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Ecological Risk Assessment for the State-Wide Small Pelagic Scalefish Resource

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List of Acronyms

CDR	Catch Disposal Record
CoP	South Coast Purse Seine Fishery Code of Practice for Responsible Fishing
DPIRD	Department of Primary Industries and Regional Development
EBFM	Ecosystem Based Fisheries Management
EPBC Act	<i>Environment Protection and Biodiversity Conservation Act 1999</i>
ERA	Ecological Risk Assessment
ETP	Endangered, Threatened and Protected Species
FFS	Flesh-footed shearwater
ITQ	Individual Transferable Quota
IUCN	International Union for Conservation of Nature
MFL	Managed Fishery Licence
MSC	Marine Stewardship Council
PSDZ	Purse Seine Development Zone(s)
SCB	South Coast Bioregion
SCPSF	South Coast Purse Seine Fishery
TACC	Total Allowable Commercial Catch
WA	Western Australia
WCB	West Coast Bioregion
WCPSF	West Coast Purse Seine Fishery
WTO	Wildlife Trade Operation

Executive Summary

In July 2021, the Department of Primary Industries and Regional Development (Department) convened an ecological risk assessment (ERA) of the Western Australian (WA) fisheries that access the Small Pelagic Scalefish Resource (Resource). ERAs are conducted by the Department as part of its Ecosystem Based Fisheries Management (EBFM) framework.

The ERA considered the potential ecological impacts of the West Coast Purse Seine Fishery (WCPSF), South Coast Purse Seine Fishery (SCPSF), Purse Seine Development Zones (PSDZ) and the recreational fishers who catch small pelagic scalefish. The assessment focussed on evaluating the impact of each fishing sector/method on all retained and bycatch species, endangered, threatened and protected (ETP) species, habitats and the broader environment.

A broad range of stakeholders were invited to participate in the ERA workshop, including representatives of the commercial and recreational fishing sectors, as well as Commonwealth, state and local government agencies, Conservation Council of Western Australia, Murdoch University, Birdlife Australia, Great Southern Development Commission, South Coast Natural Resource Management, Commonwealth Scientific and Industrial Research Organisation and the South West Aboriginal Sea and Land Council.

Risk scores were determined based on available scientific monitoring, research information and expert knowledge on species, fishing activities, fishery regulations and management. This assessment conforms to the AS/NZS ISO 31000 risk management standard and the methodology adopted by the Department, which relies on a likelihood-consequence analysis for estimating risk.

Thirty four broad ecological components were scored cumulatively for risk. The vast majority (32) of ecological components were evaluated as low or negligible risks, which do not require any specific control measures.

The risk assessment yielded two high risks. Within the South Coast Bioregion, sandy sprat are retainable by purse seine, however, catches are extremely rare (and possibly misidentified) with no recent recorded catches. Within the West Coast Bioregion, taking sandy sprat by purse seine net is prohibited. A High risk was given to sandy sprat based on available evidence presented in the 2019/20 State of Fisheries Report (Duffy and Blay 2020). The impacts of heatwaves causing environmental limitations and contracted distribution indicates this stock is unsustainable-inadequate.

At the workshop, Flesh Footed Shearwaters (FFS) was scored a Medium/High risk. A medium risk was considered appropriate due to the potential interaction with purse seine nets based on independent observer records. However, noting concerns over the level of uncertainty associated with population modelling and fishery-dependent data, a high score was also considered.

For completeness and based on the approach adopted consistently across all ERAs, in the instance of two scores being recorded, the highest of the two is carried forward. Thus, whilst this component scored a Medium/High, for the purpose of the outcomes

of the ERA, a High risk has been attributed to FFS. It is recognised in deriving at this outcome that the high score in this component is due to uncertainty of the underlying data quality and that improving the quality and quantity of the data, will improve the risk.

It is anticipated that outcomes of the upcoming application to the Commonwealth Department of Agriculture, Water and the Environment for the SCPSF to be assessed against the Commonwealth Guidelines for the *Ecologically Sustainable Management of Fisheries*, for the purpose of becoming an approved Wildlife Trade Operation will assist in the determination of required monitoring and control measures.

It is recommended that the risks be reviewed in five years where the risk scores are used as the performance indicator for the non-target ecological assets. Monitoring and assessment of the key target species will be ongoing, with the performance indicators for those stocks evaluated on an annual basis.

1.0 Introduction

The Department of Primary Industries and Regional Development (Department) uses an Ecosystem-Based Fisheries Management (EBFM) approach that considers all relevant ecological, social, economic and governance issues to deliver community outcomes (Fletcher *et al.* 2010; 2012). Ecological Risk Assessments (ERA) are undertaken periodically to assess the impacts of fisheries on all the different components of the aquatic environments in which they operate. The outcomes of the risk assessments are used to inform EBFM-based harvest strategies and to prioritise the Department's monitoring, research and management activities (Fletcher 2015; Fletcher *et al.* 2016).

This report provides information relating to an ERA for the Small Pelagic Scalefish Resource (Resource) conducted in 2021. The assessment considered the potential ecological impacts of the West Coast Purse Seine Fishery (WCPSF), South Coast Purse Seine Fishery (SCPSF), Purse Seine Development Zones (PSDZ) and the recreational line fishers who catch small pelagic scalefish. The ERA assessed the potential ecological impacts of these fisheries on all relevant retained and bycatch species, ETP species, habitats, and the broader ecosystem.

The risk assessment methodology utilised a consequence-likelihood analysis, which involved the examination of the magnitude of potential consequences from fishing activities and the likelihood that those consequences will occur given current management controls. Risk scores were determined during an external stakeholder workshop on 27 July 2021. Once finalised, this risk assessment will help inform the development of a formal harvest strategy for the Resource. It will also inform other processes, including an upcoming application to the Commonwealth Department of Agriculture, Water and the Environment for the SCPSF to be assessed against the Commonwealth Guidelines for the *Ecologically Sustainable Management of Fisheries*, for the purpose of becoming an approved wildlife trade operation (WTO).

The scope of this ERA is for the next five years (through to 2026). It is envisioned that ERA's will be undertaken periodically (approximately every five years) to reassess any current or new issues that may arise. However, a risk assessment can also be triggered if there are significant changes identified in fishery operations or management activities that may change current risk levels.

2.0 Small Pelagic Scalefish Resource

This statewide Resource comprises various species of small pelagic scalefish. The five key species comprising the Resource are Australian sardine (*Sardinops sagax*), yellowtail scad (*Trachurus novaezelandiae*), Australian anchovy (*Engraulis australis*), scaly mackerel ('tropical sardine', *Sardinella lemuru*) and maray (*Etrumeus jacksoniensis*).

The Resource is accessed by the commercial and recreational fishing sectors, with the vast majority of catches occurring in the West Coast Bioregion (WCB) and South Coast Bioregion (SCB). In the WCB, catches are predominantly taken by WCPSF and PSDZ licence holders, using purse seine gear in waters between Geraldton and Cape Leeuwin. This region is split into three zones - Northern Development Zone (all WA waters north of 31° 00'S), Perth Metropolitan (31° 00'S to 33° 00'S) and Southern Development Zone (33° 00'S to Cape Leeuwin).

In the SCB, catches are predominantly taken by the quota managed SCPSF. These fishers use purse seine gear in waters between Cape Leeuwin and the South Australian (SA) border.

Statewide recreational catches of small pelagic species are estimated to be minor.

Monitoring and assessment of the Resource is currently based on identification and sustainability evaluation of indicator species (Department of Fisheries 2011). Indicator species are determined using a risk-based approach that calculates the 'sustainability risk' of stocks (based on the inherent vulnerability and current risk to wild stock) and the current or likely future 'management risk' of the species or stock to the community (measured as a combination of the current management information requirements, and their economic and social values). The Resource is currently managed under a constant catch harvest strategy approach, with catches limited to notional (non-legislated) total allowable commercial catches (TACC) in the WCPSF and PSDZ and legislated TACCs set for each management zone within the SCPSF.

The following chapters of the report (Sections 3 and 4) outline the aquatic environment, fishing activities undertaken by each fishing sector, available information on retained and discarded catches, and ecological impacts on habitats and ETP species. This background information will be used as the basis for scoring the individual and cumulative risks of these fishing activities impacting on each ecological component considered in this risk assessment.

3.0 Aquatic Environment

The Resource is predominately harvested by commercial fisheries operating in waters along the WCB and SCB.

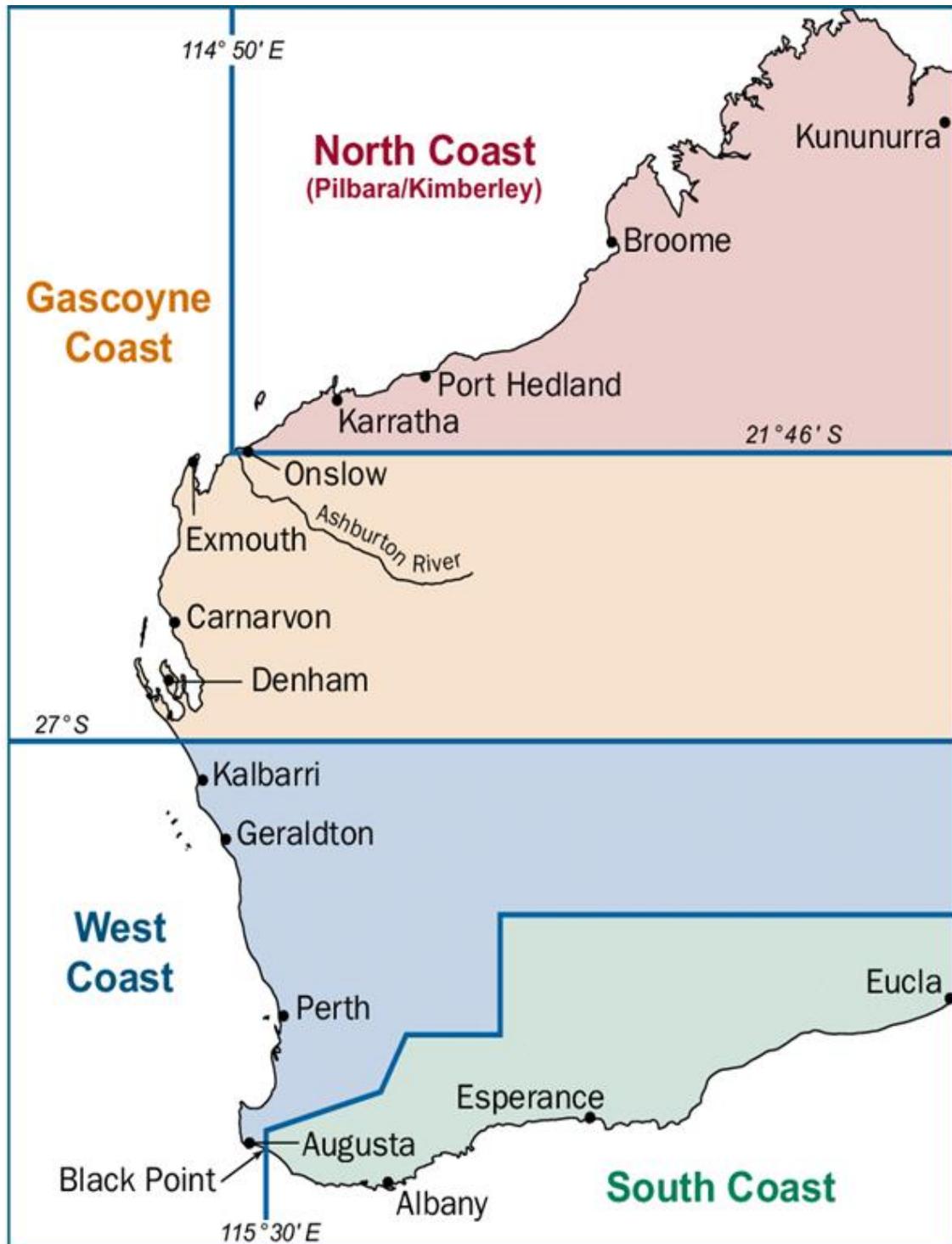


Figure 3.1 The Bioregions of Western Australia.

3.1 West Coast Bioregion

The marine environment of the WCB (Figure 3.1) from Black Point, east of Augusta, to the Zuytdorp Cliffs, north of Kalbarri (all land and water south of 27° S and west of 115° 30' E) is predominantly a temperate oceanic zone, but it is heavily influenced by the Leeuwin Current, which transports warm tropical water southward along the edge of the continental shelf (Gaughan and Santoro 2018). Most of the fish species of the region are temperate, in keeping with the coastal water temperatures that range from 18°C to about 24°C. The Leeuwin Current is also responsible for the existence of the Abrolhos Islands coral reefs at latitude 29°S and the extended southward distribution of many tropical species along the WCB and even into the South Coast.

The Leeuwin Current system, which can be up to several hundred kilometres wide along the WCB, flows most strongly in autumn/winter (April to August) and has its origins in ocean flows from the Pacific through the Indonesian Archipelago. The current is variable in strength from year to year, flowing at speeds typically around one knot, but has been recorded at three knots on occasions. The annual variability in current strength is reflected in variations in Fremantle sea levels, and is related to El Niño Southern Oscillation events in the Pacific Ocean. Weaker counter-currents on the continental shelf (shoreward of the Leeuwin Current), such as the Capes Current that flows northward from Cape Leeuwin as far as Shark Bay, occur during summer and influence the distribution of many of the coastal finfish species.

The most significant impact of the clear, warm, low-nutrient waters of the Leeuwin Current is on the growth and distribution of the temperate seagrasses. These form extensive meadows in protected coastal waters of the WCB, generally in depths of 20 m (but up to 30 m), and act as major nursery areas for many fish species.

The WCB is characterised by exposed sandy beaches and a limestone reef system that creates surface reef lines, often about 5 km off the coast. Further offshore, the continental shelf habitats are typically composed of coarse sand interspersed with low limestone reef associated with old shorelines. There are few areas of protected water along the WCB, the exceptions being within the Abrolhos Islands, the leeward sides of some small islands off the Midwest Coast, plus behind Rottnest and Garden Islands in the Perth metropolitan area.

The two significant marine embayments in the WCB are Cockburn Sound and Geographe Bay. In the WCB there are four significant estuarine systems – the Swan-Canning, Peel-Harvey and Leschenault estuaries and Hardy Inlet (Blackwood estuary). All of these are permanently open to the sea and form an extension of the marine environment except when freshwater run-off displaces the oceanic water for a short period in winter and spring. Southward of Cape Naturaliste, the coastline changes from limestone to predominantly granite and becomes more exposed to the influences of the Southern Ocean.

3.2 South Coast Bioregion

The SCB (Figure 3.1) extends east from Augusta (34.310°S, 115.30°E) to the SA border. The continental shelf waters of the SCB are generally temperate but low in nutrients, due to the seasonal winter presence of the tail of the tropical Leeuwin

Current and limited terrestrial run-off from an infertile landscape (Gaughan and Santoro 2018). Sea surface temperatures typically range from approximately 15°C to 21°C, which is warmer than would normally be expected in these latitudes due to the influence of the Leeuwin Current. The effect of the Leeuwin Current, particularly west of Albany, limits winter minimum temperatures (away from terrestrial effects along the beaches) to about 16°C to 17°C. Fish stocks in this region are predominantly temperate, with many species' distributions extending right across southern Australia. Tropical species are occasionally found, which are thought to be brought into the area as larvae as they are unlikely to form breeding populations.

The SCB is a high-energy environment, heavily influenced by large swells generated in the Southern Ocean. The coastline from Cape Leeuwin to Israelite Bay is characterised by white sandy beaches separated by high granite headlands. East of Israelite Bay, there are long sandy beaches backed by large sand dunes, until replaced by high limestone cliffs at the SA border. There are few large areas of protected water in the SCB, the exceptions being around Albany and in the Recherche Archipelago off Esperance.

The western section of the coastline receives significant winter rainfall and hosts numerous estuaries fed by winter-flowing rivers. Several of these, such as Walpole/Nornalup Inlet and Oyster Harbour, are permanently open, but most are closed by sandbars and open only seasonally after heavy winter rains. The number of rivers and estuaries decreases to the east as the coastline becomes more arid. While these estuaries are influenced by terrestrial run-off and have relatively high nutrient levels (and some, such as Oyster Harbour and Wilson Inlet, are suffering eutrophication), their outflow to the ocean does not significantly influence the low nutrient status of coastal waters.

The marine habitats of the SCB are similar to the coastline, having fine, clear sand sea floors interspersed with occasional granite outcrops and limestone shoreline platforms and sub-surface reefs. A mixture of seagrass and kelp habitats occurs along the coast, with seagrass more abundant in protected waters and some of the more marine estuaries. The kelp habitats are diverse but dominated by the relatively small *Ecklonia radiata*, rather than the larger kelps expected in these latitudes where waters are typically colder and have higher nutrient levels.

4.0 Background of Fishing Sectors

4.1 West Coast Purse Seine Fishery and Development Zones

4.1.1 History of Development

Fishing for Australian sardines in WA began in the Fremantle area during the 1950's, however, the fishery did not develop until the advent of purse seining in the 1970's. This led the fishery to expand around the WA coast. Initially all vessels were limited in size thus preventing on-board fish processing. The rapid deterioration of fish prevented vessels being able to target stocks that were distant to land processing facilities.

In the mid 1980's, the expansion of the SCPSF from 13 to 25 boats prompted the setting up of a working group in November 1986. Part of the charter for this group included investigating management options for the WCPSF. The recommendations of this group were adopted in November 1987 and included a proposal to introduce limited entry measures for Cockburn Sound and adjacent waters. It also considered that Development Zones on either side of Cockburn Sound and adjacent waters were necessary (Moore 1989).

In December 1987, the (then) Minister announced that a development plan needed to be formulated to allow for ordered growth of purse seining in WA. The '*Draft Management Plan For Perth Metropolitan Purse-Seine Fishery*' (Millington 1988) set out the controls needed for the development of the fishery. The report was put out for public comment and, after taking into consideration issues raised in submissions, the management plan for the '*Perth Metropolitan Purse-Seine Fishery*' was produced in 1989 (Moore 1989).

The management plan for the Perth Metropolitan Purse Seine Fishery was applicable to the area from Lancelin (31°S) to near Cape Bouvard (33°S). Continued access was issued under two methods. A fully transferable limited entry licence was granted to licensed fishing boats (LFB) that caught an annual average of 20 tonnes or more during the period of 1 July 1982 to 30 June 1986 inclusive, by use of purse-seine nets in the central zone. A supplementary access endorsement, which was not transferable, was granted to a LFB that caught between one and 20 tonnes during the period of 1 July 1982 to 30 June 1986 inclusive, by use of purse-seine nets in the central zone. This left eight full and five supplementary licence holders in the fishery.

The *West Coast Purse Seine Limited Entry Fishery Notice 1989* ('Management Plan') was gazetted in September 1989. The Management Plan restricted boat size to 16 metres and purse seine nets to a length of 350 metres with a minimum mesh size of 18 mm. Only limited entry licence holders were permitted to use mechanical assistance to haul nets.

Area closures included in the Management Plan were:

- Cockburn Sound, Warnbro Sound and Marmion Marine Park;
- Within 1000 meters of shore north of 31°54'S and south of 32°16'S latitudes.

In 2005, all supplementary licences in the WCPSF were transitioned to managed fishery licences (MFL) (with supplementary access only) and are now transferrable.

4.1.2 Current Management Arrangements

The WCPSF is a purse-seine net-based fishery that operates in WA waters from Lancelin (31°00'S latitude) to Cape Bouvard (33°00'S). Due to onshore handling requirements the WCPSF operates from the major harbours in this area. There are also zones on both sides of the WCPSF named the Northern (all WA waters north of 31° 00'S) and Southern Development Zones (33° 00'S to Cape Leeuwin). These areas have been going through a developmental process to determine whether the WCPSF should be extended to include a larger section of the West Coast. However, since about 2007 catches have been relatively low within the WCPSF and the PSDZ, so the process to consider including these zones within the existing WCPSF Management Plan is yet to be progressed. The WCPSF (deemed the Metropolitan Zone) and PSDZ together encompass WA waters off the southern coast from Cape Leeuwin (115°08.091' E longitude), to the Northern Territory border (Figure 4.1).

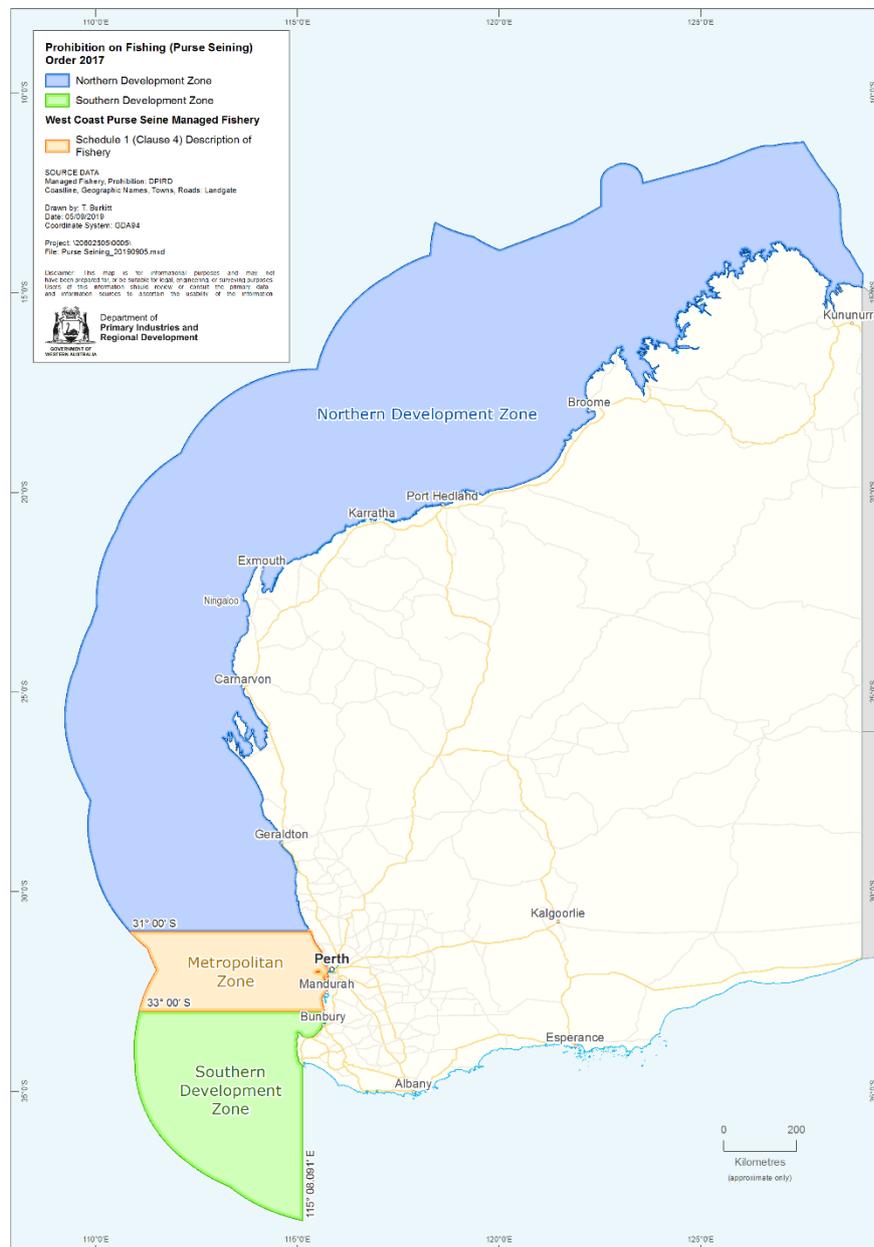


Figure 4.1 The WCPSF and PSDZ locality map.

The species captured are primarily Australian sardines (*Sardinops sagax*) and scaly mackerel (tropical sardine - *Sardinella lemuru*) with much smaller catches of yellowtail scad (*Trachurus novazelandiae*), Australian anchovy (*Engraulis australis*) and maray (*Etrumeus jacksoniensis*). Perth herring (*Nematalosa vlaminghi*), part of the West Coast Nearshore and Estuarine Scalefish Resource, may also be retained, but catches are very rare.

The principal piece of legislation used to manage fishing within the WCPSF is the WCPSF Management Plan. A *Prohibition on Fishing (Purse Seining) Order No. 7 of 2017* and an *Instrument of Exemption* issued under Sections 43 and 7(2)(e) respectively of the *Fish Resources Management Act 1994*, allows fishing in the PSDZ.

