

The Department will negotiate a research program with IMAS. Participants will be required to support the research through permit fees.

There is little history of this fishery in Tasmania hence all information collected increases the knowledge of this species.

It is envisaged that a step wise research program will be undertaken that progressively provides more information. The first year provides opportunity for basic issues such as can sardines be effectively and economically targeted and will provide basic biological information about the catch (size, age and reproductive condition), by-catch and interactions with protected species (based on observed coverage), to be followed in further years (if warranted) with increasingly in depth research activity. Potentially this will involve information that could then be utilised in subsequent processes, for example to support a daily egg production method (DEPM) biomass survey.

Catch effort records on a shot by shot basis will be required. This will include information such as location, time, amount caught, percentage of school caught, any by-catch and interactions with protected species. Information will be required within 24 hours of landing.

Within the catch limits set, it is desirable to spread the catch both temporally and spatially to maximise the information from fishing and that may be obtained from samples. It will be expected that a biological sample will be retained from every shot made in the developmental process – i.e. 100% coverage for biological samples.

Recognising that there is a limit to the information that can be collected within the catch limits set and by purse seine fishing (due to gear selectivity), opportunistic sampling using different types of gear may also be required. Permit holders, whilst fishing for other purposes, may be requested to collect such samples to supplement those taken from commercial fishing. Gaining a detailed understanding of spawning season and spawning distribution are important to support DEPM assessments.

It is also likely that sardine stocks are shared with Victoria and possibly NSW. Opportunities for complementary or joint research will also be explored.

The initial research objectives are:

- Describe the size structure of the commercial catch;
- Describe biological characteristics of the catch, including a preliminary description of age and growth, maturity status and reproductive cycle;
- Provide an assessment of TEP interactions and bycatch.

Assumptions made:

- Industry will be responsible for providing a sample of approximately 50 fish per landing for biological examination;
- Industry will allow IMAS staff on board vessels to monitor fishing operations – target of at least 20% trips in first year.

Deliverables: Report findings in fishery assessment report, along with an analysis of catch and effort data.

Permit Fees

Permit fees will be required to support the developmental process, management and the research undertaken on a cost recovery basis. .

The initial research program is costed at \$40,598. This does not include any management costs.

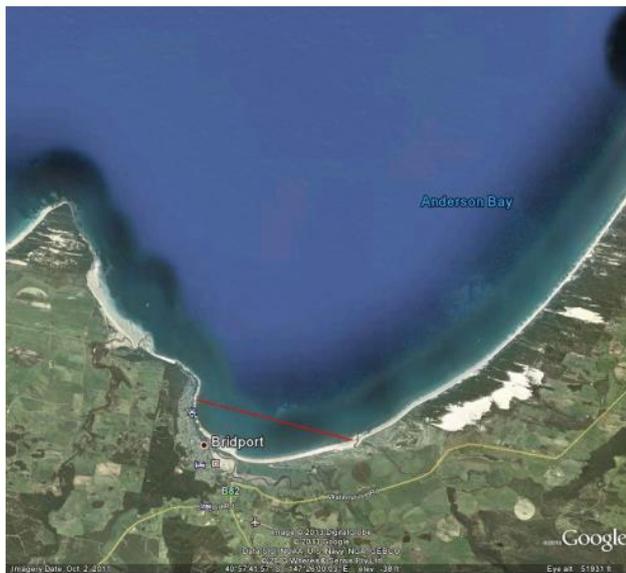
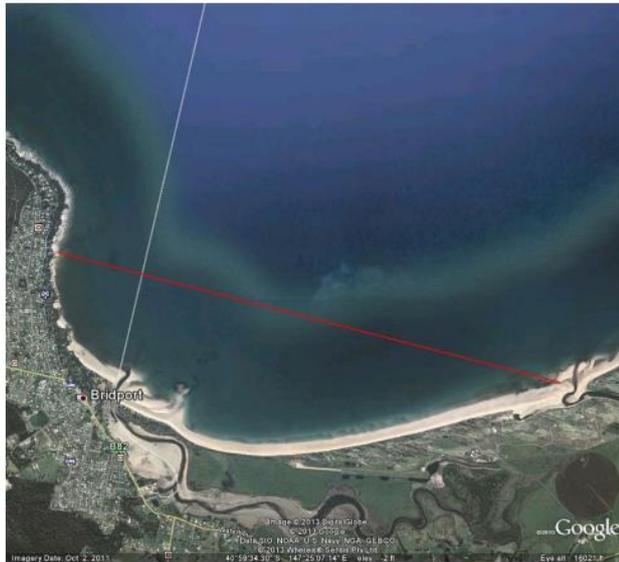
A fee for both sectors of 6.3 cents/kg will be charged for the first years permit. At a nominal beach price of \$1.00/kg this is a fee in the order of 6%. This is considered within appropriate levels and compares with many other fee schedules in established fisheries.