Access to the WCPSF is presently limited to 12 MFLs that must fish in accordance with the Management Plan. Under the Management Plan, the WCPSF is permitted to target only the six species listed above. Four of the MFLs are supplementary licences which do not allow the use of power hauled purse seine nets. In addition, the WCPSF Management Plan limits effort in the WCPSF through a number of input controls including:

- boat size (maximum 16 metres);
- type of net hauling equipment (power or hand);
- length of net (maximum 350 metres); and
- size of mesh (minimum 18 mm).

In the PSDZ, six licences (three licences in each Zone) are permitted to use power hauled purse seine nets to catch the six species listed above. One of the three licences is not permitted to take Australian sardines within the Southern PSDZ and no Australian sardines can be taken by any licences within the Northern PSDZ.

Up until 31 March 2005, the WCPSF had a TACC that was gazetted under the Management Plan. Since 2005 (following the recovery of the Australian sardine stocks after mass mortality events caused by a herpesvirus) there has been a notional combined TACC, covering both the WCPSF and the Southern PSDZ, set for Australian sardines and another for other small pelagic species. This TACC was set conservatively and has not been reached in recent fishing seasons. For the 2020/21 licensing period (1 April 2020 – 31 March 2021) the notional TACC was 2,328 tonnes for Australian sardines and 672 tonnes for other small pelagic species (including tropical sardines). The Northern PSDZ has a separate notional TACC of 2,700 tonnes for tropical sardines.

The WCPSF and PSDZ were recently assessed under the *Commonwealth Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) and found to meet the *Guidelines for the Ecologically Sustainable Management of Fisheries* and are declared exempt from export controls under Part 13 (protected species) and Part 13A (wildlife trade) of the EPBC Act, with the product from the WCPSF and PSDZ included in the List of Exempt Native Specimens (LENS). The LENS is a list of native specimens that are exempt from export prohibitions. This accreditation is valid until January 2023.

4.2 South Coast Purse Seine Fishery

4.2.1 History of Development

Fishing for Australian sardines in the Albany region commenced around 1963/64 using drop nets from the wharf in Princess Royal Harbour. The fishery developed slowly and methods changed little, until the late 1970s when purse seining took over as the main method. By 1980/81, 80 per cent of the total Australian sardine catch was taken using purse seine nets.

The Australian sardine fishery based around Albany expanded in the 1970's to meet a growing demand for bait by the southern bluefin tuna fleet. The introduction of Individual Transferable Quota (ITQs) in the Southern Bluefin Tuna Fishery in 1983 and development of a pet food market in 1984 resulted in extra boats entering the Australian sardine fishery in the mid-1980s. The number of boats operating in the King George Sound Sardine Fishery increased from 13 in early 1984 to 25 by the end of 1985. During this time the catch more than doubled from 1,596 tonnes in 1983/84 to 3,517 tonnes in 1984/85. Catches for the whole of the south coast continued to rise, peaking at approximately 8,000 tonnes in 1990 and again in 1996.

In October 1985, the waters of King George Sound became a restricted entry fishery and certain criteria were required to be met before future access would be given. Based on these criteria, there were eight full time purse seine fishermen approved to continue operating in the King George Sound Sardine Fishery (Moore 1989).

The expansion of the South Coast fishery prompted the setting up of a working group in November 1986 to review management arrangements in the King George Sound Sardine Fishery (Moore 1989). The working group recommendations were primarily aimed at limiting fishing effort in King George Sound. Many of these recommendations were included in the *King George Sound Purse Seine Limited Entry Fishery Notice* which was gazetted in 1988.

Strategies for limiting fishing effort included the creation of different categories of licences. 'A Class' licences were issued to those vessels which had remained active and had caught the minimum of 50 tonnes of Australian sardines in the three-year period prior to 30 April 1985. 'A Class' licensees were permitted year round access to King George Sound. These licensees were provided 'permanent' access to the fishery but were only permitted to transfer their licence to 'B Class' licensees and all vessels had to be owner operated. However, in 1989 'A Class' licences became fully transferable.

'B Class' licences were given to those vessels which had not caught the minimum of 50 tonnes of Australian sardines in the 3-year period prior to 30 April 1985. 'B Class' licensees were permitted access to King George Sound on a seasonal basis. These licences were non-transferable with continued access to be reviewed in 1989. In December 1989 a decision was made to extend the seasonal access for 'B Class' licensees in King George Sound until 1990.

'C Class' access permitted a licence holder to operate in the Albany Development Zone outside of King George Sound.

In 1989, a processing unit was established along the coast at Bremer Bay (east of Albany). Subsequently, the TACC for the small Australian sardine fleet based in Bremer Bay rose from 1,500 tonnes in 1990 to 2,500 tonnes in the following years, until the mass deaths of Australian sardines in the 1990s. Due to concerns about the condition of the Australian sardine stock around Bremer Bay, the quota in this area was also reduced to zero in 2000/2001.

A small Australian sardine fleet was also established around the town of Esperance which was allocated formal access in 1995. Since 1996 it has been managed in a similar fashion to the Bremer Bay and Albany fleets (brought under formal management arrangements in 1994) with gear controls and a TACC.

Prior to 1988, the WA Government did not have control over fishing in oceanic waters further than three nautical miles from shore. In April 1988 the management of small pelagic fish and many other species came under state control with the signing of the Offshore Constitutional Settlement. This gave jurisdictional control of most small pelagic fish in the Australian Fishing Zone, which extends to 200 nautical miles, to the State Government. Small pelagic species that were not covered (outside three nautical miles) include blue and jack mackerel (Peruvian & greenback jack mackerel) and yellowtail scad and redbait (Moore 1989).

4.2.2 Current Management Arrangements

The SCPSF is a purse-seine net-based fishery that operates in the waters between Cape Leeuwin and the Western Australia/South Australia border (Figure 4.2). It has five management zones, centred on King George Sound (Zone 1), Albany (Zone 2), Bremer Bay (Zone 3), Esperance (Zone 4) and a Developmental Zone near Augusta (Zone 5) where the recorded catch has been negligible in recent years. Due to onshore handling requirements the fishery operates from the major harbours on the South Coast. The SCPSF was the largest tonnage fishery in WA during the late 1980s and early 1990s, until a virus devastated Australian sardine stocks in 1995 and 1998/99. While surveys demonstrated strong recovery by the mid-2000s, catches have remained well below the TACC, which is conservatively set at 5,683 tonnes.

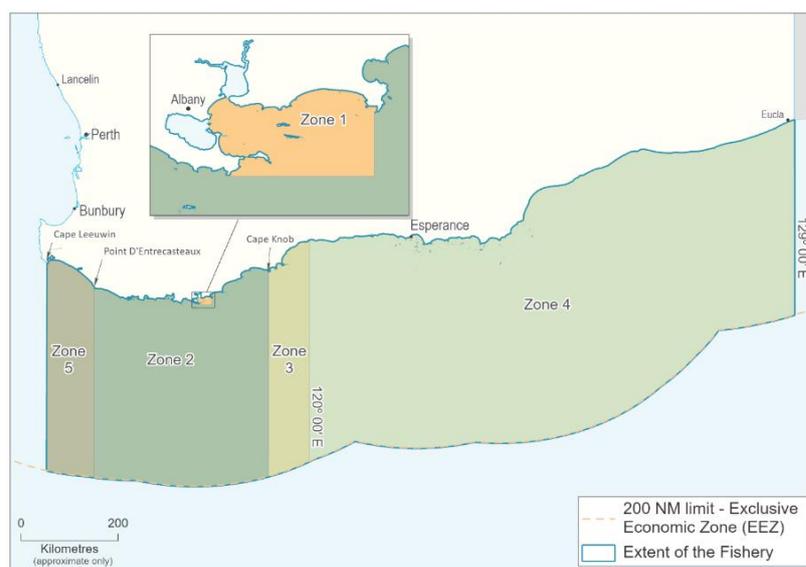


Figure 4.2 The SCPSF and Management Zones locality map.

The principal species captured is Australian sardine (*Sardinops sagax*), with much smaller catches of scaly mackerel (*Sardinella lemuru*), yellowtail scad (*Trachurus novazelandiae*), Australian anchovy (*Engraulis australis*) and maray (*Etrumeus jacksoniensis*). The SCPSF is also entitled to retain sandy sprat (*Hyperlophus vittatus*) and blue sprat (*Spratelloides robustus*), but catches are very rare.

The fishery is managed by the *South Coast Purse Seine Managed Fishery Management Plan 1994* through a combination of input and output controls including limited entry, species restrictions, gear requirements and specifications, access to specific zones, closed areas within the fishery and a TACC.

This fishery is primarily managed through output controls in the form of ITQ units with licence holders allocated units within particular zones of the fishery. These units can be temporary or permanently transferred to other licence holders. The total number of units allocated across the fishery amount to 890. There are 32 MFLs in the fishery.

The majority of the fishing effort in the SCPSF is concentrated around the Albany area. The licences presently permitted to take small pelagic fish in the SCPSF consists of:

- Zone 1 – Albany

20 licensees currently hold sufficient units to allow them to fish in zone 1 of the SCPSF. Seven of these licensees also hold sufficient units to also fish in zone 2 of the fishery.

- Zone 2 – King George Sound

There are eight licensees that currently hold sufficient units to allow them to fish in zone 2 of the fishery. Seven of these also have access to zone 1.

- Zone 3 – Bremer Bay

Seven licensees currently hold sufficient units to allow them to fish in zone 3 of the fishery. None of these licensees have units in other zones of the fishery.

- Zone 4 – Esperance

There are currently five licensees with sufficient units to allow them to fish in zone 4 of the fishery. None of these licensees have units in other zones of the fishery.

Four of the five zones in the SCPSF (i.e. zones 1 – 4) have been allocated a set number of ITQ units whose values are determined by dividing the TACC for that zone by the total number of units allocated to that zone. The TACC has been relatively stable over the past 10 years and will be reviewed on an as needs basis but is primarily dependant on the status of fish stocks. The current TACC for each zone are:

- Zone 1 and 2 (combined): 2,683 tonnes;
- Zone 3: 1,500 tonnes; and
- Zone 4: 1,500 tonnes.

Zone 5 of the SCPSF is considered a Development Zone and can only be fished by a licence holder in the SCPSF with a minimum holding in another zone, it has no specific TACC or units and has not been fished for a number of years.

A Code of Practice (CoP) for responsible fishing has been developed for this fishery (Appendix F). The CoP sets out principles and standards of behaviour for responsible fishing practices and continuous improvement in the sustainable management, conservation and utilisation of these fishery resources.

The Department also holds (generally annual) management meetings with stakeholders and Western Australian Fishing Industry Council (WAFIC) in which the fishery data and performance are discussed. Management settings are also reviewed at these meetings.

4.3 Fishing Gear and Methods

The gear used by the majority of boats accessing the Resource (within the WCPSF, SCPSF and PSDZ) is a purse seine net which is a fishing net designed to surround a shoal of fish. It has a cork or float line and a series of rings attached to the lead or ground line through which is passed a purse line which, when hauled, closes the bottom of the net (see Figure 4.3).

The SCPSF vessels operating in King George Sound range in lengths from 14.4 to 19.4 m and use nets ranging in size (length x drop) from about 320 x 45 m to 380 x 90 m. Net hanging ratios, defined as the difference between the length of a fully horizontally stretched section of net and the horizontal length of that section where it is attached to the cork line, divided by the former (Figure 4.4), ranged from 0.02 to 0.18 for five vessels operating in Zone 1 (King George Sound) of the SCPSF when measured in November 2017. Lampara nets, which are fishing nets designed to surround a shoal of fish with a cork or float line and a bottom lead line, which when hauled, closes together to trap the encircled fish, are also permitted to be used in the WCPSF. Purse seine and lampara net methods are used in the pelagic environment, away from shore, and do not involve significant contact with the seabed thereby avoiding impact on benthic and reef environments.

Fishing trips typically last for several hours and, at most, could be up to half a day (or overnight). The short trip duration maximises the freshness of the fish prior to reaching the factories. Within the WCB, some vessels store the catch in purpose built holds with an ice-slurry.

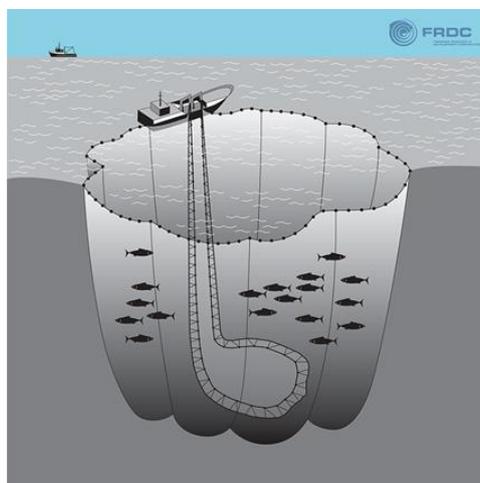


Figure 4.3 Example of a purse seine net. Source: www.fish.wa.gov.au

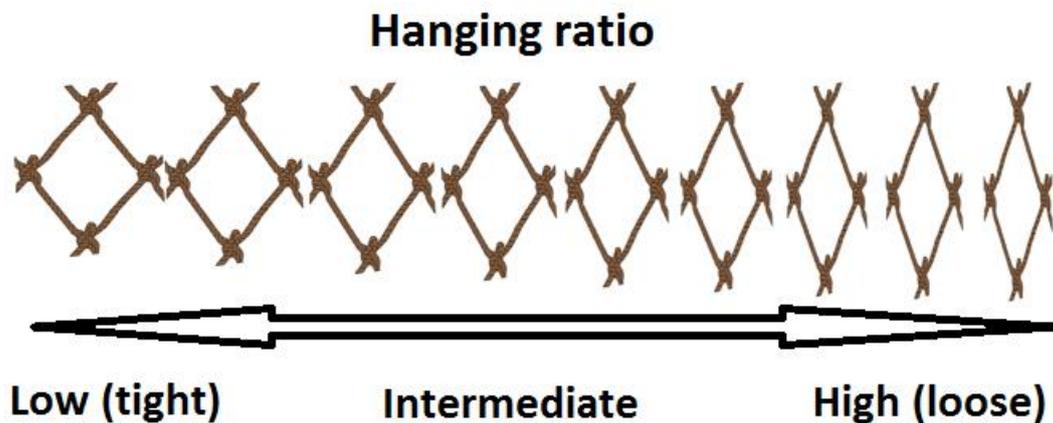


Figure 4.4 Hanging ratio of fishing net is determined by the degree to which it is stretched horizontally before being attached to the float line of a purse seine net. Adapted from Prado (1990).

4.4 Bait

On rare occasions commercial fishers use pollard to attract small pelagic fish away from areas where purse seine nets cannot be set (e.g. rough ground). Otherwise bait is not used.

4.5 Recreational Fishery

Small pelagic species are not a major focus of recreational fishers although a range of input and output controls currently exist to manage fishing of these species. These include a daily bag limit of 30 fish for yellowtail scad, and a combined daily bag limit of 9 litres for all baitfish in the families Clupeidae, Engraulidae and Atherinidae, including Australian sardines and scaly mackerel. Recreational netting for baitfish using set, haul and throw nets is permitted but requires a licence and is subject to guidelines. A recent survey of boat-based recreational fishers estimated that the catches of Australian sardines, scaly mackerel and yellowtail scad are minor in WA (annual catch of each species <1 t; Ryan *et al.* 2019).

4.6 Retained Species

4.6.1 West Coast Bioregion

Scaly mackerel and Australian sardines are the key target species within the WCB, with scaly mackerel dominating the catch since the Australian sardine virus. During 2016 - 2020, scaly mackerel and Australian sardines contributed 77% and 22%, respectively, to the total WCPSF catch. Since 1999 scaly mackerel has typically constituted 70 - 98% of annual catches in the Northern PSDZ.

Total effort and catch in the WCPSF and the PSDZ has been relatively low in recent years (Appendices C - E). A total commercial purse seine catch of 3,675 tonnes was retained in the WCB in the last five years (2016 - 2020), predominantly scaly mackerel and Australian sardines, as well as small catches of yellowtail scad, Australian anchovy and maray (Table 4.1). Low levels in 2018 can be attributed to a fire at a key fish processing facility in late 2017. Economic reasons are also responsible for lower

catch and effort over recent years. The most recent Australian sardine biomass estimate was generated in the mid-2000s from egg surveys, showing a strong recovery of the west coast stock from pre-virus levels to approximately 20,000 - 30,000 tonnes (Gaughan *et al.* 2008).

Table 4.1 Reported annual commercial purse seine catch of species permitted to be taken in the West Coast Bioregion by the West Coast Purse Seine Fishery and North and South Development Zone license holders from 2016 to 2020.

Species	Scientific name	Reported catch (tonnes)						% of total catch
		2016	2017	2018	2019	2020	Average	
Scaly mackerel	<i>Sardinella lemuru</i>	938.0	786.5	308.3	470.4	335.4	567.7	77.2
Australian sardine	<i>Sardinops sagax</i>	236.6	331.0	27.8	69.2	145.3	162	22.0
Other permitted species*		1.9	2.5	7.4	2.0	12.4	5.3	0.7

* Yellowtail scad (*Trachurus novaezelandiae*), Australian anchovy (*Engraulis australis*) and maray (*Etrumeus jacksoniensis*); individual species catch quantities confidential.

During 2016 - 2020, catches were limited to blocks immediately adjacent to Geraldton (scaly mackerel only), the Perth metropolitan area (Cockburn Sound plus two adjacent blocks) and Geographe Bay (lowest catches of the three zones) (Figure 4.5).

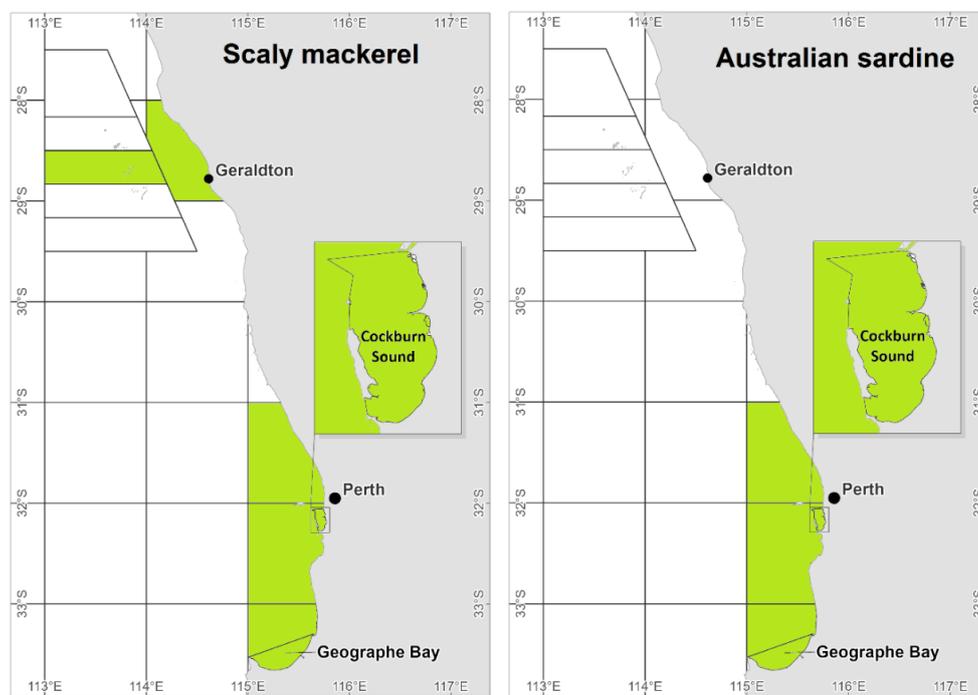


Figure 4.5 West coast fishing blocks in which purse seine catches of scaly mackerel and Australian sardines were recorded (green) from 2016 to 2020.

4.6.2 South Coast Bioregion

A total commercial purse seine catch of 8,428 tonnes was retained in the SCB in the last five years (2015/16 - 2019/20), almost all Australian sardines (>99%), as well as small catches of yellowtail scad, Australian anchovy and maray (Table 4.2). No catches of scaly mackerel, sandy sprat or blue sprat were recorded.

Table 4.2 Reported annual commercial purse seine catch of species permitted to be taken in the South Coast Bioregion by the SCPSF from 2015/16 to 2019/20.

Species	Scientific name	Reported catch (tonnes)					Average	% of total catch
		2015/16	2016/17	2017/18	2018/19	2019/20		
Australian sardine	<i>Sardinops sagax</i>	2 118.0	1 524.3	2 160.7	1 051.9	1 497.7	1 670.5	99.1
Other permitted species*		30.7	26.4	6.8	11.9	0.0	15.2	0.9

* Yellowtail scad (*Trachurus novaezelandiae*), Australian anchovy (*Engraulis australis*) and maray (*Etrumeus jacksoniensis*); individual species catch quantities confidential.

Australian sardines are predominantly taken in nearshore embayments near Albany (King George Sound), Bremer Bay and Esperance (Figure 4.6). Roughly half the total catch in the last five years (2015/16 - 2019/20) was taken in King George Sound.

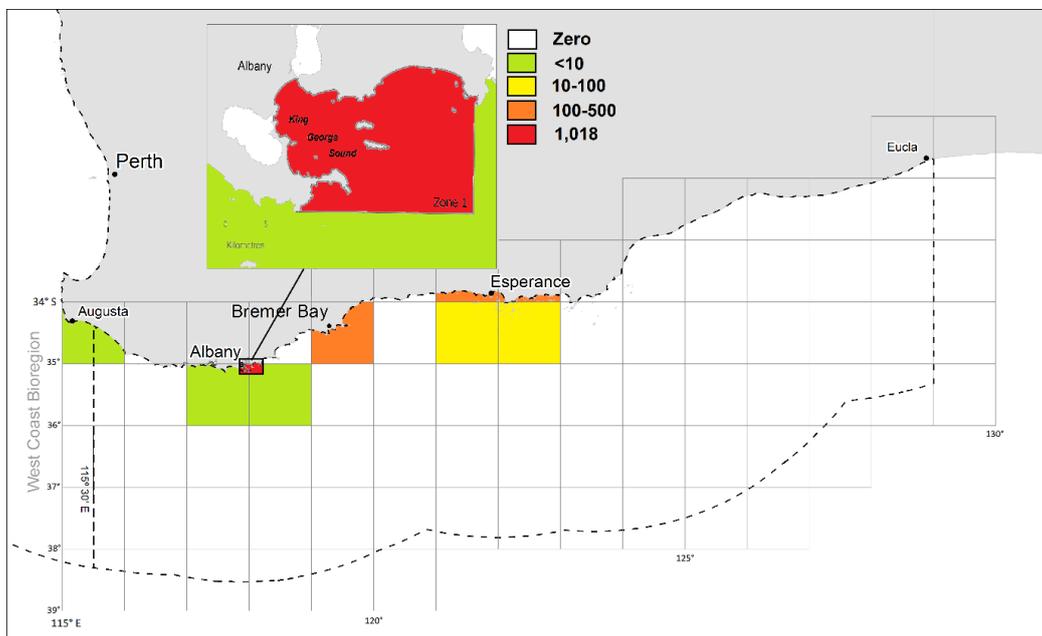


Figure 4.6 Spatial distribution of mean annual Australian sardines catch by purse seine in the South Coast Bioregion from 2015/16 to 2019/20.

4.6.3 Scaly mackerel (*Sardinella lemuru*)

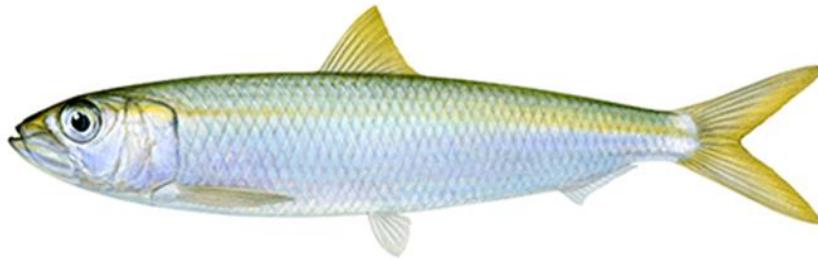


Figure 4.7 Scaly mackerel, *Sardinella lemuru*
Illustration © R.Swainston/www.anima.net.au.

Scaly mackerel are a short lived (up to seven years, attaining sexual maturity at about age two) small pelagic species (to 22 cm fork length) that feed by filtering plankton (Gaughan and Mitchell 2000). Their distribution is predominantly the tropical eastern Indian and western Pacific Oceans and northwestern WA to as far south as Geographe Bay (Whitehead 1985). In WA, where they are taken by purse seiners operating between Geraldton and Geographe Bay, they are highly mobile with a patchy distribution. Otolith chemistry showed no evidence for the existence of separate stocks between Carnarvon and Fremantle (Gaughan and Mitchell 2000). A risk-based weight of evidence assessment, using all available lines of evidence, shows the current level of risk to this stock is low (Appendix C).

4.6.4 Australian sardine (*Sardinops sagax*)



Figure 4.8 Australian sardine, *Sardinops sagax*
Illustration © R.Swainston/www.anima.net.au.

Australian sardines are distributed along the continental shelf of the southern half of the Australian mainland (Gomon *et al.* 2008). In WA they are short lived (up to 9 years; Fletcher and Blight 1996) attaining sexually maturity their second year (Fletcher 1995). Otolith chemistry and life history characteristics show that, for management and assessment purposes, WA stocks are effectively isolated from SA stocks and within WA there is separation of stocks between the West and South Coast Bioregions (Edmonds and Fletcher 1997, Gaughan *et al.* 2001, Izzo *et al.* 2017). Fishery independent egg surveys showed a major collapse of spawning biomass for these stocks in 1999 immediately following a mass mortality event caused by a herpes virus (Gaughan *et al.* 2004). Ongoing surveys demonstrated a strong recovery by the mid-2000s (Gaughan *et al.* 2008). Current risk-based weight of evidence assessments, using all available lines of evidence, show the level of risk to both west coast and south coast bioregion stocks is low (Appendixes D and E).

4.6.5 Yellowtail scad (*Trachurus novaezealandiae*)

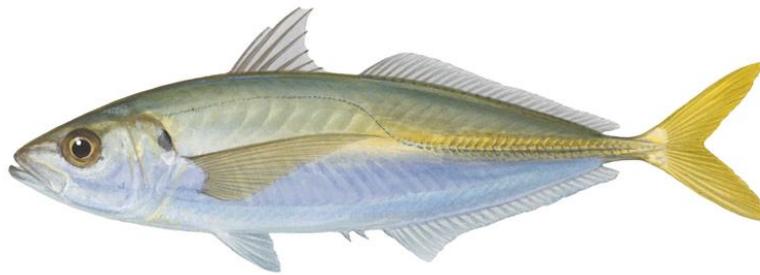


Figure 4.9 Yellowtail scad, *Trachurus novaezealandiae*
Illustration © R.Swainston/www.anima.net.au.

Yellowtail scad are found in coastal and shelf waters of southern Australia from southern Queensland to northern WA and also occur off New Zealand (Broadhurst *et al.* 2020). Yellowtail scad are assumed to comprise separate stocks in eastern and western Australia. The WA stock of yellowtail scad is not formally assessed due to insufficient data as the biology and demography of this species in WA has not been studied. In eastern Australia they attain a maximum age of 24 years, and reach sexual maturity at age 2 - 4 years (Broadhurst *et al.* 2020).

The large majority of the WA catch of yellowtail scad is taken by the commercial purse seine sector, which operates in limited areas, usually coastal embayments (e.g., King George Sound, Cockburn Sound). Thus yellowtail scad is vulnerable to the fishery only when they enter these waters. The total commercial catch of yellowtail scad has averaged 15 tonnes since 2010 (Figure 4.10). Current catches are low compared to historical levels (e.g. 104 tonnes in 1998/99 taken when the Australian sardine stock collapsed due to a virus epidemic). Low catches in recent years reflect low economic return and fishing effort rather than low stock availability. The total boat-based recreational catch of yellowtail scad in WA is negligible (estimated to be about 1,531 retained fish in 2017/18) (Ryan *et al.* 2019). The shore-based recreational catch is unknown but is assumed to also be negligible.

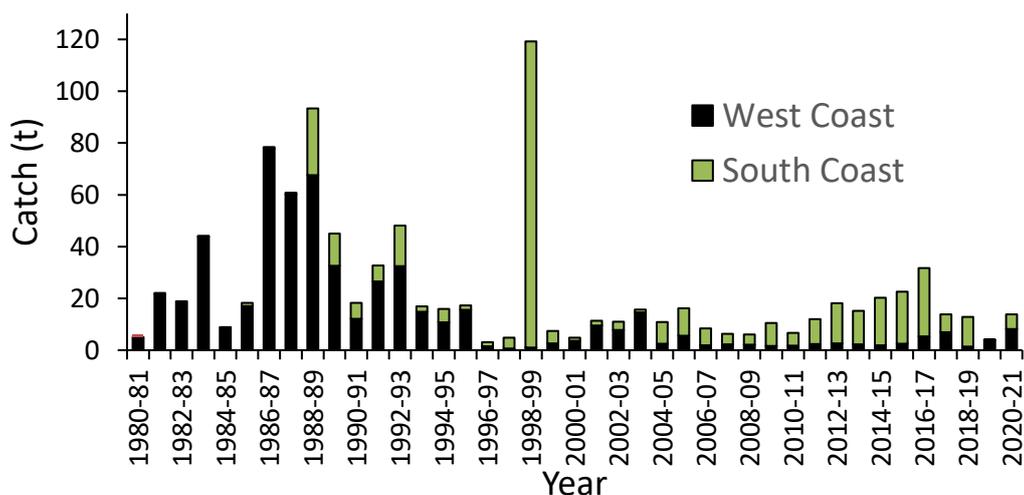


Figure 4.10 Total annual commercial catches of yellowtail scad in Western Australian waters from 1980/81 to 2019/20.

4.6.6 Other retained species

The other species that are sometimes retained by commercial purse seine fishers are:

- West Coast: Australian anchovy, and maray.



Figure 4.11 Australian anchovy, *Engraulis australis*
Illustration © R.Swainston/www.anima.net.au.

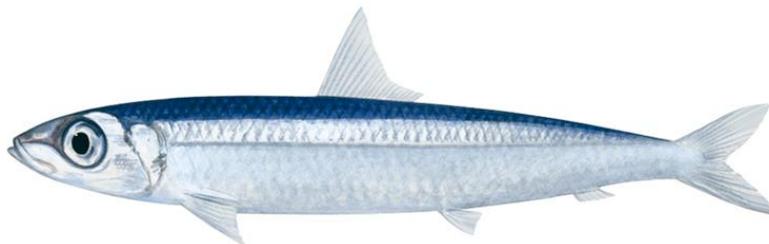


Figure 4.12 Maray, *Etrumeus teres*
Illustration © R.Swainston/www.anima.net.au.

- South Coast: Australian anchovy, maray, scaly mackerel, sandy sprat and blue sprat.



Figure 4.13 Sandy sprat, *Hyperlophus vittatus*
Illustration © R.Swainston/www.anima.net.au.

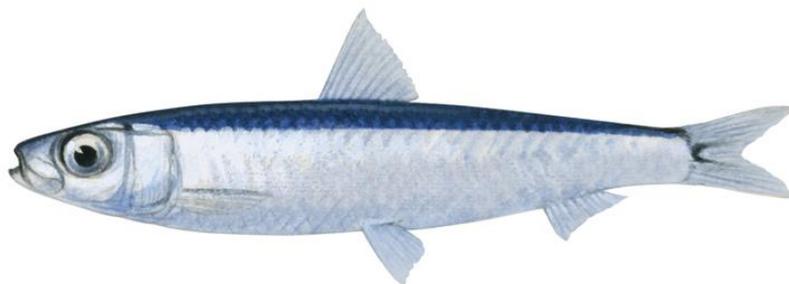


Figure 4.14 Blue sprat, *Spratelloides robustus*
Illustration © R.Swainston/www.anima.net.au.

Catches of these other species are small and infrequent (Tables 4.1 and 4.2). In each bioregion they collectively comprised <1% of the total reported catch for the last 10 years. These other species are early maturing, short lived, have a high rate of natural mortality, have a large species range and occupy a low trophic level. These characteristics are associated with low vulnerability to fishing pressure. Also, purse seine catches are mostly taken in nearshore embayments close to populations centres, e.g. Cockburn Sound and King George Sound, so fish outside those areas are not susceptible to capture.

4.7 Bycatch Species

There are only six or seven species that licensees within the WCPSF, SCPSF and PSDZ are permitted to retain. Occasionally these species may be released if fish are not the desired size or schools are of mixed species composition.

4.7.1 Other fish species and sharks

When purse seine nets are deployed, fishers are targeting baitfish species that are permitted to be retained. Occasionally other fish species, such as dusky morwong, stingrays and sharks, which are not legally permitted to be retained, are encircled by the net and must then be released. This is done by manually lowering the cork or lead line, by manually drawing the net upward to roll it over the cork line (Figure 4.15), or by bringing individuals on board for immediate release, usually alive and unharmed.

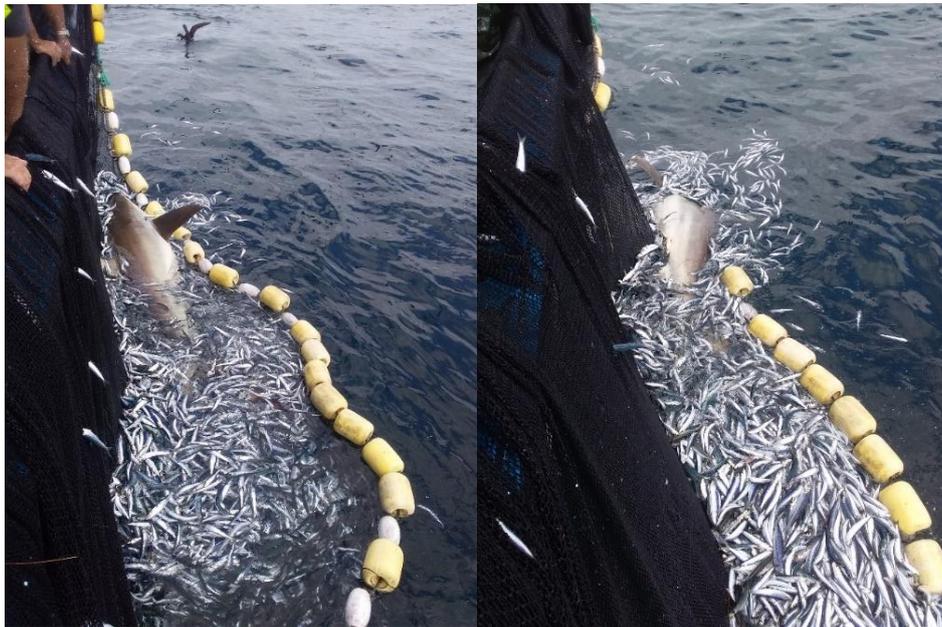


Figure 4.15 A shark is released alive and unharmed by manually dragging the net upwards to roll the shark over the cork line.

4.8 Ecological Impacts

4.8.1 *Endangered, Threatened and Protected (ETP) Species*

All commercial purse seine fishers are required to report interactions with ETP species in statutory monthly Catch and Effort Statistics (CAES) returns that are lodged with the Department. CAES returns are primarily for compiling a database of commercial fishing catch and effort for fisheries management purposes. Since 1 July 2009, SCPSF fishers have also been required to record interactions with protected species and classify the outcome as the animal being unharmed, injured or dead on Catch and Disposal Records (CDRs) which are compulsorily lodged with the Department when landing any small pelagic fish. CDRs are used primarily to track use of fish catch quota. The master of the vessel must enter catch details on to a CDR in triplicate within 30 minutes of landing ashore any small pelagic fish, before allowing any of those fish to be removed, and forward the duplicate to the Department within 24 hours. On some fishing trips the purse seine net is set on a school of fish which are then released if found to be too small or the wrong species. CDRs will only be submitted if fish are landed, so interactions on trips with zero catch will not be recorded, whereas all interactions should be recorded on CAES returns.

In 2018, all Australian, state and Northern Territory Government's endorsed the *National Plan of Action for Minimising the Incidental Catch of Seabirds in Australian Capture Fisheries* (NPOA) and agreed to report annually on progress towards its implementation and report all fishing - related seabird interactions. These reports are available here <https://www.agriculture.gov.au/fisheries/environment/bycatch/seabirds>.

The Department is also responsible for reporting ETP interactions in the publicly available annual State of the Fisheries and Aquatic Resources Report. These reports are available here <https://www.fish.wa.gov.au/About-Us/Publications/Pages/State-of-the-Fisheries-report.aspx>.

4.8.1.1 *Pinnipeds*



Figure 4.16 Australian sea lion, *Neophoca cinerea*
Illustration © R.Swainston/www.anima.net.au.

Australian sea lions (ASL; *Neophoca cinerea*) and Long-nosed fur seals (LNFS; *Arctocephalus forsteri*) are occasionally seen in King George Sound freely entering and exiting over the cork line of purse seine nets to feed on the trapped fish inside. Interactions requiring human intervention are relatively rare and no mortalities have been recorded by commercial purse seine fishers or observers.

In 2007, no pinniped mortalities or interactions requiring human intervention were recorded by independent observers during 71 trips in King George Sound when 87 shots (net deployments) were made (Puglisi 2007). During 147 trips in King George Sound with independent observers conducted between 2017 and 2021, two pinniped interactions (on a single trip) requiring human intervention were recorded, with both individuals released alive and unharmed (Norriss, J., unpublished data).

The Commonwealth *Environment Protection and Biodiversity Act 1999* (EPBC Act) affords protected status for both ASLs and LNFS under the 'Marine Species' list (EPBC Act 1999; section 248) due to their inclusion in the Convention on International Trade in Endangered Species of Wild Fauna and Flora Appendix II. ASLs are also currently listed as Endangered under the EPBC Act, whereas there is no additional conservation listing for LNFS. This is echoed by the Threatened and Priority Fauna List under the WA *Biodiversity Conservation Act 2016* (BCA) where both are listed as protected and ASLs are additionally listed as Vulnerable.

The ASL is the only pinniped species endemic to Australia (Gales *et al.* 1992). Based on geographic distance analysis among colonies, 13 distinct ASL metapopulations or regions have been identified, six in WA and seven in SA (Pitcher 2018). Although the geographic range of this species extends across WA and SA, the vast majority of pup production occurs in SA (86%; Shaughnessy *et al.* 2011), which is likely to also reflect the distribution of adult animals.

The ASL is slow to mature and females have few young over their lifetime (Gales and Costa 1997). It is the only pinniped species which has a non-annual breeding cycle, with intervals between pupping seasons of 17 - 18 months (Ling and Walker 1978; Higgins and Gass 1993; Shaughnessy *et al.* 2006; Goldsworthy *et al.* 2014). Female ASLs become sexually mature at 4.5 - 6 years of age, and males at six years or more (Goldsworthy 2015). The mean age of breeding females is 11 years (McIntosh 2007). Age - specific survival probabilities are high (0.98) after six years of age and are similar for males and females; the maximum longevity recorded is 26 years for females and 21.5 years for males (McIntosh 2007).

Breeding colonies for the ASL are found only in SA and WA waters, from Kangaroo Island (SA) to the Houtman Abrolhos Islands (WA) (Gales *et al.* 1994). However, the species is known to forage in Commonwealth waters adjacent to these states (DSEWPac 2013a).

Breeding colonies occur on islands or remote sections of coastline and have been recorded at 81 sites: 34 in WA and 47 in SA (Goldsworthy 2015). Of these, around 58 are considered regular breeding colonies at which five or more pups per breeding cycle have been recorded (Shaughnessy *et al.* 2011).

4.8.1.2 Dolphins



Figure 4.17 Common dolphin, *Delphinus delphis*
Illustration © R.Swainston/www.anima.net.au.

While listed as a protected species, there are currently no specific concerns for the population status of dolphins within southern WA.

In 2018, the Department of Biodiversity, Conservation and Attractions (DBCA) initiated a process where managers and scientists used a prioritisation framework as a tool to identify current priorities for research on marine mammals in Western Australia (Waples and Raudino 2018). Common dolphins were identified as one of eight high priority species for fundamental research, reflecting the limited information available on basic population biology on this species in WA. Both common dolphins and Indo-Pacific bottlenose dolphins were identified as high priority species for applied research to understand population impacts of fishing by-catch.

Dolphins, mostly common dolphins (*Delphinus delphis*), sometimes attend purse seine fishing operations. From 2009/10 to 2019/20, SCPSF fishers recorded on CDRs the deaths of two dolphins, and the release of five alive and unharmed. In 2007 independent observers recorded a single dolphin mortality during 71 trips in King George Sound when 87 shots were made (Puglisi 2007). From 2017 to 2021 independent observers from the Department were on board for a total of 147 King George Sound trips in which the net was deployed, all during March and April (Norriss, J., unpublished data). On three of those trips a total of six dolphins required human intervention to be released alive and unharmed. The mortality of a single common dolphin was recorded on each of another two of those 147 trips, i.e. a total of two deaths.

4.8.1.3 Sygnathids



Figure 4.18 Leafy seadragon, *Phycodurus eques*
Illustration © R.Swainston/www.anima.net.au.

One leafy seadragon (*Phycodurus eques*), listed as a protected species by the *Fish Resources Management Regulations 1995*, was recorded by independent observers as being released alive on one of 147 fishing trips in King George Sound between 2017 and 2021 (Norriss, J., unpublished data).

4.8.1.4 Seabirds – Flesh Footed Shearwaters



Figure 4.19 Flesh Footed Shearwater, *Ardenna carneipes*

4.8.1.4.1 Life History

Flesh-footed shearwaters (*Ardenna carneipes*) (FFS) are trans-equatorial migrants that nest in burrows on southern hemisphere islands ranging from St Paul Island in the southern Indian Ocean to New Zealand, including islands off Australia’s south coast and Lord Howe Island off New South Wales. In WA they nest over summer on at least 40 islands from about Cape Leeuwin to the Recherche Archipelago. FFS are pursuit predators capable of diving to at least 66 metres. Over winter, adult FFS migrate to the northern hemisphere, returning late September/early October to commence their breeding cycle (Figure 4.20). Young birds remain at sea for a period of years before returning to their natal island to breed, so each island’s breeding colony can be regarded as a distinct population. FFS are known to mate for life, so if one mate dies the remaining bird may not successfully mate again for a period of years. In addition, during chick growth post hatching (March/April) both parents are required to provision the young bird, and if one parent dies the young bird is likely to starve.

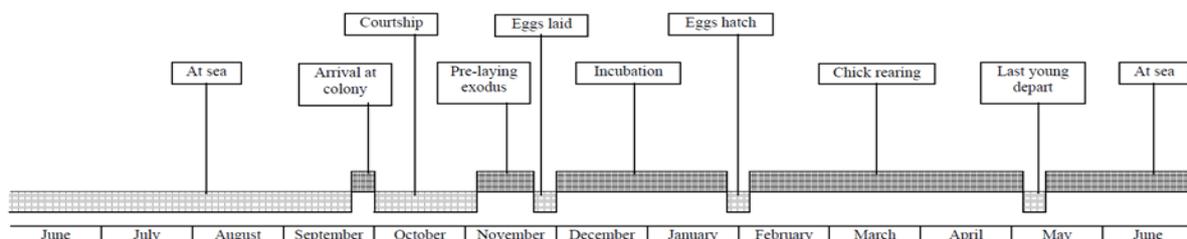


Figure 4.20 General guide to annual life cycle of the Flesh-footed shearwater. From Powell (2004).

4.8.1.4.2 FFS Status and Population Trends

A survey of breeding islands by Lavers (2015) during 2011 - 2014 estimated the WA population to be between 18,376 to 35,906 breeding pairs, based on the assumption

that they breed annually, as has been reported in many but not all shearwater species (breeding frequency data is unavailable for FFS). The estimate therefore does not account for birds that may have skipped breeding at the time of the survey. The population estimate is much smaller than previous estimates from surveys undertaken mostly in the 1970s and 1980s. Although this is partly due to errors in historical survey methods, there is good evidence of declines on islands with large colonies, mirroring observed and suspected declines across the remainder of the species' breeding range. Lavers (2015) estimated the global FFS population to be 40,606 to 73,678 breeding pairs, meaning WA is home to about almost half of the world's population.

A period of higher bycatch mortality for FFS was likely to have occurred from about 1985 to 1998 due to historically high levels of SCPSF fishing effort, as well as the impact of Japanese long-liners operating during this period in waters off WA but which were excluded from the Australian Fishing Zone in 1997 (Gales *et al.* 1998). The effects of the mass mortalities of Australian sardines in 1995 and 1999 on feeding and breeding success of FFS has not been quantified but seabirds elsewhere in Australia were shown to be negatively impacted.

FFS are protected, listed as a 'near threatened' species under the International Union for Conservation of Nature, and as a 'Migratory Species' in section 209 of the EPBC Act. Following a scientific assessment of the species' threat status by the Act's Threatened Species Scientific Committee the decision was made that the species is not eligible for listing under the EPBC Act. Therefore, a recovery plan for this species has not been produced. In WA, this species is listed as Vulnerable under the BCA. In addition, noting their trans-equatorial migratory nature, they are listed under the bilateral migratory bird agreements with Japan and the Ramsar Convention on Wetlands. This status recognises their tendency to aggregate in flocks in coastal areas following return from migrations, which makes them vulnerable to disturbance and predation.

4.8.1.4.3 History of Fishery Interactions with SCPSF

The FFS is taken as bycatch by the SCPSF operating in King George Sound (Lavers 2015, Norriss *et al.* 2020) (Figure 4.21). FFS are pursuit predators capable of diving to over 60 metres in depth. They target schools of small baitfish such as Australian sardines and may drown when attempting to surface underneath a net fold that has formed underwater (Norriss *et al.* 2020). The level of bycatch in the SCPSF is likely to be associated with the amount of fishing effort in King George Sound. Historically, effort was highest from around 1985 to 1998 at about 1,000 to 3,000 boat days annually, before an Australia-wide collapse of sardine stocks due to a herpesvirus pandemic in early 1999. Since 2003 effort has been much lower, ranging from 437 to 767 boat days.



Figure 4.21 Flesh-footed shearwaters attending a purse seine net holding Australian sardines in King George Sound.

Two sources of data from compulsory reporting by fishers of protected species interactions, including FFS, are available for the SCPSF: statutory monthly CAES returns and per trip CDRs.

In the 11 year period 2009/10 to 2019/20, SCPSF fishers recorded on CDRs the following interactions with flesh-footed shearwaters (Table 4.3):

- 557 mortalities due to fishing
- 9 injured, and
- 4,220 released alive and unharmed.

All mortalities except two were reported from Zone 1 (King George Sound). Analysis of CDR data from Zone 1 from 2009/10 to 2017/18 indicated that the mortality rate per fishing trip was highly seasonal, peaking in March and April, coinciding with the later stages of chick rearing (Figure 4.22a; Powell *et al.* 2007, Norriss *et al.* 2020). This period also coincides with the period of highest fishing effort (March to May), when Australian sardines undertake an inshore movement that makes them more vulnerable to the fishery (Figure 4.22b). Thus the increased risk from elevated mortalities per trip is compounded by more trips.

Table 4.3 Flesh-footed shearwater interactions recorded by SCPSF fishers on Catch and Disposal Records from 1 July 2009 to 30 June 2020.

Year	Dead	Injured	Alive & unharmed
2009-10	17	0	261
2010-11	109	6	860
2011-12	55	1	780
2012-13	151	2	753
2013-14	79	0	333
2014-15	16	0	158
2015-16	46	0	312
2016-17	40	0	290
2017-18	38	0	329
2018-19	0	0	76
2019-20	6	0	69
Total	557	9	4,221

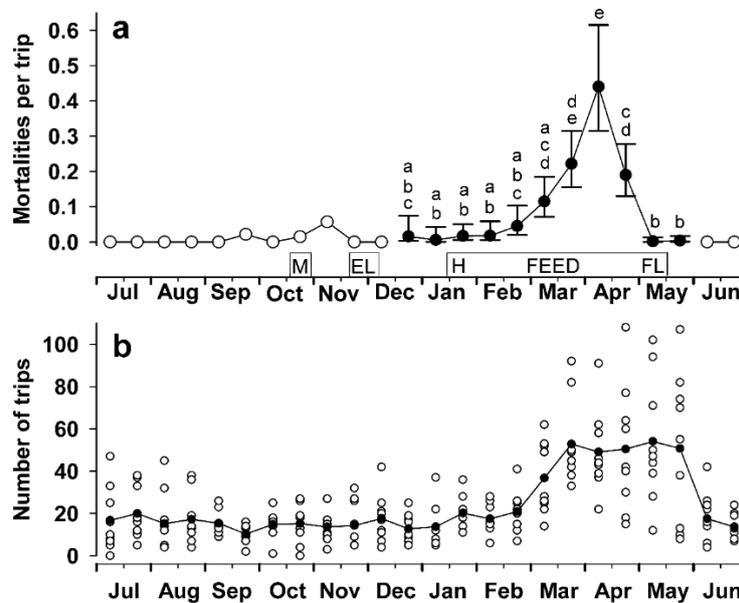


Figure 4.22 (a) The rate of flesh-footed shearwater mortalities per trip in King George Sound (Zone 1 of the SCPSF) recorded by purse seine fishers in each half-month from 1 July 2009 to 30 June 2018, and the approximate timing of courtship and mating (M), egg laying (EL), hatching (H), chick feeding (FEED), and fledging (FL). Black circles: mean mortality rates ($\pm 95\%$ confidence limits) for each half-month calculated by a generalized linear model with the results of pairwise comparisons of significant differences ($p < 0.05$) between half-months denoted by the letters above estimates; white circles: nominal mean mortalities, i.e. total mortalities divided by total number of trips. (b) The total number of fishing trips by purse seine vessels in King George Sound that landed fish in each half-month from 1 July 2009 to 30 June 2018. White circles: number of fishing trips in each year; black circles: mean. From Norriss *et al.* (2020).