The rationale of staged payments is recognised. However, all the costs are to reimburse IMAS costs (there is no cost recovery for DPIPWE) and most costs are fixed, therefore, all the monies are required.

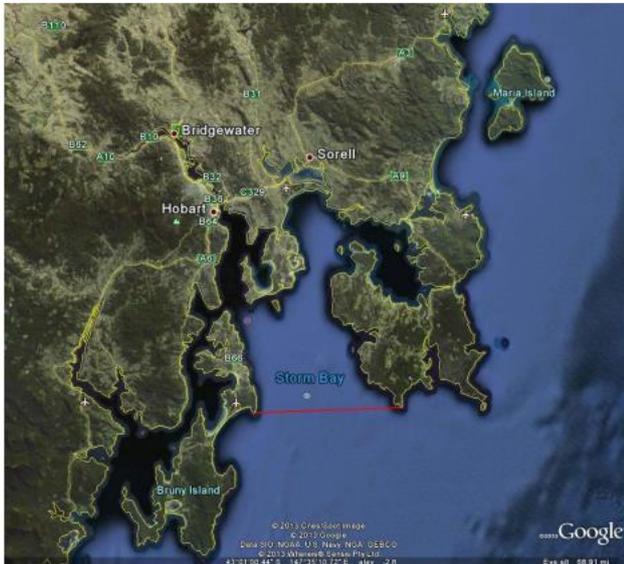
The Department requires payments for accounts upon invoice. A staged fee will be implemented with an initial up-front payment of one quarter of the amount (\$4,725) and then three further equal payments three months apart (i.e. four equal payments spaced one at issue, one at the three months, one at six months and one at nine months).

This fee will be charged irrespective of the catch realised. These monies are required to support the research being put in place. Ongoing engagement will be required with IMAS and close cooperation between fishers, management and research will also be required.