Independent observers accompanied purse seine vessels fishing in King George Sound during the peak bycatch period (March and April) in 2007 and 2008 (data supplied by the WA Fishing Industry Council) and more recently in 2017, 2018, 2019,

2020 and 2021. For all years combined, 266 trips in which the net was deployed were observed, and a total of 258 mortalities were recorded (Table 4.4). From 2017 to 2021 (inclusive), observers on 147 trips recorded four birds that were injured (assumed to have died and included in mortality count) and 325 requiring human intervention to be released alive and unharmed from the net. Zero mortalities were recorded on at least 70% of trips in any year, suggesting the formation of net folds that can trap and drown birds is infrequent. The highest number of mortalities on any trip was 72 in 2020, caused by the breakdown of an outboard motor on a dinghy used to position the mother boat and maintain net shape. The second highest number of mortalities on any trip was 15.

Table 4.4 The number of flesh-footed shearwater mortalities (includes four injured), birds released alive and unharmed, and fishing trips with net deployment recorded by independent observers on board purse seine vessels operating in King George Sound in March and April in seven different years. Alive and unharmed is defined as requiring human intervention to be freed from the purse seine net. NA= not available. * Includes 72 mortalities on a single trip when gear failure resulted in loss of control of net.

Year	Trips observed	Alive and unharmed	Mortalities	Mortalities per trip
2007	49	NA	54	1.10
2008	70	NA	55	0.79
2017	51	118	30	0.59
2018	52	130	32	0.62
2019	14	13	1	0.07
2020*	9	29	73	8.11
2021	21	35	13	0.62

Estimates of total annual mortalities were generated for 2016/17 and 2017/18 using a general linear model that extrapolated observer data using the temporal pattern of bycatch mortalities shown in Figure 4.23 (Norriss *et al.* 2020). The estimates were increased by assuming a level of cryptic mortality (unobserved and not readily detectable components of fishing mortality), estimated to be an additional 30% of observed mortalities, and 1% of birds released alive and unharmed were assumed to have died. For 2016/17 and 2017/18 the estimates of annual mortalities ($\pm 95\%$ confidence limits) in King George Sound were 123 (52-251) and 172 (91-302) respectively.

The sustainability risk to the WA FFS population from bycatch in Zone 1 of the SCPSF was assessed by comparing the estimated annual mortalities above with conservative estimates of potential biological removal (PBR), defined as the number of mortalities in addition to natural mortalities that a population is likely to sustain while remaining above half the carrying capacity (Norriss *et al.* 2020). Inputs to the PBR estimate, derived from published literature, included FFS age at first reproduction (~ 6.7 years) and the proportion of adults surviving and breeding annually (~ 0.93 year⁻¹ and 0.9, respectively), with probability distributions explicitly stated. Another input was the

population size of WA FFS, estimated by Lavers (2015) to be 27,141 (18,376 – 35,906) breeding pairs based on nest burrow surveys between 2011 and 2014. For the purpose of estimating PBR, this population estimate was conservatively adjusted by re-sampling from an assumed log-normal distribution with a mean of 27,141 and a log scale standard deviation of 0.1, but only retaining values from the lower quartile. Two scenarios were considered for the risk assessment. The first assumed the whole WA population attended the King George Sound fishing operations. The second conservatively assumed visitation by only the closer the breeding colonies (between longitudes ~116°E and 119°E), comprising about 50% of the WA population. The PBR estimate ($\pm 95\%$ confidence limits) for the whole WA population was 989 (742-1,304) and the conservative PBR estimate for the closer colonies was 495 (369-660).

The finding that the 95% confidence limits (CLs) for estimated total annual bycatch mortalities in Zone 1 of the SCPSF for 2016/2017 and 2017/2018 were below and did not overlap the 95% CLs of the conservative PBR estimate (Figure 4.23) suggests that, for those years, removals by this fishery in isolation were well below the maximum level that can be sustained. It is recognised, however, that future assessments of the FFS population in WA also need to consider impacts from other fisheries including recreational, as well as anthropogenic mortalities from introduced species, plastic ingestion, mercury contamination, and climate change (Lavers 2015). They should also consider the potential beneficial effects on the population of the enhanced food supply from the fishery, as has been demonstrated for other fisheries (e.g. Oro 1996).

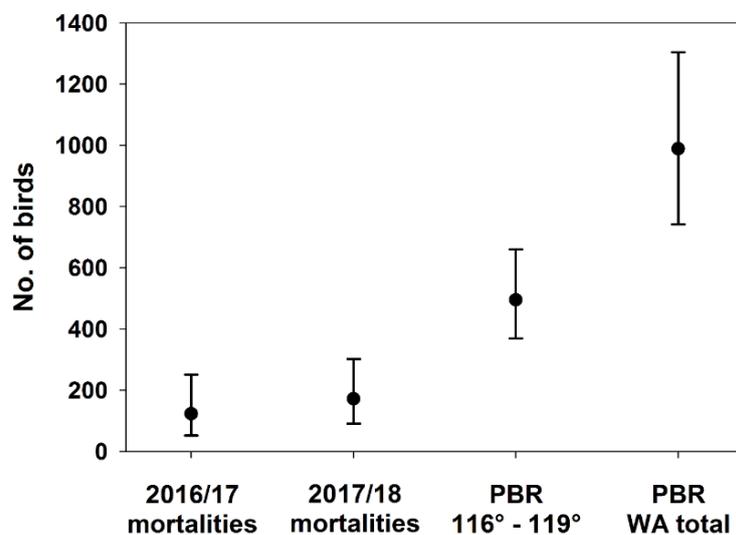


Figure 4.23 Estimates ($\pm 95\%$ confidence limits) of the number of flesh-footed shearwater mortalities in 2016/17 and 2017/18 in Zone 1 (King George Sound) of the SCPSF, and the estimated level of potential biological removal (PBR) for ~50% of the WA population in breeding colonies located closest to the Sound, i.e., between longitudes ~116°E and 119°E, and for the total WA population.

4.8.1.4.1 History of Bycatch Mitigation Initiatives

Industry Code of Practice

The SCPSF has formulated a CoP for Responsible Fishing (Appendix F), which sets out guidelines and standards of behaviour for responsible fishing practices within the fishery with a view to ensuring the effective conservation, management, and development of resources.

The CoP was expanded and updated by the WAFIC and SCPSF licence holders during 2017 to reflect updated bycatch mitigation measures and other changes to the SCPSF (Appendix F). The CoP includes a Manual for (Net) Setting Protocol and Wildlife Interaction and Species Identification Guide, as was developed in 2005 by Ocean Watch Australia Ltd and the Commonwealth SeaNet environmental extension service (a sub-program of Ocean Watch Australia) in conjunction with fishers and WAFIC. The SeaNet program finished in 2013 and WAFIC, along with licence holders in the SCPSF, now manage the CoP to ensure it stays relevant and reflects bycatch mitigation best practice.

Special Management Period

A Special Management Period (SMP), currently designated as 1 March to 30 April (the period of highest bycatch mortality rate), was introduced in 2006 as a period of enhanced bycatch mitigation. This includes an ongoing voluntary dawn moratorium on fishing from 05:00 to 09:00 between 1st and 31st March, and from 05:30 to 09:00 between 1st and 30th April, when bycatch risk is thought to be highest, as it is also the peak chick provisioning time for nesting FFS. The SMP was first introduced to address potential bycatch issues identified by the Commonwealth Government as part of the (then) WTO export approval conditions, and subsequently was required by the then WA Minister for Fisheries.

Other Voluntary Initiatives

A range of other voluntary initiatives have been implemented to mitigate bycatch of FFS, some of which are set out in the CoP.

Other mitigation initiatives attempted include:

- Sound deterrence: high volume sound over a wide spectrum, bordering on painful to the human ear. It was ineffective as a deterrent and quickly discontinued.
- Weighted line (ongoing): some vessels have attached a weighted line (0.2 to 0.3 kg per metre) along their net, parallel to and about five to eight metres below the float line (Figure 4.24), designed to maintain vertical tension on the net to prevent folds developing that can trap and drown birds. Although the mean bycatch mortality per trip recorded by observers in 2017 and 2018 was slightly lower in both years when weighted lines were used, this was not statistically significant. Moreover, other variations in fishing gear and time of day fishing (e.g. night v. day) among vessels may have impacted this result (Norriss *et al.* 2020).
- Shark oil olfactory deterrent: the efficacy of shark liver oil as an olfactory deterrent to attending purse seine operations was investigated, but no evidence of reduced attendance was detected (Puglisi 2007).

- No fishing on days of high FFS activity and elevated risk of interaction in King George Sound, during the SMP and at times of strong south-westerly winds.
- Tow-off procedure: Three crew members to be on-board to operate during daylight hours to implement the tow-off procedure, or two crew members if vessels have a thruster.
- Voluntary four-day fishing closures: In 2007 fishers voluntarily agreed to cease fishing for four consecutive days on three occasions (2 - 5 Mar, 16 - 19 Mar, 6 - 9 April) in an attempt to discourage habitual net attendance by birds, with the intent being to encourage them to forage elsewhere. The trial was considered by fishers to be ineffective.
- In January 2020, the Southern Seafood Producers Association wrote to the Minister for Fisheries, advising they would not be undertaking some of the voluntary measures previously agreed to, due to financial impact. The Minister accepted the new arrangements and stated that he “expects industry will take all necessary steps to keep FFS mortalities to an absolute minimum, and that legislative intervention may be considered should the need arise”.

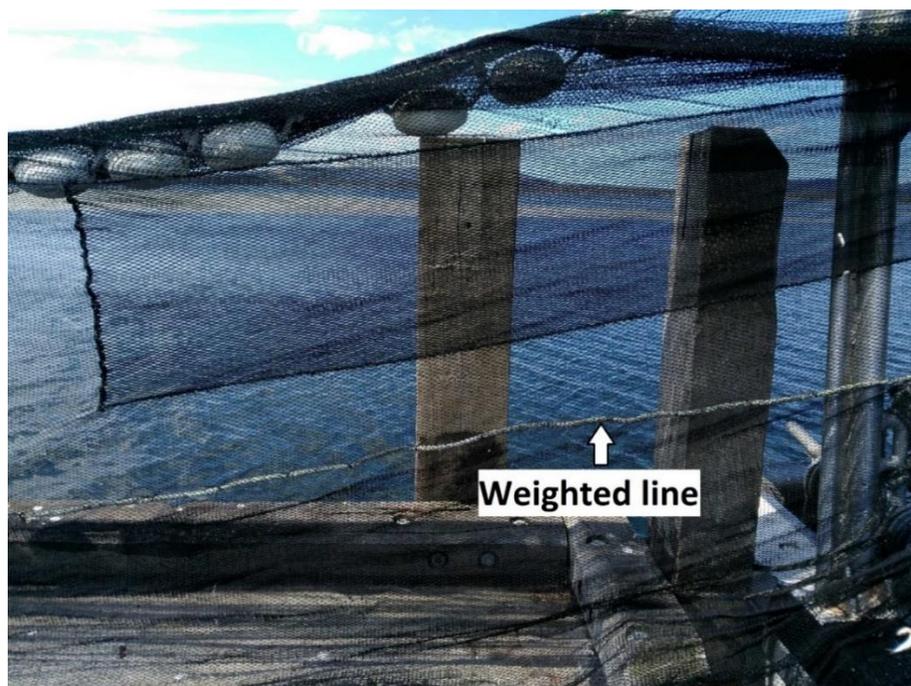


Figure 4.24 Weighted line (about 0.2 kg per metre) threaded horizontally along purse seine net about 5 metres down from the float line, designed to keep net taut when hanging in water to prevent development of net folds that can trap seabirds.

4.8.1.4.1 Government Management of SCPSF and FFS Interactions

In addition to the number of mitigation measures outlined above, the Department has also undertaken the following measures:

- Ongoing stakeholder and community liaison and communication, including (generally annual) Management Meetings with the SCPSF and the provision of reports and ongoing reviews to the Minister for Fisheries.
- The formulation of a SCPSF Working Group to oversee mitigation measures during the SMP. This group was in operation from 2006 to 2012 and initially included representation from the WA Conservation Council.
- Coordination and management of the SCPSF industry and peak sector bodies to ensure responsible competence and compliance in operational management and accurate/improved reporting.
- Compilation of information to effectively achieve Marine Stewardship Council pre-assessment.
- While there is no quantitative data on interactions between recreational fishers and FFS, there are anecdotal reports that recreational fishers interact with seabirds, including FFS and thus the Department recognises the importance of promoting best fisher practices, including interactions with FFS. The Department continues to work with Recfishwest in the context of the Commonwealth NPOA.

4.8.2 Habitats

Purse seine nets have little or no impact on benthic habitats during normal operations. On rare occasions nets may be deployed in shallow waters and come into contact with habitats such as seagrass beds. The light structure of the net is expected to cause minimal damage to benthic habitats when this occurs, and kept to a small, localised area. Moreover, the likely net damage from contact with reef or coral motivates fishers to avoid these areas entirely.

4.8.3 Ecosystem Structure

4.8.3.1 Trophic interactions

Small pelagic fish (often referred to as 'forage fish') are low trophic level species that are important for ecosystem structure and function. They dominate the diets of many higher-trophic level predators including fish, birds, cephalopods and marine mammals, making them vulnerable to variations in forage fish biomass (Cury *et al.* 2000; Smith *et al.* 2011).

A review of global seabird populations suggested that total prey ('forage fish') biomass should be maintained above a threshold of 'one third of the maximum prey biomass observed in long-term studies', below which seabird breeding success consistently declined (Cury *et al.* 2011).

Australian sardines are a key prey item for many marine predators along the southern Australian coast (Goldsworthy *et al.* 2013). In SA waters, ecosystem modelling

indicated that annual exploitation of Australian sardines at a rate equal to 10 - 20% of the estimated spawning biomass did not significantly impact on ecosystem function, or high trophic level species (Goldsworthy *et al.* 2013).

Australian sardines and scaly mackerel are two of at least 25 recorded prey species taken by little penguin (*Eudyptula minor*) colonies on Penguin and Garden Islands near the Perth metropolitan area (Klomp and Wooller 1988; Murray *et al.* 2011). Analysis of 212 stomach contents from 102 little penguins revealed Australian sardines in 6% of birds sampled, constituting 3% of all identified prey items (Klomp and Wooller 1988). The proportions for scaly mackerel were less than 1% for both parameters.

The trophic importance of scaly mackerel is less clear. Seabird species are known to occasionally consume scaly mackerel, but there is no evidence of predatory specialisation on scaly mackerel by any species. On WA's West Coast, the Houtman-Abrolhos Islands archipelago is the largest (by number) seabird breeding station in the eastern Indian Ocean and lies adjacent to the Northern Development Zone of the WCPSF. A study of the diet of six seabird species at the Houtman-Abrolhos between 1998 and 2001 showed scaly mackerel to occur in only two: the crested tern (*Sterna bergii*) and the wedge-tailed shearwater (*Ardenna pacifica*) (Gaughan *et al.* 2002). The volume and frequency of occurrence of scaly mackerel in their diet was 22.5% and 23.4% for crested terns and 11.1% and 12.2% for wedge-tailed shearwaters, respectively. Total annual consumption of scaly mackerel was estimated to be 30.5 tonnes for crested terns and 3 655 – 3 768 tonnes for wedge-tailed shearwaters.

In WA, the most recent spawning biomass estimate for Australian sardines is from the mid-2000s, based on fishery-independent egg surveys. Spawning biomass in the West Coast and South Coast stocks was estimated to be about 20,000 – 30,000 t and 65,000 – 129,000 t, respectively (Gaughan *et al.* 2008). No further surveys have been conducted but annual catches on both the South and West Coasts have never exceeded 5% of those mid-2000s spawning biomass estimates, suggesting that a very minor level of stock depletion (and associated ecosystem trophic impact) is now occurring in each Bioregion (Appendices D and E).

Biomass of scaly mackerel has not been estimated, but available evidence indicates that this stock is also being minimally depleted by current catch levels (Appendix C).

4.8.3.2 *Translocation (pests and disease)*

Pests and diseases may be transferred via vessels in wet areas such as bilges, decks, anchor wells and sea chests and in niche area of the hull. Fishing vessels may present additional areas including on wet fishing gear or holding tanks. Overall, fishing vessels are typically rated very low risk in terms of translocation of marine pests and diseases at an international scale but examples of local transmission of pest species such as *Undaria pinnatifida* can be identified (Bridgwood and McDonald 2014).

Given that commercial fishers are not permitted to use their boats or gear outside of Australian waters, the risk of international transmission of introduced marine pests and diseases is effectively zero. This suggests a negligible risk of translocation of pests and diseases due the activity of this fishery.

4.8.3.3 *Ghost fishing*

Commercial purse seine nets are valuable and are always retrieved, negating the possibility of ghost fishing.

4.8.4 **Broader Environment**

4.8.4.1 *Air quality*

Commercial fishing vessels operating in the WCPSF, SCPSF and PSDZ use fuel and emit greenhouse gases. Currently, there are 11 vessels actively fishing for the Resource, with an average annual effort of 76 fishing days per vessel. This fleet operates over a large geographical area and the impact of vessel emissions on air quality over this area is expected to be minor.

4.8.4.2 *Water quality*

Fishing vessels utilising the Resource have the potential to reduce water quality through discarding of debris and litter as well as by accidental oil and fuel spills. The WCPSF, SCPSF and PSDZ operate over a large geographical area and the impact of accidental spills on water quality over this area is expected to be negligible. The majority of commercial fishers do not use packaged bait, reducing the likelihood of littering. The SCPSF CoP stipulates measures to be taken by operators to minimise any type of pollution at sea.

4.8.4.3 *Noise pollution*

Water is an efficient medium for transporting sound waves. In the marine environment sound transmission is highly variable and can be dependent on the acoustic properties of the seabed and surface, variations in sound speed and the temperature and salinity of the water (Richardson *et al.* 1995).

For most marine animals, sound is important for communication; for locating particular features, prey and peers; and for short-range and long-range navigation (Evans *et al.* 2016, Erbe *et al.* 2015). Sounds from anthropogenic sources can mask vocal communication, disrupt normal behaviours, and cause temporary or permanent threshold shifts in hearing (Evans *et al.* 2016, Hazel 2009).

Currently, little is known regarding the effects of noise pollution on most marine species in Australia. The main anthropogenic activities producing high levels of noise are seismic surveys of sub-bottom strata, active sonars, explosions, pile driving, vessels, dredging and drill rig activities (Evans *et al.* 2016).

5.0 External Factors

While a number of external influences and activities within the Resource have the potential to impact on the productivity and sustainability of the fisheries resources and the broader ecosystem in the future (e.g. urban developments, dredging and climate change), these were not explicitly assessed within the scope of this ERA (see Section 6.1).

6.0 Risk Assessment Methodology

Risk assessments have been extensively used as a means to filter and prioritise the various fisheries management issues identified in Australia (Fletcher *et al.* 2002). The risk analysis methodology utilised for this risk assessment of the Resource is based on the global standard for risk assessment and risk management (AS/NZS ISO 31000), which has been adopted for use in a fisheries context (see Fletcher *et al.* 2002, Fletcher 2005; 2015). The broader risk assessment process is summarised in

Figure 6.1.

The first stage establishes the context or scope of the risk assessment, including determining which activities and geographical extent will be covered, a timeframe for the assessment and the objectives to be delivered (Section 6.1). Secondly, risk identification involves the process of recognising and describing the relevant sources of risk (Section 6.2). Once these components have been identified, risk scores are determined by evaluating the potential consequences (impacts) associated with each issue, and the likelihood (probability) of a particular level of consequence actually occurring (Section 6.3).

Risk evaluation is completed by comparing the risk scores to established levels of acceptable and undesirable risk to help inform decisions about which risks need treatment. For issues with levels of risk that are considered undesirable, risk treatment involves identifying the likely monitoring and reporting requirements and associated management actions, which can either address and/or assist in reducing the risk to acceptable levels.

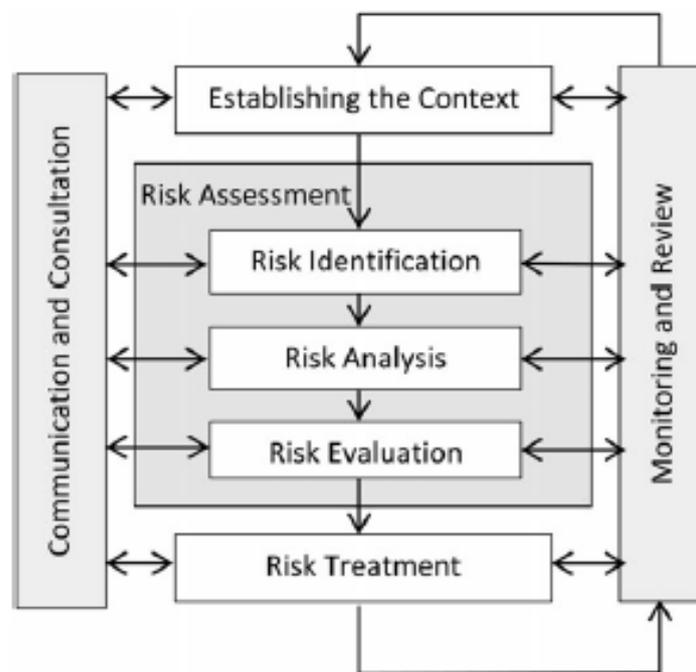


Figure 6.1 Position of risk assessment within the risk management process.

6.1 Scope

This risk assessment covered the ecological impacts of the SCPSF, WCPSF and PSDZ, and recreational fishing sectors that catch small pelagic fish. The calculation of risk in the context of a resource is usually determined within a specified period, which for this assessment is the next five years (i.e. until 2025).

For the purpose of this assessment, risk is defined as *the uncertainty associated with achieving a specific management objective or outcome* (adapted from Fletcher 2015). For the Department, 'risk' is the chance of something affecting the agency's performance against the objectives laid out in their relevant legislation. In contrast, for the commercial fishing industry, the term 'risk' generally relates to the potential impacts on their long-term profitability. For the general community, 'risk' could relate to possible impact on their enjoyment of the marine environment. The aim for each of these groups is to ensure the 'risk' of an unacceptable impact is kept to an acceptable level.

An important part of the risk assessment and risk management process is communication and consultation with stakeholders. ERAs undertaken by the Department typically engage all stakeholders of the Resource to participate in a workshop and collectively scoring risk issues. This allows the assessment to consider not only the ecological sustainability of the fishing activities but also how different external environmental, social and economic drivers may affect the performance of the resource. The current assessment considered only the ecological impacts of fishing, as required to inform the harvest strategy for the Resource.

6.2 Risk Identification

The first step in the risk assessment process was to identify issues relevant to the resource being assessed. These were identified using a component tree approach (Figure 6.2), where major risk components are deconstructed into smaller sub-components that are more specific to allow the development of operational objectives (Fletcher *et al.* 2002). The component trees are tailored to suit the individual circumstances of the Resource being examined by adding and expanding some components and collapsing or removing others.

The development of the preliminary component tree for evaluating the ecological sustainability of the Resource was based on:

- previous informal risk assessments undertaken for the fisheries;
- risks identified during previous Commonwealth assessments under Parts 13 and 13A of the EPBC Act.
- identified gaps in Marine Stewardship Council (MSC) performance indicators, as identified during the pre-assessment of the Resource against the MSC Fisheries Standards in 2015; and
- an internal risk assessment workshop undertaken by Departmental staff in July 2021.

There was an opportunity to add to the preliminary component tree during the ERA workshop held on 27 July 2021.

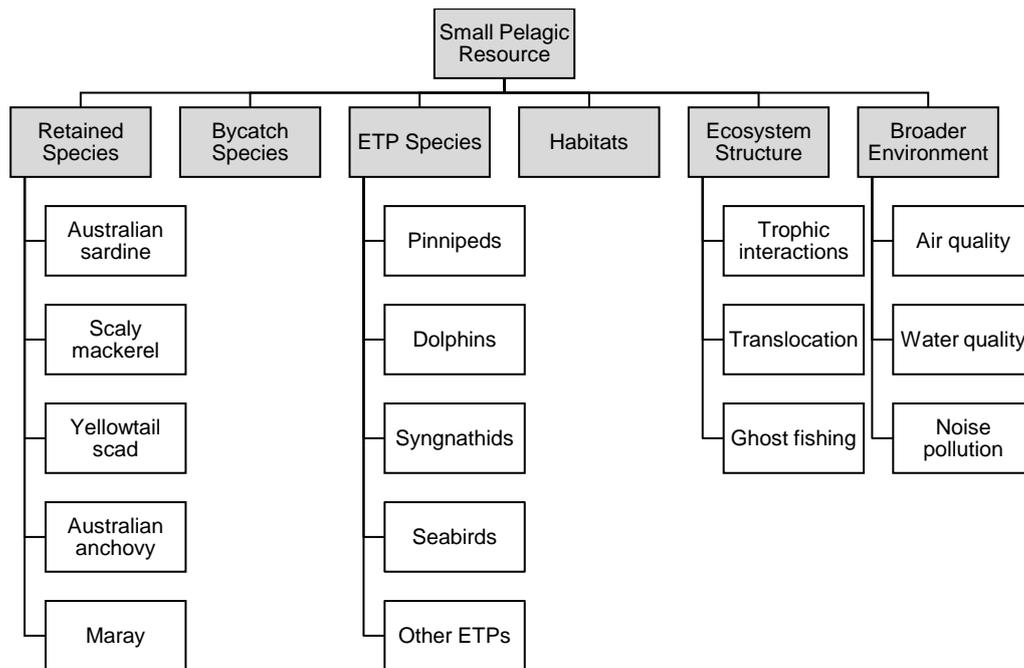


Figure 6.2 Preliminary component tree for assessing the ecological sustainability of the Small Pelagic Resource.

6.3 Risk Assessment Process

The risk analysis process assists in separating minor acceptable risks from major, unacceptable risks and prioritising management actions. Once the relevant components and issues for the Resource are identified, the process to prioritise each was undertaken using the ISO 31000-based qualitative risk assessment methodology. This methodology utilised a consequence-likelihood analysis, which involved the examination of the magnitude of potential consequences from fishing activities and the likelihood that those consequences will occur given current management controls (Fletcher 2015).

Although consequence and likelihood analyses can range in complexity, this assessment utilised a 4x4 matrix (Table 6.1). The consequence levels ranged from 1 (e.g. minor impact to fish stocks) to 4 (e.g. major impact to fish stocks) and likelihood levels ranged from 1 (Remote; i.e. < 5 % probability) to 4 (Likely; i.e. ≥ 50 % probability).

Scoring involved an assessment of the likelihood that each level of consequence is occurring, or is likely to occur within the five-year period specified for this assessment. If an issue is not considered to have any detectable impact, it can be considered to be a “0” consequence; however, it is preferable to score such components as there being a remote (1) likelihood of a minor (1) consequence.

The assessment used a set of pre-defined likelihood and consequence levels (see Appendix A). In total five consequence tables are used in the risk analysis to accommodate for the variety of issues and potential outcomes:

- Target/retained species – measured at a stock level;
- Non-retained (bycatch) species – measured at a stock level;

- ETP species – measured at a population or regional level;
- Habitats – measured at a regional level; and
- Ecosystem/Environment – measured at a regional level.

Where relevant, the risks of each fishing sector and fishing method considered within the scope of the assessment were assessed cumulatively. For each component, the consequence and likelihood scores were evaluated to determine the highest risk score using the risk matrix (Table 6.1). Each component was then assigned a risk level within one of five categories: Negligible, Low, Medium, High or Severe (Table 6.2).

Department staff conducted an initial risk analysis of the Resource during an internal workshop held on 12 July 2021. This primarily focused on scoring the risks to the target and retained species for which quantitative information is available to assess stock status and/or their vulnerability to fishing. For Primary species, that are managed against biologically-based reference levels, the risk of all fishing on the broader stocks has typically been determined as part of their stock assessments and thus there was no need to re-evaluate these scores.

An external stakeholder ERA workshop was then held at the Department’s Albany Office on 27 July 2021. A broad range of stakeholders were invited to participate in the ERA workshop (Appendix B). While the risk scores and associated narrative relating to the retained species were presented and discussed, the workshop primarily focused on assessing the risks of fishing impacts on bycatch and ETP species, benthic habitats and the broader ecosystem.

Table 6.1 4x4 Consequence – Likelihood Risk Matrix (based on AS 4360 / ISO 31000; adapted from Department of Fisheries 2015).

		Likelihood			
		Remote (1)	Unlikely (2)	Possible (3)	Likely (4)
Consequence	Minor (1)	Negligible	Negligible	Low	Low
	Moderate (2)	Negligible	Low	Medium	Medium
	High (3)	Low	Medium	High	High
	Major (4)	Low	Medium	Severe	Severe

Table 6.2 Risk levels applied to evaluate individual risk issues (modified from Fletcher 2005).

Risk Levels	Description	Likely Reporting & Monitoring Requirements	Likely Management Action
Negligible	Acceptable; Not an issue	Brief Notes – no monitoring	Nil
Low	Acceptable; No specific control measures needed	Full Notes needed – periodic monitoring	None specific
Medium	Acceptable; With current risk control measures in place (no new management required)	Full Performance Report – regular monitoring	Specific management and/or monitoring required
High	Not desirable; Continue strong management actions OR new / further risk control measures to be introduced in the near future	Full Performance Report – regular monitoring	Increased management activities needed
Severe	Unacceptable; Major changes required to management in immediate future	Recovery strategy and detailed monitoring	Increased management activities needed urgently

7.0 Risk Analysis

Thirty four broad ecological components were identified as potentially impacted by the Resource (Figure 7.1). Where relevant, some of these were further separated into smaller categories to score the risks for individual species or groups of species. Where the individual risks of the different fishing sectors and methods could not be easily distinguished, or were assessed to be the same, these have been reported together as the cumulative risk.

The risk ratings for each risk issue considered in the assessment are summarised in Table 7.1. Note, the risk justifications include comments from stakeholders who attended the workshop. While these are a summary of individual views and may not be representative of every stakeholder at the workshop, the risk scores are reflective of the group consensus at the workshop.

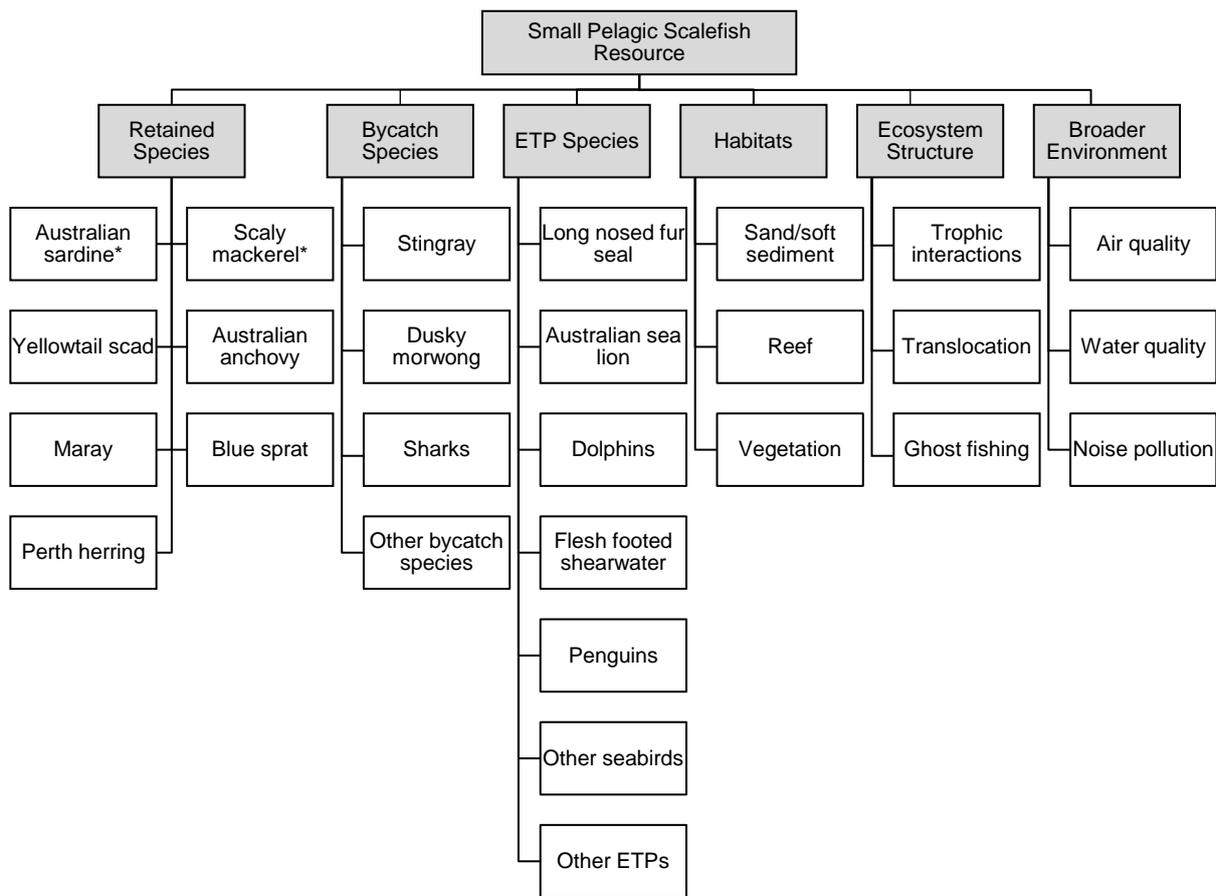


Figure 7.1. Final component tree for assessing the ecological sustainability of the State-Wide Small Pelagic Scalefish Resource.
 * denotes Primary species, that will be managed against formal harvest strategy reference levels.

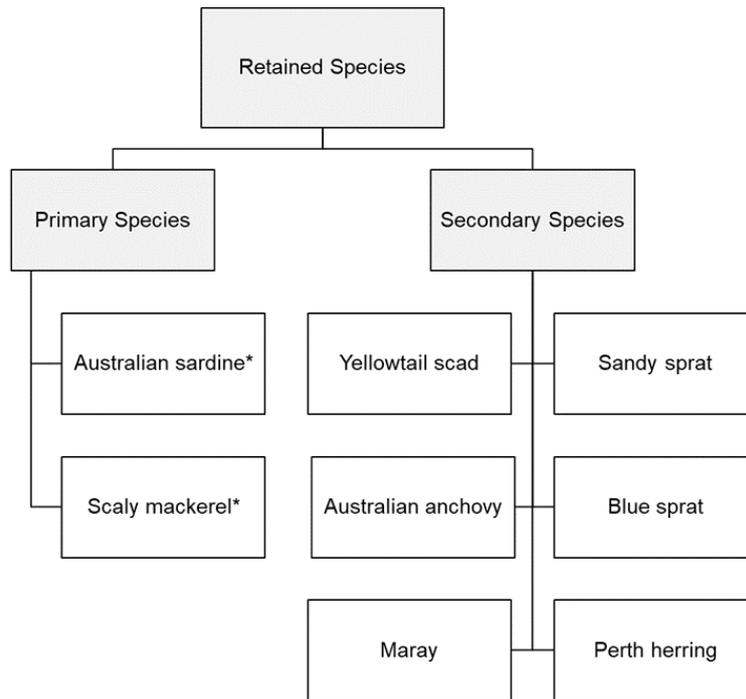
Table 7.1. Overview of the objectives, components, and risk scores and ratings considered in the 2021 ecological risk assessment of the Resource.

Aspect	Fishery Objective	Component	Issues	Risk Scoring	Risk rating
Retained species (primary)	To maintain biomass of each retained species at a level where the main factor affecting recruitment is the environment	Australian sardine *	All fishing on stock	C2, L2	LOW
		Scaly mackerel (WCB) *	All fishing on stock	C2, L2	LOW
		Scaly mackerel (SCB) *	All fishing on stock	C2, L2	LOW
Retained species (secondary)	To maintain biomass of each retained species at a level where the main factor affecting recruitment is the environment	Yellowtail scad	All fishing on stock	C1, L2	NEGLIGIBLE
		Australian anchovy	All fishing on stock	C1, L2	NEGLIGIBLE
		Maray	All fishing on stock	C1, L2	NEGLIGIBLE
		Blue sprat (WCB)	All fishing on stock	C1, L2	NEGLIGIBLE
		Blue sprat (SCB)	All fishing on stock	C1, L1	NEGLIGIBLE
		Perth herring	All fishing on stock	C1, L1	NEGLIGIBLE
		Sandy sprat	All fishing on stock	C3, L3	HIGH
Bycatch species	To ensure fishing impacts do not result in serious or irreversible harm to bycatch (non-retained) species populations	Stingray	All fishing on stock	C1, L1	NEGLIGIBLE
		Dusky morwong	All fishing on stock	C1, L1	NEGLIGIBLE
		Sharks	All fishing on stock	C1, L1	NEGLIGIBLE
		Other bycatch species	All fishing on stock	C1, L1	NEGLIGIBLE
ETP species	To ensure fishing impacts do not result in serious or irreversible harm to ETP species' populations	Long nosed fur seal	All fishing on stock	C1, L1	NEGLIGIBLE
		Australian sea lion	All fishing on stock	C1, L1	NEGLIGIBLE
		Dolphins (Common and Bottlenose)	All fishing on stock	C1, L3	LOW
		Syngnathids	All fishing on stock	C1, L1	NEGLIGIBLE
		Flesh Footed Shearwaters	All fishing on stock	C3, L2 / C3, L3	HIGH

Aspect	Fishery Objective	Component	Issues	Risk Scoring	Risk rating
		Penguins	All fishing on stock	C1, L1	NEGLIGIBLE
		Other seabirds	All fishing on stock	C1, L1	NEGLIGIBLE
		Other sharks	All fishing on stock	C1, L1	NEGLIGIBLE
		Other marine mammals	All fishing on stock	C1, L1	NEGLIGIBLE
		Marine reptiles	All fishing on stock	C1, L1	NEGLIGIBLE
Habitats	To ensure the effects of fishing do not result in serious or irreversible harm to habitat structure and function	Sand/soft sediment	All fishing on stock	C1, L1	NEGLIGIBLE
		Reef	All fishing on stock	C1, L2	NEGLIGIBLE
		Vegetation (e.g. seagrass)	All fishing on stock	C1, L1	NEGLIGIBLE
Ecosystem Structure	To ensure the effects of fishing do not result in serious or irreversible harm to ecological processes	Trophic interactions	All fishing on stock	C2, L3	LOW
		Translocation (pests, diseases)	All fishing on stock	C1, L2	NEGLIGIBLE
		Ghost fishing (lost gear)	All fishing on stock	C1, L1	NEGLIGIBLE
Broader Environment	To ensure the effects of fishing do not result in serious or irreversible harm to the broader environment	Air quality	All fishing on stock	C1, L1	NEGLIGIBLE
		Water quality	All fishing on stock	C1, L1	NEGLIGIBLE
		Noise pollution	All fishing on stock	C1, L1	NEGLIGIBLE

* denotes Primary species, that will be managed against formal harvest strategy reference levels.

7.1 Retained Species



7.1.1 *Australian sardine*

Risk Rating: Cumulative impact of harvesting the Resource on West Coast Australian sardine stock (C2xL2 = LOW)

Risk Rating: Cumulative impact of harvesting the Resource on South Coast Australian sardine stock (C2xL2 = LOW)

- For management and assessment purposes, WA stocks are effectively isolated from SA stocks and within WA there is separation of stocks between the West and South Coast Bioregions.
- Australian sardines are predominantly taken in nearshore embayments near Albany (King George Sound), Bremer Bay and Esperance.
- The current weight-of-evidence assessment of Australian sardines in WA indicates that West Coast and South Coast stocks are being fished at a sustainable level (Appendices D and E).

7.1.2 *Scaly mackerel*

Risk Rating: Cumulative impact of harvesting the Resource on scaly mackerel stock (C2xL2 = LOW)

- In WA, scaly mackerel are highly mobile with a patchy distribution.
- Scaly mackerel are the key target species within the West Coast Bioregion, with scaly mackerel dominating the catch in this area.

- The current weight-of-evidence assessment of scaly mackerel in WA indicates that the stock is being fished at a sustainable level (Appendix C).

7.1.3 Yellowtail scad

Risk Rating: Cumulative impact of harvesting the Resource on yellowtail scad (C1×L2 = NEGLIGIBLE)

- Yellowtail scad are assumed to comprise separate stocks in Eastern and Western Australia. The WA stock of yellowtail scad is not formally assessed due to insufficient data as the biology and demography of this species in WA has not been studied.
- Yellowtail scad comprises the highest catch of minor species.
- The large majority of the WA catch of yellowtail scad is taken by the commercial purse seine sector, which operates in limited areas, usually coastal embayments (e.g., King George Sound, Cockburn Sound). Thus yellowtail scad is vulnerable to the fishery only when they enter these waters.
- The boat based recreational catch is negligible (<1 t, Ryan *et al.* 2019). Commercial catches were highest in 1980s & 1990s when purse seine effort was highest, and have been consistent at a lower level since ~2005 with a concurrently much lower purse seine effort. Catches are consistent with a negligible to low risk.

7.1.4 Australian anchovy

Risk Rating: Cumulative impact of harvesting the Resource on Australian anchovy (C1×L2 = NEGLIGIBLE)

- Australian anchovy is one of the five key species comprising the Resource, however, catches are small and infrequent (<1% of the total reported catch for the last 10 years).

7.1.5 Maray

Risk Rating: Cumulative impact of harvesting the Resource on maray (C1×L2 = NEGLIGIBLE)

- Maray is one of the five key species comprising the Resource, however, catches are small and infrequent (<1% of the total reported catch for the last 10 years).
- Maray are recreationally insignificant (Ryan *et al.* 2019), with catches from limited nearshore embayments.

7.1.6 Blue sprat

Risk Rating: Cumulative impact of harvesting the Resource on west coast blue sprat stock (C1×L2 = NEGLIGIBLE)

Risk Rating: Cumulative impact of harvesting the Resource on south coast blue sprat stock (C1×L1 = NEGLIGIBLE)

- Blue sprat is one of the five key species comprising the Resource, however, catches are small and infrequent (<1% of the total reported catch for the last 10 years).

7.1.7 *Perth herring*

Risk Rating: Cumulative impact of harvesting the Resource on Perth Herring (C1×L1 = NEGLIGIBLE)

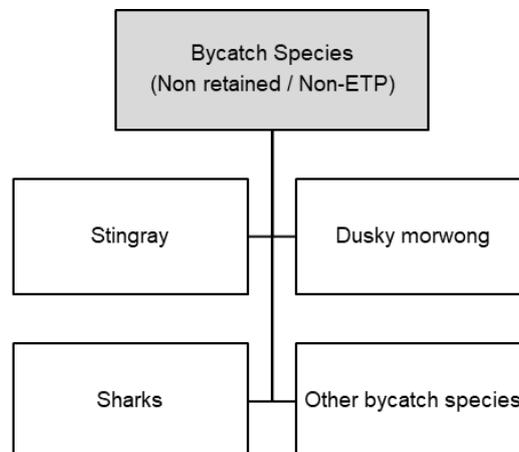
- Perth herring form part of the West Coast Nearshore and Estuarine Scalefish Resource, and whilst they may also be retained, catches are very rare (no records of catches in the past 20 years).

7.1.8 *Sandy sprat*

Risk Rating: Cumulative impact of harvesting the Resource on sandy sprat (C3×L3 = HIGH)

- The South Coast Purse Seine Fishery is entitled to retain sandy sprat, which forms part of the South Coast Nearshore and Estuarine Scalefish Resource, however, catches are very rare.

7.2 Bycatch Species (Non retained/Non ETP)



7.2.1 *Stingray*

Risk Rating: Cumulative impact of harvesting the Resource on stingrays (C1×L1 = NEGLIGIBLE)

- Legally not permitted to be retained, however, may be encircled by net. Stingrays are released by lowering the net and allowing the animal to swim free.

7.2.2 *Dusky morwong*

Risk Rating: Cumulative impact of harvesting the Resource on dusky morwong stock (C1×L1 = NEGLIGIBLE)

- The stock structure and biology of dusky morwong is currently unknown. They are likely to be long-lived, slow moving and relatively sedentary, making them potentially vulnerable to overfishing by certain fishing methods.
- Legally not permitted to be retained, however, may be encircled by net. Dusky morwongs are released by lowering the net and allowing the animal to swim free, or by bringing individuals on board for immediate release, usually alive and unharmed.

7.2.3 Sharks

Risk Rating: Cumulative impact of harvesting the Resource on shark stocks (C1xL1 = NEGLIGIBLE)

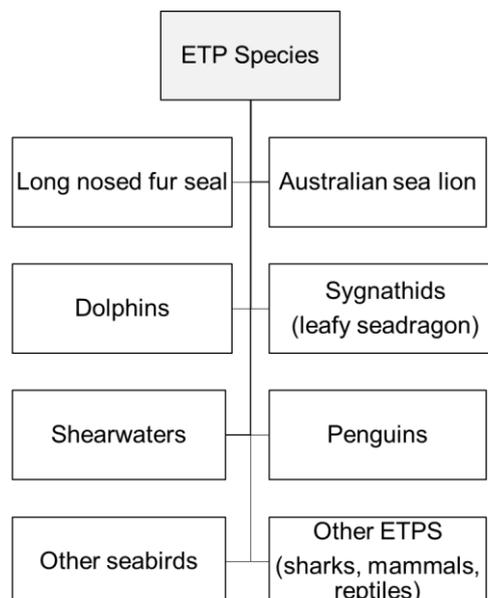
- Legally not permitted to be retained, however, may be encircled by net. Sharks are released by manually lowering the cork or lead line, manually drawing the net upward in order to roll the animal over the cork line, or by bringing individuals on board for immediate release, usually alive and unharmed.

7.2.4 Other bycatch species

Risk Rating: Cumulative impact of harvesting the Resource on other minor bycatch species (C1xL1 = NEGLIGIBLE)

- Available data suggests that the WCPSF, SCPSF and PSDZ catches and discard low numbers of other species such as samsonfish, in estimated quantities that are too low to have any measurable impact on each species.

7.3 ETP Species



7.3.1 Long nosed fur seal

Risk Rating: Impact of harvesting the Resource on long nosed fur seals (C1xL1 = NEGLIGIBLE)

- Long nosed fur seals are occasionally seen in King George Sound freely entering and exiting over the cork line of purse seine nets to feed on the trapped fish inside.
- Interactions requiring human intervention are relatively rare and no mortalities have been recorded by commercial purse seine fishers or observers.

7.3.2 Australian sea lion (ASL)

Risk Rating: Impact of harvesting the Resource on Australian sea lions (C1×L1 = NEGLIGIBLE)

- ASLs are endemic to southern Australia, with 13 distinct ASL metapopulations, six in WA waters and the remainder in SA (Pitcher 2018). Due to the life history characteristics of the species, low mortality rates may have significant impacts.
- ASLs are occasionally seen in King George Sound freely entering and exiting over the cork line of purse seine nets to feed on the trapped fish inside.
- Interactions requiring human intervention are relatively rare and no mortalities have been recorded by commercial purse seine fishers or observers.
- During the independent observer period in 2007, no pinniped mortalities or interactions requiring human intervention were recorded during 71 trips in King George Sound when 87 shots (net deployments) were made (Puglisi 2007).
- During 147 trips in King George Sound with independent observers conducted between 2017 and 2021, two pinniped interactions (on a single trip) requiring human intervention were recorded, with both individuals released alive and unharmed (Norriss, J., unpublished data).
- *Specific comment recorded for Australian sea lion; DPIRD representative:* records and information on 'non-harmful interactions' from licensees would be beneficial to the management of the Resource and for the purposes of assessments such as this, i.e. provisioning.

7.3.3 Dolphins

Risk Rating: Impact of harvesting the Resource on the common dolphin (C1×L3 = LOW)

Risk Rating: Impact of the Resource on the bottlenosed dolphin (C1×L3 = LOW)

- There are currently no specific concerns for the population status of dolphins within southern WA.
- No interactions have been recorded from WCPSF.
- Common dolphins usually attend purse seine fishing operations (>50 % of trips) in King George Sound (JN personal obs.).