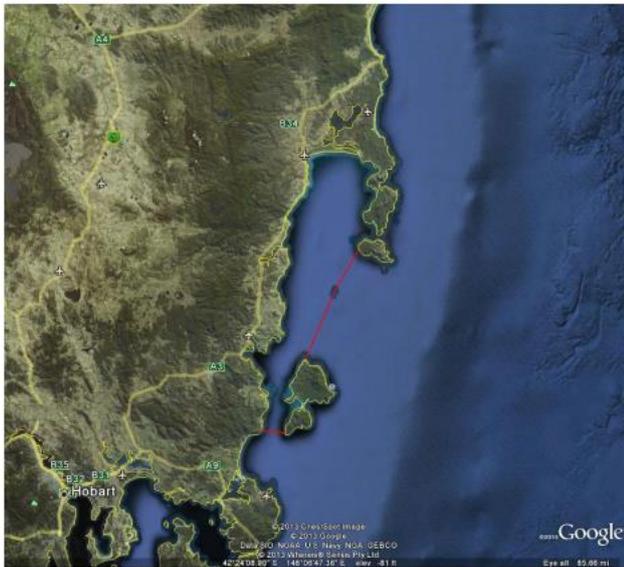
Appendix 1 Major spatial closures



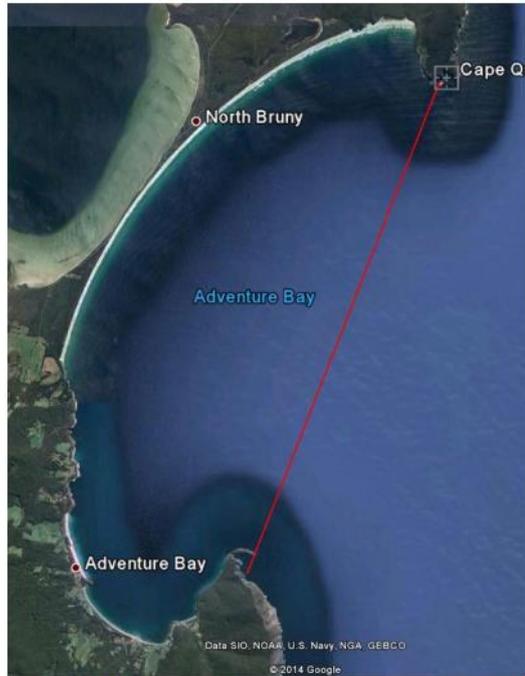
Closed area at Anderson Bay (both sectors)



Closed area Storm Bay/Derwent north of line Cape Queen Elizabeth (large scale sector)



Closed area GOB, Maria Island, Mercury Passage (large scale sector)



Closed area Adventure Bay, Penguin Island to Cape Queen Elizabeth (all sectors)

Developmental Fisheries Management Policy Document

The State Government is committed to encouraging the progression of developmental fisheries to allow a broader range of options for commercial fishers, particularly in the area of value-adding to low-value species.

Supporting developmental fisheries (fisheries which are not provided for in any existing fisheries management plan or regulations) can be resource intensive. To maximise the benefits of an investment in developmental fisheries the Government has adopted the following policy position -

The Tasmanian Government supports providing opportunities for the development of long term environmentally sustainable, commercially profitable and socially acceptable fisheries to deliver economic growth for the State.

Developmental fishery opportunities will be supported by the Minister only where it can be satisfactorily demonstrated by a proponent that a long term, commercially profitable, environmentally sustainable and socially acceptable fishery can be developed.

A major and increasingly important issue in advancing developmental fishing activities is an expectation that the Government can demonstrate to the satisfaction of the community the environmental sustainability and social acceptability of that activity.

This requires a level of information to provide the necessary confidence that a particular fishing activity will not result in an unacceptable environmental or social impact. Where information is absent, unreliable, inadequate or uncertain, a risk based approach to fisheries development is necessary to ensure that there is an acceptable risk with respect to detriment of resources, the environment and or to other stakeholders.

Where scientific understanding is such that an acceptable level of risk cannot be demonstrated, there will be a cost in acquiring that understanding. This cost may prove to be a barrier in advancing a developmental fishery proposal. Proponents will be required to meet that cost and to assist where they reasonably can to the collection of data to support a scientific understanding.

In addition, fisheries development activities to be authorised under permit issued pursuant to the *Living Marine Resources Management Act 1995* must be consulted on with relevant fishery bodies.

It is recognised that there will be very few large scale development opportunities but there may be a number of small scale opportunities.

Implementation of the policy

There are two categories of fishery developments in the context of this policy: Category (1) - completely novel fishing activities that are outside an existing fishery management plan or regulations and Category (2) - those which might be an adjunct to an existing fishery using current fishing methods/gears compatible with and provided for under a prevailing fisheries management plan. These two categories will be managed differently.

A key objective of this policy is not to stimulate investment in capital equipment, vessels and fishing gear that is totally reliant on the developmental fishing operation / activity.

The following overarching principles have been determined by the Minister to guide the management of **Category (I)** developmental fishery proposals by the Department of Primary Industries, Parks, Water and Environment (DPIPWE).