- From 2009/10 to 2019/20, SCPSF fishers recorded on CDRs the deaths of two dolphins, and the release of five dolphins alive and unharmed.
- Definition of an 'interaction' and 'human intervention' is unclear, with certain examples such as lowering the float line or dropping rings to allow various species to escape not regarded as an interaction by many fishers and thus is not reported. It was highlighted that DPIRD needs to be clear across all fisheries what the definition of an interaction is.
- *Specific comment recorded for dolphins; DPIRD representative:* the definition of an interaction is where the animal needs human intervention to be released/escape.
- *Specific comment recorded for dolphins; commercial fishery representative:* Very common for pinnipeds to leap in/out of purse seine net, with no human intervention required to allow them to escape. Occurs in WCB and SCB fisheries. This is not regarded as an 'interaction' by fishers, and so is not reported.
- *Specific comment recorded for dolphins; commercial fishery representative:* in the Bremer Bay region, a 'zipline' setup was introduced approximately one year ago which has been helpful in allowing animals to escape.
- *Specific comment recorded for dolphins; UWA:* both common (mostly female and calves) and Indo-Pacific bottle-nosed dolphins occur in the fishery area year-round. Coastal dolphins are long-lived species that have low reproductive rates and extended investment in their offspring, and consequently are inherently vulnerable to human impacts and less resilient to recovery. In WA, Indo-Pacific bottlenose dolphins occur in small, isolated populations or communities that have limited geographical ranges which exacerbates their vulnerability to threats such as bycatch. Recently updated IUCN status for the Indo-Pacific bottlenose dolphin was revised to 'Near Threatened'.
- *Specific comment recorded for dolphins; UWA:* has spent a lot of time in King George Sound doing marine mammal surveys. In 2020, when undertaking weekly dolphin surveys, purse seine vessels were often sighted. When actively fishing, both common dolphins and bottlenose dolphins attended the vessels on most occasions. Despite dolphins aggregating near nets, no negative interactions between dolphins and fishers were observed.

7.3.4 Syngnathids

Risk Rating: Impact of harvesting the Resource on syngnathids (C1xL1 = NEGLIGIBLE)

- Syngnathids generally associate with macroalgae and seagrass, which are sometimes caught in commercial fishing nets. As these weeds are typically

shaken out of the net as it is being hauled, the syngnathids are rarely landed on the vessel.

- One leafy seadragon was recorded by independent observers as being released alive on one of 147 fishing trips in King George Sound between 2017 and 2021 (Norriss, J., unpublished data).

7.3.5 *Flesh Footed Shearwaters (FFS)*

Risk Rating: Impact of harvesting the Resource on Flesh Footed Shearwaters (C3xL2 = MEDIUM; C3xL3 = HIGH)

- FFS are trans-equatorial migrants that nest in burrows on southern hemisphere islands, including Australia's south coast and Lord Howe Island.
- FFS return to WA late September / early October to commence breeding cycle on about 40 islands, leaving WA around May.
- WA population estimate is 18,376 to 35,906 breeding pairs from nest burrow surveys between 2011 and 2014 (assumed 100% breeding participation – population may be underestimated) (Lavers 2015).
- FFS are pursuit predators, more active in daytime, capable of diving to over 60 metres in depth. They target schools of small baitfish such as Australian sardines and may drown when attempting to surface underneath a net fold that has formed underwater (Norriss *et al.* 2020).
- The level of bycatch in the SCPSF is likely to be associated with the amount of fishing effort in King George Sound. There have been zero interactions with FFS in the WCB.
- The majority of King George Sound interactions occur in March and April, coinciding with the later stages of chick rearing. This period also coincides with the period of highest fishing effort (March to May), when Australian sardines undertake an inshore movement that enhances their catchability.
- In the 11 year period 2009/10 to 2019/20, SCPSF fishers recorded 557 mortalities, nine injured and 4,220 released alive and unharmed on CDRs. All except four of these interactions occurred within King George Sound.
- Of 266 independently observed King George Sound trips during the peak bycatch period (March and April), a total of 258 mortalities were recorded.
- In addition to a number of mitigation measures that have been implemented, along with measures undertaken by the Department, the SCPSF has formulated a Voluntary CoP for Responsible Fishing that includes a Special Management Period for March and April in King George Sound.
- *Specific comment recorded for FFS; CCWA, Australasian Seabird Group:* Published estimates of mortalities by Lavers *et al.* are likely under estimates of the overall population. Any estimates based on surveys of breeding populations

are inaccurate because they assume all birds participate in breeding each year. FFS are known to forage over large areas (100's of km), therefore a bird seen in one zone may have traveled from another zone. High densities seen by fishers in King George Sound may not represent a large local population, but instead might actually be an aggregation of birds from multiple populations from distant areas. It was acknowledged that Lavers *et al.* is the research that is available for assessment, however, it should be treated cautiously with a low level of certainty.

- *Specific comment recorded for FFS; Birdlife Australia:* released birds may survive but this interaction could still be stressful and negatively impact on their breeding success (sub-lethal effects).
- *Specific comment recorded for FFS; commercial fishery representative:* FFS behave differently at Bremer Bay, they stay on the surface and don't seem to dive much. We run a very high power block which pulls the net and prevents the net folds from forming.
- *Specific comment recorded for FFS; DBCA:* DBCA would never issue a Section 40 (permit to take wildlife) to the fishery for the purpose of managing seabird bycatch as this would deincetevise development of additional mitigation measures; at same time, they were highly unlikely to prosecute fishers for accidentally killing birds during their operations (e.g. during equipment failure).
- The workshop had conflicting views as to the cause of dead FFS sometimes found washed up on shorelines in the Albany region. One view was that washups are due to purse seine fishing, not other causes, and are evidence of higher mortalities than assessments allow for. Conversely, fishery representatives strongly dispute washups being due to purse seine fishing, arguing that any FFS killed during operation would be collected as it would not be in the best interests of the fishery to allow them to washup, highlighting that washups have occurred in the past on days that follow non-fishing periods such as public holidays.
- The workshop agreed to treat the entire South Coast FFS population as a single unit for the purposes of risk scoring; and to assess the impact of the entire SCPSF as a single unit rather than splitting into zones. It was acknowledged that FFS occur throughout the entire SCPSF and evidence of interactions is higher in King George Sound given this area is the focus of the FFS observer program.
- The workshop was unable to reach a consensus on the risk rating. One view was that there was no clear evidence that the FFS population is being impacted by the SCPSF. An alternative view was that the available data had a high level of uncertainty, especially around potential biological removal estimates, and that FFS are susceptible to fishery induced mortality. The workshop therefore agreed to implement the two scores, being a MEDIUM/HIGH risk rating.

- For completeness and based on the approach adopted consistently across all ERAs, in the instance of two scores being recorded, the highest is carried forward. Thus, whilst it is maintained that this component scored a Medium/High, for the purposes of the outcomes of the ERA, a High risk has been attributed to FFS.
- It is noted that Dr Nic Dunlop representing the CCWA abstained from scoring for FFS in the workshop but did provide information and narrative which contributed to the scoring.

7.3.6 Other ETP species – Penguins

Risk Rating: Impact of harvesting the Resource on penguins (C1xL1 = NEGLIGIBLE)

- Interactions with other ETP species occur in small numbers for mostly vagrant species and likely to be released alive.
- No interactions have been recorded with penguins.

7.3.7 Other ETP species – Other seabirds

Risk Rating: Impact of harvesting the Resource on other seabirds (C1xL1 = NEGLIGIBLE)

- Other seabirds that frequent the WA coastline and have the potential to interact with the harvesting of the Resource include great skuas, gannets and crested terns.
- Interactions with other ETP species occur in small numbers for mostly vagrant species and likely to be released alive.
- Minimal interactions have been recorded with other seabirds.

7.3.8 Other ETP species – Other sharks

Risk Rating: Impact of harvesting the Resource on other sharks (C1xL1 = NEGLIGIBLE)

- Other sharks that frequent the WA coastline and have the potential to interact with the harvesting of the Resource include white sharks, sawfish and manta rays.
- Interactions with other ETP species occur in small numbers for mostly vagrant species and likely to be released alive.
- No interactions with ETP shark species have been recorded.

7.3.9 Other ETP species – Other marine mammals

Risk Rating: Impact of harvesting the Resource on other marine mammals (C1xL1 = NEGLIGIBLE)

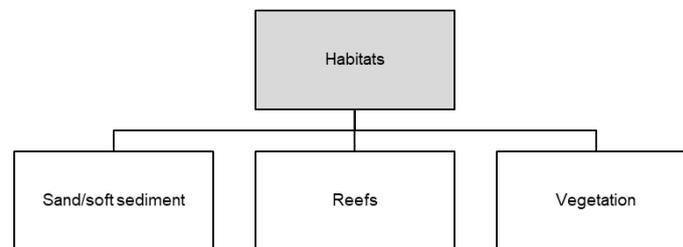
- Interactions with other ETP species such as whales occur in small numbers for mostly vagrant species and likely to be released alive.
- No interactions with other ETP marine mammal species have been recorded.

7.3.10 Other ETP species – Marine reptiles

Risk Rating: Impact of harvesting the Resource on marine reptiles (C1xL1 = NEGLIGIBLE)

- Interactions with other ETP species occur in small numbers for mostly vagrant species and likely to be released alive.
- No interactions have been recorded with marine reptiles, including sea snakes and turtles.

7.4 Habitats



7.4.1 Sand/soft sediment

Risk Rating: Impact of harvesting the resource on sand/soft sediment habitats (C1xL1 = NEGLIGIBLE)

- Sand and soft sediment are inherently unstable, dynamic habitats.
- Purse seine nets with their metal rings are expected to have little or no impact on benthic habitats during normal operations.
- Purse seine nets are lifted directly from the benthos, rather than dragged. Therefore, are unlikely to have even a minor impact on the sand and sediment.

7.4.2 Reefs

Risk Rating: Impact of harvesting the resource on reef habitats (C1xL1 = NEGLIGIBLE)

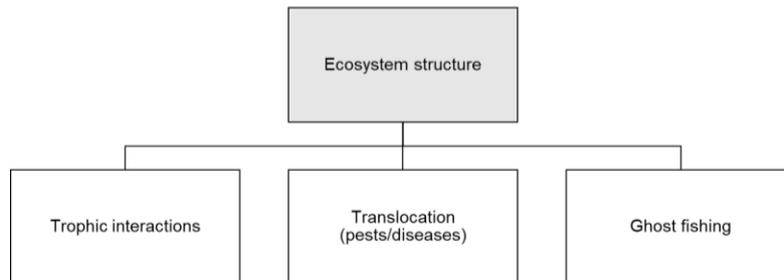
- Purse seine nets are lifted directly from the benthos, rather than dragged, and so each net has a small footprint.
- The likely net damage from reef contact motivates fishers to avoid these areas entirely.

7.4.3 Vegetation

Risk Rating: Impact of harvesting the resource on marine vegetation (e.g. macroalgae and seagrass) (C1xL1 = NEGLIGIBLE)

- Purse seine nets are deployed infrequently and are lifted directly from the benthos, rather than dragged, and so each net has a small footprint.
- Purse seine nets with their metal rings are expected to have little or no impact on benthic habitats during normal operations.
- On rare occasions nets may be deployed in shallow waters and come into contact with habitats such as seagrass beds, causing minimal damage.

7.5 Ecosystem Structure



7.5.1 Trophic interactions

Risk Rating: Impact of harvesting the Resource on trophic interactions (C1xL3 = LOW)

- The removal of species retained by the WCPSF, SCPSF and PSDZ has the potential to alter key elements of the ecosystem, including predator-prey interactions. Small pelagic fish are low trophic level species that are important for ecosystem structure and function.
- Small pelagic fish dominate the diets of many higher-trophic level predators making them vulnerable to variations in forage fish biomass (Cury *et al.* 2000; Smith *et al.* 2011). Australian sardines are a key prey item for many marine predators along the southern Australian coast (Goldsworthy *et al.* 2013).
- Australian sardines and scaly mackerel are two of at least 25 recorded prey species taken by little penguin colonies on Penguin and Garden Islands near the Perth metropolitan area (Klomp and Wooller 1988; Murray *et al.* 2011).
- Australian sardines and scaly mackerel stocks are currently being fished to sustainable levels and there has been no perceived material change to ecosystem structure or function.
- *Specific comment recorded for trophic interactions; CCWA:* several bird species consume Australian sardines as a major prey item, including crested turns, wedgetail shearwaters and little penguins. Local depletion of bird species could be an issue in areas of condensed effort such as King George Sound. Studies have shown that provisioning can have negative impacts on bird populations.

7.5.2 *Translocation (pests & disease)*

Risk Rating: Impact of harvesting the Resource on the ecosystem by translocating pests and diseases (C1×L2 = NEGLIGIBLE)

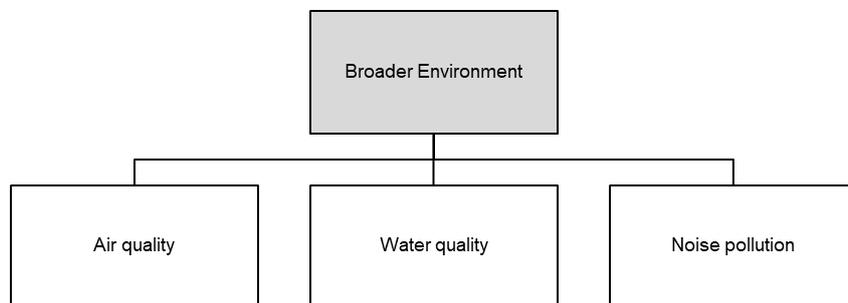
- Fishing vessels that harvest the Resource and move between different areas have the potential to introduce or translocate marine pests and/or disease.
- WCPSF, SCPSF and PSDZ vessels do not travel into international waters and have a low susceptibility to inoculation from pests and diseases because they typically work in remote ocean locations and from a limited number of predominantly low-risk ports.

7.5.3 *Ghost fishing*

Risk Rating: Impact of harvesting the Resource on the ecosystem by ghost fishing of lost gear (C1×L1 = NEGLIGIBLE)

- Fishing vessels harvesting the Resource have the potential to lose fishing gear whilst fishing, which could result in the continued capture of species.
- The impact of ghost fishing was assessed as negligible as the fishing vessels harvesting the Resource have not recorded any lost gear in recent history and any purse seine nets that are lost are always retrieved due to their economic value.

7.6 **Broader Environment**



7.6.1 *Air quality*

Risk Rating: Impact of harvesting the Resource on the air quality (C1×L1 = NEGLIGIBLE)

- Fishing vessels utilising the Resource utilise fuel and emit exhaust fumes and greenhouse gas.
- Currently 11 active commercial vessels averaging 76 days per vessel, roughly 2 - 10 hours per day with operations spread over a large geographical area.
- The likelihood of any measurable impact of fuel exhaust or greenhouse gas emissions on air quality was considered negligible.

7.6.2 Water quality

Risk Rating: Impact of harvesting the Resource on water quality (C1xL1 = NEGLIGIBLE)

- Fishing vessels utilising the Resource have the potential to reduce water quality through discarding of debris and litter as well as by accidental oil and fuel spills.
- The WCPSF, SCPSF and PSDZ do not use packaged bait, reducing the likelihood of littering.
- The SCPSF Code of Practice (Appendix F) stipulates measures to be taken by operators to minimise any type of pollution at sea.
- The likelihood of any measurable impact of oil/fuel discharge on water quality was considered negligible.

7.6.3 Noise pollution

Risk Rating: Impact of underwater noise pollution from fishing vessels harvesting the Resource (C1xL1 = NEGLIGIBLE)

- Fishing vessels utilising the Resource have the potential to contribute to noise pollution.
- The impact of fishing vessels harvesting the Resource on noise pollution levels was assessed as negligible. There is potential for noise pollution from other sources (e.g. other larger vessels, seismic surveys) to have a greater impact.

8.0 Risk Evaluation & Treatment

This risk assessment has assisted in the identification and evaluation of the different types of ecological risks associated with the Resource. Different levels of risk have different levels of acceptability, with different requirements for monitoring and reporting, and management actions (see Table 6.2 for a summary). Risks identified as negligible or low are considered acceptable, requiring either no or periodic monitoring, and no specific management actions. Issues identified as medium risk are considered acceptable provided specific monitoring, reporting, and management measures are implemented. Risks identified as high are considered 'not desirable', requiring strong management actions or new control measures to be introduced in the near future. Severe risks are considered 'unacceptable' with major changes to management required in the immediate future (Fletcher *et al.* 2002).

Thirty four components associated with the ecological sustainability of the Resource were scored for risk (Table 8.1). The vast majority (32) were evaluated as low or negligible risks, which do not require any specific control measures (as per Fletcher *et al.* 2002; Table 6.2).

Table 8.1. Summary of scores across each risk issue scored cumulatively in the 2021 risk rating of the State-Wide Small Pelagic Scalefish Resource.

Ecological Sustainability	Component	Risk Score					Total
		Negligible	Low	Medium	High	Severe	
	Retained species	6	3	-	1	-	10
	Bycatch species	4	-	-	-	-	4
	ETP species	8	2	-	1*	-	11
	Habitats	3	-	-	-	-	3
	Ecosystem structure	2	1	-	-	-	3
	Broader environment	3	-	-	-	-	3
	Total	26	6	-	2*	-	34

* One component of the ETP aspect was scored a Medium and High risk rating during the workshop.

At the workshop, FFS was scored a Medium/High risk. A medium was considered appropriate due to the potential interaction with purse seine nets based on independent observer records. However, noting concerns over the level of uncertainty associated with population modelling and fishery-dependent data, a high score was also considered. For completeness and based on the approach adopted consistently across all ERAs, in the instance of two scores being recorded, the highest is carried forward. Thus, whilst it is maintained that this component scored a Medium/High, for the purposes of the outcomes of the ERA, a High risk has been attributed to FFS.

As the risk assessment yielded a high risk, this will require further control measures, to be determined following the outcomes of the upcoming application to the Commonwealth Department of Agriculture, Water and the Environment for the SCPSF to be assessed against the Commonwealth Guidelines for the *Ecologically Sustainable Management of Fisheries*, for the purpose of becoming an approved WTO.

Sandy sprat was given a risk score of high because that is the risk determined by the Department in its most recent assessment for the stock fished in the WCB. However, it is noted that this species is legally not allowed to be retained in the WCB by purse seiners. In the SCB, sandy sprat are naturally very rare, and may well constitute a separate biological stock to the WCB. They are legally retainable for the SCPSF, but are rarely, if ever, taken (the most recent reported catch was in 1993 but this may have been a mis-identified species). The decision to include sandy sprat in this ERA was discussed in the workshop and it was decided that this species was technically in scope. In practical terms, the recovery, harvest and mitigation measures for sandy sprat is managed through the West Coast Nearshore and Estuarine Finfish Harvest Strategy and will be included in the ERA process pertinent to that resource.

It is recommended that the risks be reviewed within five years, or in conjunction with the development of a formal harvest strategy for the Resource, where risk scores are used as the performance indicator for the non-target ecological assets. Monitoring and assessment of the key target species will be ongoing, with the performance indicators evaluated on an annual basis.

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Appendix A: Likelihood and Consequence Levels

LIKELIHOOD LEVELS

1	Remote	The consequence has never been heard of in these circumstances, but it is not impossible within the timeframe (Probability <5%).
2	Unlikely	The consequence is not expected to occur in the timeframe but it has been known to occur elsewhere under special circumstances (Probability 5 - <20%).
3	Possible	Evidence to suggest this consequence level is possible and may occur in some circumstances within the timeframe (Probability 20 - <50%).
4	Likely	A particular consequence level is expected to occur in the timeframe (Probability ≥50%).

CONSEQUENCE LEVELS

1. Ecological: Target/Primary (Retained & Discarded) Species		
1	Minor	Fishing impacts either not detectable against background variability for this population; or if detectable, minimal impact on population size and none on dynamics. Spawning biomass > Target level
2	Moderate	Fishery operating at maximum acceptable level of depletion. Spawning biomass < Target level but > Threshold level (B_{MSY})
3	High	Level of depletion unacceptable but still not affecting recruitment levels of stock. Spawning biomass < Threshold level (B_{MSY}) but > Limit level (B_{REC})
4	Major	Level of depletion is already affecting (or will definitely affect) future recruitment potential of the stock. Spawning biomass < Limit level (B_{REC})

2. Ecological: Non-Target/Secondary (Retained & Discarded) Species		
1	Minor	Measurable but minor levels of depletion of fish stock.
2	Moderate	Maximum acceptable level of depletion of stock.
3	High	Level of depletion of stock unacceptable but still not affecting recruitment level of the stock.
4	Major	Level of depletion of stock are already affecting (or will definitely affect) future recruitment potential of the stock.

3. Ecological: Threatened, Endangered and Protected Species (ETPs)		
1	Minor	Few individuals directly impacted in most years.
2	Moderate	Level of capture is the maximum that will not impact on recovery.
3	High	Recovery may be affected.
4	Major	Recover times are clearly being impacted.

4. Ecological: Habitat		
1	Minor	Measurable impacts but very localized. Area directly affected well below maximum accepted.
2	Moderate	Maximum acceptable level of impact to habitat with no long-term impacts on region-wide habitat dynamics.
3	High	Above acceptable level of loss/impact with region-wide dynamics or related systems may begin to be impacted.
4	Major	Level of habitat loss clearly generating region-wide effects on dynamics and related systems.

5. Ecological: Ecosystem/Environment		
1	Minor	Measurable but minor changes to the environment or ecosystem structure but no measurable change to function.
2	Moderate	Maximum acceptable level of change to the environment or ecosystem structure with no material change in function.
3	High	Ecosystem function altered to an unacceptable level with some function or major components now missing and/or new species are prevalent.
4	Major	Long-term, significant impact with an extreme change to both ecosystem structure and function; different dynamics now occur with different species/groups now the major targets of capture or surveys.

Appendix B: ERA Workshop Stakeholders

Table C.1. List of invited ERA workshop stakeholders.

Name	Organisation
Brent Wise	DPIRD (Aquatic Science and Assessment)
Shirree Blazeski	DPIRD (Aquatic Resource Management)
Jeffrey Norriss	DPIRD (Aquatic Science and Assessment)
Mathew Hourston	DPIRD (Aquatic Science and Assessment)
Kim Smith	DPIRD (Aquatic Science and Assessment)
Gary Jackson	DPIRD (Aquatic Science and Assessment)
Tim Nicholas	DPIRD (Aquatic Resource Management)
Nick Blay	DPIRD (Aquatic Resource Management)
Russell Adams	DPIRD (Operations and Compliance)
Robert Bogumil	DPIRD (Operations and Compliance)
Matthew Wilson	DPIRD (Operations and Compliance)
Mick Kelly	DPIRD (Operations and Compliance)
Todd A'Vard	DPIRD (Operations and Compliance)
Jim Mendolia	WCPSF (Commercial Licensee)
Paul Merendino	WCPSF (Commercial Licensee)
Climarc Super Pty Ltd	WCPSF (Commercial Licensee)
Glenn Foxtton	WCPSF (Commercial Licensee)
Aquatic Life Industries	WCPSF (Commercial Licensee)
Searom Global Pty Ltd	WCPSF (Commercial Licensee)
Fish Feeds Australia	WCPSF (Commercial Licensee)
Frank Ianni	WCPSF (Commercial Licensee)
Bryn Westerberg	SCPSF (Commercial Licensee)
Tony Westerberg	SCPSF (Commercial Licensee)
Peter Westerberg	SCPSF (Commercial Licensee)
Greg Sharp	SCPSF (Commercial Licensee)
Brad Kennedy	SCPSF (Commercial Licensee)
Nada Gowdie	SCPSF (Commercial Licensee)
Latitude Fisheries Pty Ltd	SCPSF (Commercial Licensee)
Lucky S Fishing	SCPSF (Commercial Licensee)
Chancliff Holdings	SCPSF (Commercial Licensee)
Lindsay Michael	SCPSF (Commercial Licensee)
Hugh Gilbert	SCPSF (Commercial Licensee)
L & G Martin	SCPSF (Commercial Licensee)
Trilogy Pty Ltd	SCPSF (Commercial Licensee)
Guardon Fisheries	SCPSF (Commercial Licensee)
Trevor Wheatcroft	SCPSF (Commercial Licensee)
Peter Jecks	NPSDZ (Commercial Licensee)
Clinton Lodge	NPSDZ (Commercial Licensee)
Manny Soulos	SPSDZ (Commercial Licensee)
Alan & Peta Miles	SPSDZ (Commercial Licensee)
Darryl Hockey	Western Australian Fishing Industry Council
Matt Pember	Western Australian Fishing Industry Council

Neil MacGuffie	Southern Seafood Producers WA Association
Andrew Rowland	Recfishwest
Piers Verstegen	Conservation Council of Western Australia
Nic Dunlop	Conservation Council of Western Australia
Beth Walker	Birdlife Australia
Vicki Stokes	Birdlife Australia
Natasha Monks	Great Southern Development Commission
Peter Hartley	Department of Biodiversity, Conservation and Attractions
Tim Button	Department of Biodiversity, Conservation and Attractions
Stephen Toole	Department of Biodiversity, Conservation and Attractions
Jonathan Pirdham	Department of Biodiversity, Conservation and Attractions
Ryan Parker	Department of Biodiversity, Conservation and Attractions
Kim Williams	Parks and Wildlife Service
Carol Biddulph	Western Australian Seabird Rescue
Justin Bellinger	South Coast Natural Resource Management
Brett Molony	Commonwealth Scientific and Industrial Research Organisation
Belinda Cannell	University of Western Australia
Harriet Paterson	University of Western Australia
Kirsty Alexander	University of Western Australia
Neil Loneragan	Murdoch University
Matt Watson	Marine Stewardship Council
Simon Goldsworthy	South Australian Research and Development Institute
Tim Ward	South Australian Research and Development Institute
Sally Weekes	Australian Fisheries Management Authority
Cassie Pert	Department of Agriculture, Water and the Environment
Mandy Goodspeed	Department of Agriculture, Water and the Environment
James Woodhams	Department of Agriculture, Water and the Environment
Wayne Nannup	South West Aboriginal Sea and Land Council

Table C.2. List of ERA workshop attendees.

Name	Organisation
Brent Wise	DPIRD (Aquatic Science and Assessment)
Shirree Blazeski	DPIRD (Aquatic Resource Management)
Mathew Hourston	DPIRD (Aquatic Science and Assessment)
Kim Smith	DPIRD (Aquatic Science and Assessment)
Jeffrey Norriss	DPIRD (Aquatic Science and Assessment)
Gary Jackson	DPIRD (Aquatic Science and Assessment)
Tim Nicholas	DPIRD (Aquatic Resource Management)
Nick Blay	DPIRD (Aquatic Resource Management)
Robert Bogumil	DPIRD (Operations and Compliance)
Matthew Wilson	DPIRD (Operations and Compliance)
Mathew Kuhn	DPIRD (Operations and Compliance)
Kim Walshe	DPIRD (Aquaculture Management) (Observer)
Bryn Westerberg	SCPSF (Commercial Licensee)
Tony Westerberg	SCPSF (Commercial Licensee)
Peter Westerberg	SCPSF (Commercial Licensee)

Graeme Drew	SCPSF (Commercial Licensee)
Steve Lodge	WCPSF (Commercial Licensee)
Michelle Winter	WCPSF (Commercial Licensee)
Terry Romaro	WCPSF (Commercial Licensee)
Brett Hogan	NPSDZ (Commercial Licensee)
Alan Miles	SPSDZ (Commercial Licensee)
Shane Miles	SPSDZ (Commercial Licensee)
Neil MacGuffie	Southern Seafood Producers WA Association
Peter Rogers	Western Australian Fishing Industry Council
Nic Dunlop	Conservation Council of Western Australia
Vicki Stokes	Birdlife Australia
Barry Baker	Australasian Seabird Group
Peter Hartley	Department of Biodiversity, Conservation and Attractions
Tim Button	Department of Biodiversity, Conservation and Attractions
Stephen Toole	Department of Biodiversity, Conservation and Attractions
Jonathan Pirdham	Department of Biodiversity, Conservation and Attractions
Harriet Paterson	University of Western Australia
Kirsty Alexander	University of Western Australia
Matt Watson	Marine Stewardship Council

Table C.3. List of ERA workshop apologies.

Name	Organisation
Steven Davies	WCPSF (Commercial Licensee)
Semi Skoljarev	SCPSF (Commercial Licensee)
Nada Gowdie	SCPSF (Commercial Licensee)
Peter Jecks	NPSDZ (Commercial Licensee)
James Woodhams	Australian Bureau of Agricultural and Resource Economics and Sciences
Brett Molony	Commonwealth Scientific and Industrial Research Organisation
Ryan Parker	Department of Biodiversity, Conservation and Attractions
Brad Kneebone	Denmark Bird Group
Fiona O'Sullivan	Western Australian Seabird Rescue

Appendix C: Risk-Based Weight of Evidence Assessment of scaly mackerel (*Sardinella lemuru*), West Coast Bioregion, WA

Assessment date: March 2021

Type of assessment: Annual review and update

Executive Summary

Western Australia's scaly mackerel population from at least Carnarvon in the north to Fremantle constitute a single stock for management and assessment purposes, based on evidence from otolith chemistry. Virtually all catches are taken by commercial purse seiners operating in limited areas off Geraldton and Fremantle. The species has a high biological resilience and low vulnerability to fishing pressure, consistent with a low estimate of fishing mortality during the mid-1990s, a period of historically significant catch. Catch and effort has been much lower over the last decade, suggesting the current level of spawning stock depletion from fishing is likely to be minor. **The current risk level is therefore estimated to be Low**, with current management measures maintaining the stock at an acceptable level.

Future Monitoring & Assessment

Annual monitoring of catch information is ongoing.

A review/update of this assessment will be undertaken annually.

Risk-Based Weight of Evidence Table

Category	Line of evidence
Catch	Annual catches peaked at around 1,200 and 2,700 tonnes from 1999 to 2006 before declining and ranging between 300 and 1,200 tonnes in the last decade. The recent low catches are associated with lower economic returns.
Level 1. Catch Historically low catches over the last decade are consistent with the maintenance of adequate spawning biomass.	
Effort	Although fishing effort has gradually transitioned from targeting Australian sardines to scaly mackerel, it has been at historically low levels since about 2006 due in part at least to lower economic returns.
Catch rate	Due to mixed species targeting, patchy distribution of scaly mackerel and the concentration of catch among very few vessels, nominal catch rate is an unreliable index of abundance.

Level 2. Catch + Fishery-Dependent Catch Rate.

Historically low fishing effort since 2006 indicates the maintenance of adequate spawning biomass.

Biology and vulnerability

Biological traits such as low trophic level, short life span, a high rate of natural mortality, and sexual maturity at a young age are biological characters that make scaly mackerel resilient to fishing pressure. Vulnerability to fishing is low because although the biological stock is widespread fishing operations occur within limited areas, requiring fish to enter those areas to become vulnerable.

Age composition

Tentative age estimates from catch at age sampling between 1995 and 1997 indicated a low *F/M* estimate of 0.25, well within the target reference level of 0.67 and suggesting that catch levels around that time (*i.e.*, 500-2,000 tonnes per annum) were sustainable.

Level 3: Biology and vulnerability

Evidence of high resilience and low vulnerability to fishing mortality was supported by the low estimate of fishing mortality during a period of significant catch, suggesting minimal fisheries impact on the spawning stock.

Final Risk

The current risk level is estimated to be LOW.

Age based estimates of low fishing mortality during a period of significant catch were supported by evidence of high biological resilience and low vulnerability to fishing pressure. A much lower level of catch and effort in the last decade suggests current spawning stock depletion from fishing is likely to be minor.

Level 1 assessment: catch

Virtually all catches of scaly mackerel are taken by the West Coast Purse Seine Fishery (WCPSF) and licensees in the associated purse seine Northern Development Zone, operating adjacent to Fremantle and Geraldton, respectively. The period of highest annual catches was from 1999 to 2006 when they fluctuated between 1,200 and 2,700 tonnes (Figure 1). They then declined to fluctuate between 300 and 1,200 tonnes in the last decade. The decline appears to be associated with lower economic returns as industry competed with very large increases in the catch of Australian sardines in South Australia over the same period (Ward *et al.* 2020). Catches by the recreational sector are negligible.

Level 2 assessment: effort and catch rate

Annual fishing effort (boat days) was above 890 for every year between 1978 and 1999, peaking at 2,858 in 1987. Since then it has declined and remained below 500 since 2006, associated with lower economic returns as industry competed with very large increases in the catch of Australian sardines in South Australian over the same period (Ward *et al.* 2020). Effort of just 116 days in 2009 was the lowest on record. Near Fremantle effort had gradually transitioned from targeting Australian sardines to scaly mackerel, particularly after the former suffered a mass mortality event in 1998/99. For this reason, as well as the generally patchy distribution of scaly mackerel (Gaughan and Mitchell 2000) and the concentration of most of the catch in just a small number of vessels in recent years, catch rates are not a reliable index of abundance.

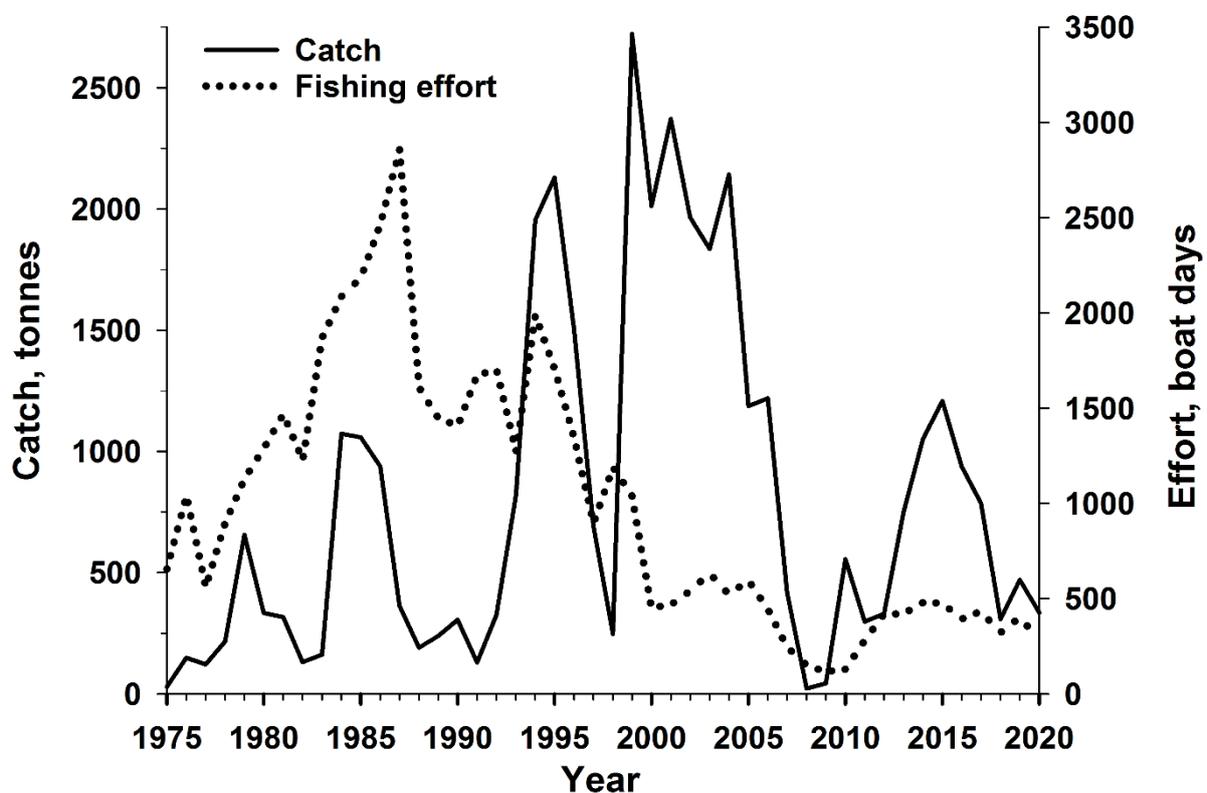


Figure 1. Annual commercial purse seine catch of scaly mackerel and fishing effort by the WCPSF and licensees in purse seine Development Zones.

Level 3 assessment: Biology, vulnerability, and age composition

Biology: Scaly mackerel are a predominantly tropical species with a natural distribution encompassing the western Pacific and eastern Indian Oceans as well as from northwestern WA to as far south as Geographe Bay (Whitehead 1985). Otolith chemistry evidence indicates a single continuous biological stock from at least Carnarvon in the north to Fremantle where the species is patchily distributed (Gaughan and Mitchell 2000). They feed by filtering plankton, making them low trophic level consumers, are short lived (up to 7 years) with an estimated high rate of natural

mortality (see below), and attain sexually maturity at the age of only 2 years (Gaughan and Mitchell 2000). Thus their biology makes them comparatively resistant to fishing pressure.

Vulnerability: Although the stock fished in WA ranges from at least Carnarvon to Fremantle based on otolith chemistry evidence (Gaughan and Mitchell 2000), almost all of the catch is taken near Geraldton and Fremantle. Thus only when fish enter those areas do they become vulnerable to fishers.

Age composition: Tentative and unvalidated age estimates using otoliths from fish taken commercially between 1995 and 1997 showed scaly mackerel have a high estimated rate of natural mortality $M= 0.93$ (Gaughan and Mitchell 2000). The sample comprised of fish aged between 1 and 7 years, resulting in an estimated fishing mortality of $F=0.23$ and giving a low estimate of $F/M= 0.25$. This was well within the target reference level of 0.67, and suggested that catch levels around that time (*i.e.*, 500-2,000 tonnes per annum) were sustainable.

Final risk assessment

A formal harvest strategy has yet to be developed, but reference levels for this risk assessment are spawning biomass relative to unfished biomass: target 40%, threshold 30% and limit 20%.

Consequence (Stock Depletion) Level	Likelihood				Risk
	L1 Remote (<5%)	L2 Unlikely (5-20%)	L3 Possible (20-50%)	L4 Likely (>50%)	
C1 Minor (above Target)				Low	4
C2 Moderate (below Target, above Threshold)		Low			4
C3 High (below Threshold, above Limit)	Low				3
C4 Major (below Limit)					-

Consequence 1 - Minor Depletion

Scaly mackerel is short lived with a high biological resilience to fishing pressure which has been historically low since about 2006. When catches were higher in earlier years, tentative catch at age data suggested very low levels of fishing mortality. The scaly

mackerel biological stock is wide ranging stock but is vulnerable to the fishery over a limited area. These lines of evidence suggest that **Minor** depletion is currently **Likely**.

Consequence 2 - Moderate Depletion

Although the age composition analysis is dated, the lower catches in recent years for a species comparatively resilient to fishing, from a limited area of a widespread stock, suggest the prospect of a **Moderate** stock depletion is **Unlikely**.

Consequence 3 - High Depletion.

Catch history, biology and inherent vulnerability, together with a tentative age-based analysis during a time of higher catches, suggest that the likelihood of a **High** depletion of the stock is **Remote**.

Consequence 4 - Major Depletion.

Not plausible

Overall risk

The risk level for the WCB scaly mackerel stock for the next five years is estimated to be **Low**. The stock is likely maintained above target level, an acceptable level of risk under current management arrangements and ongoing level of stock status monitoring.

Appendix D: Risk-Based Weight of Evidence Assessment of Australian sardine (*Sardinops sagax*), West Coast Bioregion, WA

Assessment date: March 2021

Type of assessment: Annual review and update

Executive Summary

Western Australia's West Coast Bioregion (WCB) population of Australian sardines constitute a distinct stock for management and assessment purposes. Virtually all catches are taken by commercial purse seiners operating in limited areas between Perth and Geographe Bay. Due to continually very low exploitation rates relative to the last spawning biomass estimate in the mid-2000s, coupled with the species' inherent resilience and low vulnerability to fishing pressure, **the current risk level is estimated to be Low**, with current management measures maintaining the stock at an acceptable level.

Future Monitoring & Assessment

Annual monitoring of catch information is ongoing.

A review/update of this assessment will be undertaken annually.

Risk-Based Weight of Evidence Table

Category	Line of evidence
Catch	Annual catches since a strong recovery of spawning stocks in the mid-2000s have been historically very low and well below the notional quota, attributable in part to lower economic returns, suggest adequate spawning biomass has been maintained.
Level 1. Catch	
Very low exploitation rates since a strong recovery of spawning stock since the mid-2000s suggest a minimal impact on spawning biomass.	
Effort	Low effort in recent years is associated with limited economic returns, with much of it transitioned to targeting tropical sardines.
Catch rate	Due to mixed species targeting and the concentration of catch in a small number of vessels, nominal catch rate is unreliable as an index of abundance.
Level 2. Catch + Fishery-Dependent Catch Rate.	
Historically low recent catch and effort are consistent with the persistence of adequate spawning stock, providing no evidence of unacceptable stock depletion.	

Biology and vulnerability	Low trophic level, short lived, a high rate of natural mortality and sexual maturity at a young age are biological characters that make Australian sardines resilient to fishing pressure. Vulnerability to fishing is low because although Australian sardines are naturally distributed throughout the continental shelf, fishing operations occur within limited areas (adjacent to Perth and in Geographe Bay), requiring fish to enter those areas to become vulnerable.
Level 3: Biology and vulnerability High resilience and low vulnerability to fishing mortality is consistent with only minor stock depletion.	
Spawning biomass	Daily egg production surveys demonstrated a strong recovery of spawning biomass in the mid-2000s following a mass mortality event in 1998/99. Since then annual catches have never exceeded 5% of those mid-2000s spawning biomass estimates.
Level 4. Spawning biomass. Although the most recent spawning biomass estimates are dated from the mid-2000s, the low rate of exploitation relative to those estimates since then indicates a remote likelihood that spawning biomass is likely to have remained above target, with a remote likelihood of falling below threshold levels.	
Final Risk The current risk level is estimated to be LOW. Continued low exploitation rates (catch) relative to the last spawning biomass estimate in the mid-2000s, coupled with the species' inherent resilience to fishing pressure.	

Level 1 assessment: catch

Virtually all WCB catches of Australian sardine are taken between Perth and Geographe Bay by the West Coast Purse Seine Fishery and licensees in the associated Southern Development Zone. Annual catches peaked at around 2,000 to 4,300 t in the mid-1990s before declining precipitously due to a mass mortality event in 1998/99 caused by a herpesvirus (Figure 1). By the mid-2000s egg surveys demonstrated a strong recovery of the spawning biomass to about 25,000 tonnes (20,000 – 30,000) (Gaughan *et al.* 2008). Since then catches have remained relatively low, never above 331 t. This appears to be associated with lower economic returns as industry competed with very large increases in the South Australian catch over the same period (Ward *et al.* 2020). These recent catches were well below the conservatively set notional quota of 2,328 t.

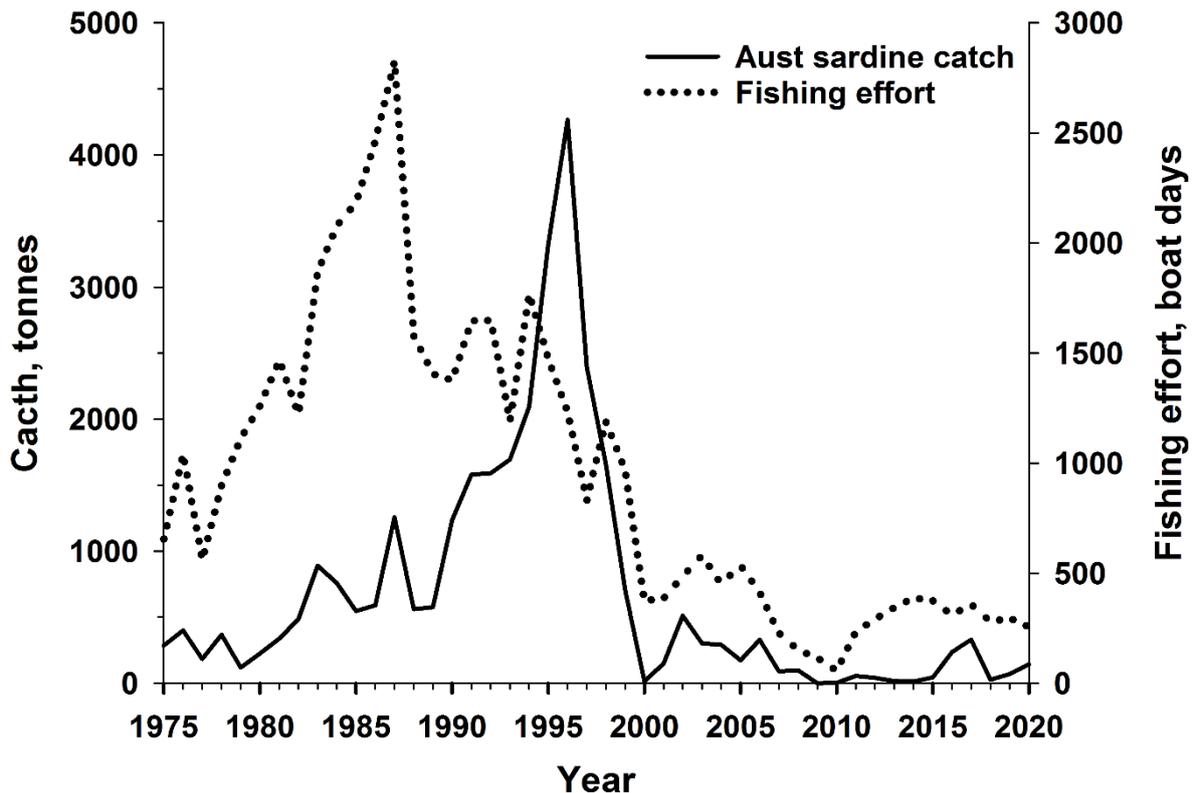


Figure 1. Annual commercial purse seine catch of Australian sardine in the WCB, and fishing effort by purse seiners in management zones where the species is taken, i.e. the Perth Metropolitan and Southern Development Zones.

Level 2 assessment: effort and catch rate

Annual fishing effort peaked at about 2,100 – 2,900 boat days between 1984 and 1987 then gradually declined through the 1990s when catches were highest (Figure 1). During this time the effort gradually transitioned to targeting scaly mackerel (*Sardinella lemuru*). The devastation of the stock by a mass mortality event in 1998/99 further redirected effort to scaly mackerel. A strong recovery of the stock by the mid-2000s (Gaughan *et al.* 2008) did not result in increased effort, partly attributable at least to reduced economic returns as industry competed with very large increases in the South Australian catch starting about this time (Ward *et al.* 2020). Effort fell to an all-time low of just 56 vessel days in 2010. Since 2000 the fishery has been marked by historically low Australian sardine catches and overall effort. Catch rates are not a useful index of abundance due to the effort gradually transitioning to the targeting of scaly mackerel and the concentration of most of the catch in just a small number of vessels in recent years.

Level 3 assessment: Biology, vulnerability and age composition

Biology: Australian sardines are naturally distributed along the continental shelf of the southern half of the Australian mainland (Gomon *et al.* 2008). Otolith chemistry and life history characteristics show that, for management and assessment purposes, WA

stocks are effectively isolated from South Australian stocks and within WA there is separation of stocks between the West and South Coast Bioregions (Edmonds and Fletcher 1997, Gaughan *et al.* 2001, Izzo *et al.* 2017). Australian sardines feed by filtering plankton, making them low trophic level consumers. In WA they are short lived, up to 9 years (Fletcher and Blight 1996), with a high rate of natural mortality ($M= 0.66$ for SCB stock, Hall (2000)), attaining sexually maturity in their second year (Fletcher 1995). Thus their biology makes them comparatively resistant to fishing pressure.

Vulnerability: Although Australian sardines occur naturally in continental shelf waters, almost all of the WCB catch is taken near Perth and Geographe Bay. Thus only when fish enter those areas do they become vulnerable to fishers.

Level 4 assessment: Spawning biomass

Fishery independent egg surveys showed a major collapse in spawning biomass in 1999 immediately following a mass mortality event caused by a herpes virus (Gaughan *et al.* 2004). Ongoing surveys demonstrated a strong recovery to about 20,000 – 30,000 tonnes by the mid-2000s (Gaughan *et al.* 2008). No further surveys have been conducted but annual catches on both the south and west coasts have never exceeded 5% of that mid-2000s spawning biomass estimate, suggesting only a minor level of stock depletion.

Final risk assessment

A formal harvest strategy has yet to be developed, but reference levels for this risk assessment are spawning biomass relative to unfished biomass: target 40%, threshold 30% and limit 20%.

Consequence (Stock Depletion) Level	Likelihood				Risk
	L1 Remote (<5%)	L2 Unlikely (5-20%)	L3 Possible (20-50%)	L4 Likely (>50%)	
C1 Minor (above Target)				Low	4
C2 Moderate (below Target, above Threshold)		Low			4
C3 High (below Threshold, above Limit)	Low				3
C4 Major (below Limit)					-

Consequence 1 - Minor Depletion

Continued low exploitation rates (catch) relative to the last spawning biomass estimate in the mid-2000s, coupled with the species' inherent resilience to fishing pressure which occurs in limited areas of the stocks distribution, suggest that **Minor** depletion is **Likely**.

Consequence 2 - Moderate Depletion

Although spawning biomass estimates from egg surveys are dated, the lower catches in recent years for a species comparatively resilient to fishing, from a limited area of the stock, suggest the prospect of a **Moderate** stock depletion is **Unlikely**.

Consequence 3 - High Depletion.

A low exploitation rate since the mid-2000s when a strong recovery had been demonstrated by fishery independent (egg) surveys, together with the species' fishery resilient biology and low inherent spatial vulnerability, suggest that the likelihood of a **High** depletion of the stock is **Remote**.

Consequence 4 - Major Depletion.