- Proponents must satisfy the Minister that a proposal will provide long term commercially viable, environmentally sustainable and socially acceptable outcomes consistent with the objectives* of the *Living Marine Resources Management Act 1995* (the Act) that are in the interests of the Tasmanian community.
- Development proposals will be advanced through careful analysis, adopting a risk based approach and consultation with relevant fishing bodies.
- The Minister will determine which developmental fishery proposals will be advanced following consideration against the criterion in dot point one. The Minister's decision will be informed by a preliminary assessment of the proposal against a matrix of criteria including the biology of the proposed target species and current knowledge of stocks, the impacts of the proposed fishing method on the marine environment, potential by-catch, market opportunities for the product, potential conflicts with other fisheries and competing marine values.
- Should the Minister support the proposal, the proponent will be invited to submit a developmental fishery plan in accordance with guidelines provided by DPIPWE.
- In the absence of the necessary scientific knowledge to support an assessment of the environmental sustainability of a developmental fishing proposal, the proponent will be required as part of the developmental fishery management plan develop a research plan in consultation with a fisheries research provider recognised by DPIPWE and meet the costs and provide assistance where appropriate to the acquisition of this knowledge.
- Authorisation to undertake any developmental fishing activities approved will be provided through permits issued pursuant to the *Living Marine Resources Management Act 1995*. A fee will apply to the granting of any permit, determined by the Minister, which will reflect a contribution to the costs of the management of the permit.
- Permits will be granted for a maximum period of one year. Subsequent permits may be granted to permit holders at the expiry of their permit following review and satisfactory performance against permit conditions.
- The granting of a permit to authorise a developmental fishing activity can provide no entitlement to long term access to any future fishery managed under a fishery management plan. The development of a fishery management plan is the process by which access to a fishery will be determined.
- In the event that a fishery management plan were to be developed following a developmental fishery process, that plan would aim to establish a managed fishery in which a fair return is provided to the State for access to the fishery resource.
- The Minister will determine on a case by case basis the process to identify who and/or a class of person who may participate in a particular developmental fishing activity, so that a proponent may not necessarily be granted exclusive access to a particular developmental fishing activity or area.
- Proponents will be required to secure an existing fishing licence (vessel) and be granted or be a holder of a fishing licence (personal) in addition to a permit to advance a Category I fisheries development proposal.
- Sole reliance on a developmental proposal as a standalone fishing enterprise will be carefully scrutinised to determine the long term commercial viability of such an operation.

The following principles have been determined by the Minister to guide **Category 2** developmental fishery proposals by the Department of Primary Industries, Parks, Water and Environment (DPIPWE).

- A proposal received which is determined to meet the criterion of a Category 2 proposal will be considered by DPIPWE against an assessment matrix. Advice from the Institute for Marine and Antarctic Studies (IMAS) and industry bodies will ascertain the commercial viability, environmental sustainability and social acceptance of the fishery development proposal before a report is provided to the Minister.
- The Minister will then determine if any fishery development proposal of this category will be advanced by way of permits.
- If the Minister determines that a proposal should be advanced as a developmental fishery, a decision will be required if this single permit should be advanced, or if all holders of the fishing licence to which the proposed activity is considered to be an adjunct activity would be invited to apply to participate and provided with the conditions under which a developmental fishery will be conducted.
- The Minister will determine those licence holders to whom permits to participate in a developmental fishery will be issued.
- Persons granted permits to participate in a developmental fishery will be required to meet the costs and provide assistance where appropriate to the acquisition of the necessary scientific information to support the developmental fishery.
- A fee, determined by the Minister, will apply to the granting of any permit, to reflect a contribution to the costs of the management of the permit to support the developmental fishing activity.
- Permits will be granted for a maximum period of one year. Subsequent permits may be granted to permit holders at the expiry of their permit following a review and satisfactory performance against permit conditions.
- The granting of a permit to authorise a developmental fishing activity can provide no entitlement to long term access to any future fishery managed under an amended fishery management plan. The amendment of a fishery management plan is the process by which access to a fishery will be determined. This process will address, as part of a range of issues and considerations, the activities of the permit holder in the developmental fishery.

*Section 7 (1) – Purpose and Objectives of the *Living Marine Resources Management Act 1995* states:

The purpose of this Act is to achieve sustainable development of living marine resources having regard to the need to –

- (a) increase the community's understanding of the integrity of the ecosystem upon which fisheries depend; and
- (b) provide and maintain sustainability of living marine resources; and
- (ba) take account of a corresponding law; and
- (c) take account of the community's needs in respect of living marine resources; and
- (d) take account of the community's interests in living marine resources.