Not plausible

Overall risk

The risk level for the WCB Australian sardine stock for the next five years is estimated to be **Low**. The stock is likely maintained above target level, an acceptable level of risk under current management arrangements and ongoing level of stock status monitoring.

Appendix E: Risk-Based Weight of Evidence Assessment of Australian sardine (*Sardinops sagax*), South Coast Bioregion, WA

Assessment date: March 2021

Type of assessment: Annual review and update

Executive Summary

Western Australia's South Coast Bioregion (SCB) population of Australian sardines constitute a distinct stock for management and assessment purposes. Virtually all catches are taken by the South Coast Purse Seine Fishery operating in a small number of marine coastal embayments. Due to continually low exploitation rates relative to the last spawning biomass estimate in the mid-2000s, coupled with recent historically high nominal catch rates and the species' inherent resilience and low vulnerability to fishing pressure, **the current risk level is estimated to be Low**, with current management measures maintaining the stock at an acceptable level.

Future Monitoring & Assessment

Annual monitoring of catch information is ongoing.

A review/update of this assessment will be undertaken annually.

Risk-Based Weight of Evidence Table

Category	Line of evidence
Catch	Annual catches since a strong recovery of spawning stocks in the mid-2000s have been historically low and well below the conservatively set quota, attributable in part to lower economic returns, suggesting only a minor depletion of spawning biomass since that time.
Level 1. Catch	
Very low exploitation rates since a strong recovery of spawning stock since the mid-2000s suggest a minimal impact on spawning biomass.	
Effort	Historically low levels of higher efficiency effort in recent years is associated with limited economic returns.
Catch rate	While recent historical highs in the nominal catch rate (tonnes per boat day) can largely be attributed to increased fishing efficiency, the catch rate is consistent with the persistence of adequate spawning stock throughout this period, providing no evidence of unacceptable stock depletion.
Level 2. Catch + Fishery-Dependent Catch Rate.	

Catch and catch rates are consistent with the persistence of adequate spawning stock, providing no evidence of unacceptable stock depletion.	
Biology and vulnerability	Low trophic level, short lived, a high rate of natural mortality and sexual maturity at a young age are biological characters that make Australian sardines resilient to fishing pressure. Vulnerability to fishing is low because the large majority of the catch is taken within coastal embayments whereas the species is distributed throughout continental shelf waters.
Level 3: Biology and vulnerability High resilience and low vulnerability to fishing mortality is consistent with only minor stock depletion.	
Spawning biomass	Daily egg production surveys demonstrated a strong recovery of spawning biomass in the mid-2000s following a mass mortality event in 1998/99. Since then annual catches have never exceeded 5% of those mid-2000s spawning biomass estimates.
Level 4. Spawning biomass. Although the most recent spawning biomass estimates are dated from the mid-2000s, the low rate of exploitation since then indicates spawning biomass is likely to have remained above target, with a remote likelihood of falling below threshold levels.	
Final Risk The current risk level is estimated to be LOW. Based on persistently low exploitation rates (catch) relative to the last spawning biomass estimate in the mid-2000s, historically high recent nominal catch rates, and the species' inherent resilience and low vulnerability to fishing pressure.	

Level 1 assessment: catch

Annual catches peaked at around 5,500 to 8,000 t in the 1990s before declining precipitously due to a mass mortality event in 1998/99 caused by a herpesvirus (Figure 1). By the mid-2000s egg surveys demonstrated a strong recovery of the spawning biomass to about 97,000 tonnes (65,000 – 129,000) (Gaughan *et al.* 2008). Since then catches have remained relatively low at about 1,000 to 2,700 t. This appears to be associated with lower economic returns as industry competed with very large increases in the South Australian catch over the same period (Ward *et al.* 2020). These recent catches were well below the conservatively set quota of 5,683 t.

Level 2 assessment: effort and catch rate

Annual fishing effort peaked at about 6,000 boat days around 1990 then gradually declined through the 1990s when catches were highest (Figure 1). A mass mortality event in 1998/99 caused by a herpesvirus resulted in effort temporarily decreasing to below 1,000 boat days until slightly increasing to 1,000 to 1,500 as the stock recovered in the mid-2000s and then declining below 1,000 boat days in recent years. The

historically low effort since the mid-2000s is associated with reduced economic returns as industry competed with very large increases in the South Australian catch of Australian sardines over the same period (Ward *et al.* 2020). However, nominal catch rates (tonnes per boat day) over this period increased to historically high levels. Much of this increase is attributable to higher fishing efficiency as larger vessels use modern electronics, although occasional constraints in the onshore capacity to accept and process catches during the autumn period of high fish abundance has reduced catch rates.

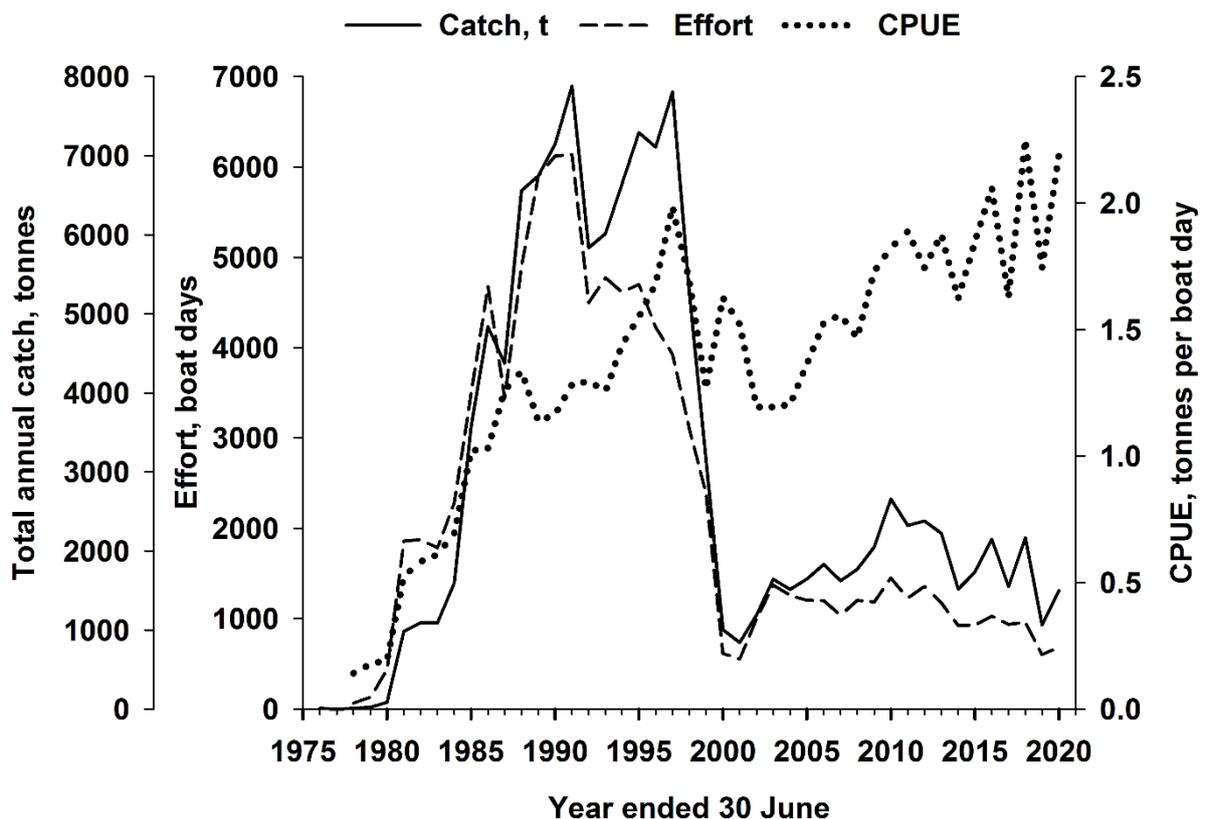


Figure 1. Annual commercial catches, effort, and nominal catch per unit effort (CPUE) for Australian sardines in the South Coast Purse Seine Fishery operating in the South Coast Bioregion of Western Australia.

Level 3 assessment: biology and vulnerability

Biology: Australian sardines are naturally distributed along the continental shelf of the southern half of the Australian mainland (Gomon *et al.* 2008). Otolith chemistry and life history characteristics show that, for management and assessment purposes, WA stocks are effectively isolated from South Australian stocks and within WA there is separation of stocks between the West and South Coast Bioregions (Edmonds and Fletcher 1997, Gaughan *et al.* 2001, Izzo *et al.* 2017). Australian sardines feed by filtering plankton, making them low trophic level consumers. In WA they are short lived, up to 9 years (Fletcher and Blight 1996), with a high rate of natural mortality ($M= 0.66$

for SCB stock, Hall (2000)), attaining sexually maturity in their second year (Fletcher 1995). Thus their biology makes them comparatively resistant to fishing pressure.

Vulnerability: Although Australian sardines occur naturally in continental shelf waters, almost all of the SCB catch is taken by purse seine fishers operating in a small number of marine coastal embayments. Thus only when fish enter those embayments do they become vulnerable to fishers.

Level 4 assessment: spawning biomass

Fishery independent egg surveys showed a major collapse in spawning biomass in 1999 immediately following a mass mortality event caused by a herpesvirus (Gaughan *et al.* 2004). Ongoing surveys demonstrated a strong recovery by the mid-2000s (Gaughan *et al.* 2008). No further surveys have been conducted but annual catches on both the south and west coasts have never exceeded 5% of the mid-2000s post recovery spawning biomass estimates.

Final risk assessment

A formal harvest strategy has yet to be developed, but reference levels for this risk assessment are spawning biomass relative to unfished biomass: target 40%, threshold 30% and limit 20%.

Consequence (Stock Depletion) Level	Likelihood				Risk
	L1 Remote (<5%)	L2 Unlikely (5-20%)	L3 Possible (20-50%)	L4 Likely (>50%)	
C1 Minor (above Target)				Low	4
C2 Moderate (below Target, above Threshold)		Low			4
C3 High (below Threshold, above Limit)	Low				3
C4 Major (below Limit)					-

Consequence 1 - Minor Depletion

Continued low exploitation rates (catch) relative to the last spawning biomass estimate in the mid-2000s, coupled with the species' inherent resilience to fishing pressure which occurs in limited areas of the stocks distribution, suggest that **Minor** depletion is **Likely**.

Consequence 2 - Moderate Depletion

Although spawning biomass estimates from egg surveys are dated, the lower catches in recent years for a species comparatively resilient to fishing, from a limited area of the stock, suggest the prospect of a **Moderate** stock depletion is **Unlikely**.

Consequence 3 - High Depletion.

A low exploitation rate since the mid-2000s when a strong recovery had been demonstrated by fishery independent (egg) surveys, together with the species' fishery resilient biology and low inherent spatial vulnerability, suggest that the likelihood of a **High** depletion of the stock is **Remote**.

Consequence 4 - Major Depletion.

Not plausible

Overall risk

The risk level for the SCB Australian sardine stock for the next five years is estimated to be **Low**. The stock is likely maintained above target level, an acceptable level of risk under current management arrangements and ongoing level of stock status monitoring.

Appendix F: South Coast Purse Seine Managed Fishery – Commercial Fishing Industry Code of Practice for Responsible Fishing.

South Coast Purse Seine Managed Fishery

Commercial Fishing Industry Code of Practice for Responsible Fishing



This Code of Practise for Responsible Fishing (Code) sets out voluntary guidelines and standards of behaviour for responsible fishing practises within Zone 1 of the South Coast Purse Seine Managed Fishery (SCPSF) with a view to ensuring the effective conservation, management, and development of resources, with due respect for the ecosystem and biodiversity.

This version of the Code was updated by the Western Australian Fishing Industry Council (WAFIC) and operators from the SCPSF in 2021. It is based on previous versions of a Code of Practise and the Manual for Setting Protocol, Wildlife Interaction and Species Identification.

These two documents were originally developed in 2005 by Ocean Watch Australia Ltd and the SeaNet environmental extension service in conjunction with fishers and WAFIC. The SeaNet program finished in 2013 and WAFIC, along with licence holders in the SCPSF now manage this Code of Practice.

Fishers of the SCPSF provided feedback from industry to ensure that the Code is relevant to the SCPSF, and the Code is a “living document” that will be regularly updated to reflect best practice as mitigation measures, fishing practices and regulatory standards evolve.

This Code is directed toward SCPSF fishers and all persons having an interest in the conservation and management of its fishery resources, or the development of such resources, and those engaged in the capture, trade, processing and marketing of fish, fishing operations, fisheries research, and integration into fisheries management for the SCPSF.

This document is endorsed, supported, reviewed, and maintained by the commercial fishing industry.

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Western Pacific Regional Fishery Management Council provided photos and artwork.

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South Coast Purse Seine Managed Fishery Industry Code of Practice for Responsible Fishing Setting Protocol, Wildlife Interaction and Species Identification

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1. Introduction

The South Coast Purse Seine Managed Fishery (SCPSF) is based on the capture of pilchards (*Sardinops sagax*) by purse seine gears in the waters between Cape Leeuwin and the Western Australia/South Australia border. The *South Coast Purse Seine Limited Entry Fishery Notice 1994* also covers the take of yellowtail scad (*Trachurus novaezelandiae*), Australian anchovy (*Engraulis australis*), scaly mackerel (*Sardinella lemuru*), sandy sprat (*Hyperlophus vittatus*) blue sprat (*Spratelloides robustus*) and maray (*Etrumeus jacksoniensis*).

Major objectives of this Code are to:

- Codify a strategy for responsible fishing and fisheries activities, taking into account all their relevant biological, technological, social, economic, environmental, and commercial aspects.
- Encourage collaboration between all fishers and other persons having an interest in the utilisation, conservation, and management of resources in the fishery to pursue the introduction and implementation of the objectives and strategy set out in the Code.
- To assist (where practical) in the collection of data on fishing grounds, fishing practices, catch, bycatch and endangered, threatened, and protected species.

This document is designed to be kept in the wheelhouse of each vessel in the fishery and included in the initial and periodic orientation of Masters and crew.

Fishers will annually review the effectiveness of the Code and update as required.

The Code review will be part of the standard agenda of the Bycatch Mitigation Working Group or as required, via another agreed process on a needs basis.

2. Industry Profile

Fishers will develop and maintain a good public profile at all times. They will assist in the promotion of public awareness and understanding of the industry's involvement in responsible fishing and the sustainable management of the fishery.

3. Fishing Practises

Selectivity of fishing gear and fishing practices shall be further developed and applied, where appropriate, to foster conservation of fish and non-fish species within an ecosystem-based fisheries management context.

Fishers shall, to the greatest extent possible (ALARP – as low as reasonably practicable), minimise the impacts on wasted catch of target and non-target species, the incidental catch of non-utilised species and other living resources.

Fishers shall ensure that documentation relating to fishing operations (discarded and retained catch of commercial and non-commercial species) is in line with the reporting requirements set out by DPIRD in the Catch Disposal Record (CDR) and Catch and Effort returns (CAES).

Fishers should assist with compliance of applicable measures to promote an adoption of best practices and focus on sustainable harvest in the aquatic environment for the SCPSF.

Fishers will cooperate to develop and apply technologies, materials, and operational methods to ensure that fishing is conducted:

- With due regard to the safety of fishers.
- Within the International Maritime Organisation's International Regulations for Preventing Collisions at Sea, as well as its provisions for the organisation of marine traffic.
- In a manner which minimises impact on the marine environment.
- In a way to minimise the damage to or loss of fishing gear. All attempts should be made to recover any lost gear.

Where possible, fishers shall also endeavour to:

- Promote the adoption of appropriate technology to maximise the value of the retained catch, i.e. be open and receptive to new technology.
- Adopt gear and practises which are selective, reduce discards, increase the survival rates of escaping fish and non-fish species, and minimise impact on marine habitat.
- Minimise interactions with threatened, endangered, and protected species as described under the Environment Protection and Biodiversity Conservation Act 1999 or other legislation.

4. Duty of Care

4.1 Vessel Owners and Operators

Vessel owners and operators have a duty of care to provide individual fishers with a safe workplace and to adhere to all laws and standards to prevent unsafe practises. This includes the provision of all relevant on-board maritime safety equipment, safe handling facilities for chemicals and oils and appropriate lifting equipment. It is also important that the relevant certificates of operation and vessel surveys are kept up to date.

4.2 Individual Fishers

All vessel crew have a duty of care to work in a safe manner and to always adhere to the work standards and levels of safety stipulated by the vessel owners and managers. This includes not presenting for work whilst unwell or under the influence of alcohol or non-prescriptive drugs.

4.3 Occupational Health and Safety

Occupational health and safety standards are the responsibility of the State in whose waters a vessel is operating. The SCPSF fishes exclusively in Western Australian waters. Occupational health and safety information can be obtained from WorkSafe (see Contacts section). Along with the current Code, all vessels are required to have an on-board Occupational Health and Safety Procedural manual or Safety Management System (SMS). New crew members should be familiar with these manuals, undertake a thorough workplace/vessel safety induction, have the appropriate training and certification and complete Code of Practice and Induction checklists. Visitors to the vessel including research observers should also complete a safety induction.

4.4 First Aid

An extensive emergency first aid kit must be on-board and stocked with all items required by the survey for that vessel's operations as required under the Uniform Shipping Laws (USL) Code / National Standard for Commercial Vessels. The location of first aid equipment should be known to all persons on board the vessel.

5. Food Safety and Quality

As fishers are providing food products for human consumption, the harvesting, handling, and processing of fish products should be carried out in a manner which maintains the nutritional value, quality and food safety of the products.

Contamination can be minimised through good vessel design and construction, hygienic working environment and appropriate handling practises.

5.1 Hygiene

A high level of hygiene must be maintained in all areas used in the handling, processing, and storage of catch. Aspects to monitor include deck maintenance, process and storage equipment and personal hygiene.

Operators should:

- Clean all surfaces and utensils such as deck, brine tanks, fish holding rooms, utensils and other fish-handling equipment using detergent and a sanitiser in the cleaning process.
- Keep refrigeration equipment and ice machines clean and working efficiently.
- Ensure the remainder of the vessel including toilets, shower and wash basins are kept clean.
- Under no circumstances smoke, eat or drink while handling or processing food quality fish.
- Wash hands and gloves before handling seafood.

5.2 Fish Quality

Efficient practises when landing fish will enhance product quality, product value and safety.

Fishers should:

- Ensure that the deck is cool, wet and clean before landing fish.
- Cool fish to reach chill temperature as soon as possible after landing.
- Ensure ice slurries and holding room temperatures are monitored and maintained at an appropriate temperature.
- Ensure all ice is made from potable (drinkable) water or clean seawater.
- Unload the catch quickly to maintain the quality.

- Only commence unloading of the vessel once all the necessary equipment, the catch and personnel are “ready to go”.

6. Other Users of the Marine Environment

Fishers share the marine environment with a variety of other users. SCPSF promotes good communication between fishers and other users of the marine environment so they can operate in an understanding, safe and cooperative manner.

6.1 Communication

Communication is the key factor in cooperative relations between fishers and other users of the marine environment. Fishers should take all steps to avoid interactions with other commercial and recreational vessels using clear communication.

- All fishers will keep open VHF Channel 16 and 72 when fishing within the vicinity of other vessels.
- Fishers should provide their mobile and satellite phone details to other SCPSF fishers to facilitate good communication.

Most recreational fishing activity is restricted to the inshore coastal environment. Be aware if you are working near recreational fishers and avoid any negative interactions.

Illegal Fishing

All suspected illegal commercial, recreational, or foreign fishing activities should be reported to AFMA or FishWatch. Contact details for these organisations are shown in the ‘Contacts’ section.

7. Marine Pollution

Fishers will take all necessary steps to ensure that marine pollution is minimised.

7.1 MARPOL and Garbage Disposal

Pollution of the marine environment by vessels of all types, including fishing vessels, is controlled by the International Convention for the Prevention of Pollution from ships (known as MARPOL).

The key elements of MARPOL that apply to vessels in the SCPSF are:

- A total ban on the disposal of plastics at sea.
- A ban on any disposal of garbage within 12 nautical miles of land or 500 metres of a floating platform.

As well as abiding by these regulations, SCPSF operators will:

- Display in vessels MARPOL placards which provide information about garbage laws.
- Minimise the taking aboard of potential garbage such as excess packaging.
- Store all rubbish retained in suitable secure containers for return to port.

- Not dispose of rags, glass, metal, bottles, crockery and similar refuse at sea.
- Not dispose of material that will float, regardless of the distance from land.
- As far as practical, collect and stow all plastic and floating garbage disposed by others and found at sea for disposal on land.
- Cut all plastic waste which forms a continuous loop to minimise impact should these be accidentally lost at sea.
- Use product specific water disposal facilities (oil, sewerage) in ports where these are provided.
- Make all attempts to recover any gear lost.

7.2 Marine Contaminants

Fishers will not discharge any oil or chemicals into the sea. The discharge of oily mixtures (including fuel) into the sea is prohibited. Waste oil and oily residues must be stored on board for disposal at port waste disposal facilities including bilge water with any concentration of oil.

7.3 Oil Spills

To reduce the likelihood of an oil spill:

- All leakage of fuel oil, lubricating oil and cooling water should be dealt with immediately when detected. If repairs cannot be carried out by the crew at sea, they should be done as soon as the vessel reaches port.
- Oil should be retained and disposed of onshore by appropriate means and containers.
- Where possible fishers will use biodegradable products in the engine and for cleaning both above and below deck.
- Cleaning of the vessel and equipment should be undertaken prior to arrival in port to avoid polluting coastal waters and harbours.
- Fishers should take care to ensure refuelling is done in a safe manner and that fuel is not spilt on the deck or into the water.

Operators should ensure that:

- Clean up equipment is in place prior to commencement of refuelling to be able to respond quickly in the event of a spill.
- Buckets are placed under breathers to contain spills in the event of a blockage or overflow.
- The fuel hose nozzle is wrapped in a rag to contain spillage or drips.
- The hose is constantly monitored and manned while refuelling.

Vessel maintenance and cleaning:

Several vessel maintenance and cleaning procedures can generate marine contaminants. These can be minimised by ensuring that;

- All slipway and/or dry dock tasks are performed at an appropriate site such as a shipyard.
- Activities which have the potential to create marine pollutants such as grit blasting, paint stripping, painting, anti-fouling etc are conducted by suitably qualified personnel.

- Materials such as rubbish, sandings, paint chips and paint cans are cleaned up immediately after use and placed in the appropriate bins for disposal.

7.4 Reporting Environmental Damage

Fishers must report any oil or chemical spills and any other incidences of environmental damage. If the spill is not reported, the offending vessel can be prosecuted for not reporting, as well as polluting. Vessels may avoid prosecution where an accident occurred, but everything has been done to minimise the pollution.

Vessels should report any other vessels seen polluting, or any pollution at sea (including freight and fishing gear). Any pollution event, which occurs beyond three nautical miles, should be reported to AMSA or DoT ASAP (see contacts page). If the incident is within a port or harbour, reports are to be made to the relevant port authority.

8. Fisheries Research

8.1 Monitoring and Assessment

Responsible fishing requires the availability of sound scientific information to inform sustainable fisheries management. Such scientific advice is reliant on good quality data pertaining to all aspects of fishing operations, including, but not limited to, catch and effort statistics, biology, ecology, technology, and bycatch. It is important that such data is reliable and accurate as it is required to monitor and assess the status of fisheries and ecosystems. Where appropriate, these assessments should be made available at a suitable level of aggregation and respecting confidentiality, to relevant stakeholder groups and organisations, to ensure the best scientific evidence is contributing toward fisheries conservation, management, and development.

8.2 Logbooks

Currently fishers operating within the SCPSF must complete a CDR for each trip catch is retained in addition to monthly CAES returns. Mandatory catch and effort reporting is one of the most important sources of information used in fisheries assessments. The precision of such assessments is reliant on the diligence of fishers to record catch and effort information in these logbooks. To ensure fish resources in this bioregion are maintained into the future, fishers should provide accurate, timely and reliable information pertaining to fishing operations and complete all appropriate fields in CDR and CAES returns. In particular, care should be taken to ensure that if any interactions with listed species occur that are not captured in the CDRs (as no catch was landed), they should be reported in the monthly CAES return. The SCPSF eagerly anticipates a single reporting procedure.

8.3 Biological Samples

Many fisheries research studies and assessments require information on, but is not limited to, the age, growth, reproduction, and stock structure of key fish species. This information is obtained from collecting material and measurements from dissections of these fish species. Additional information relating to fish capture (for example date, location, depth etc) is also generally required. In most circumstances this information can be acquired from accessing

catches at fish markets, but the cooperation of fishers may be required to provide the additional information relating to the catch.

8.4 Carriage of Observers

Many research projects have an at-sea component and although the carrying of scientific observers should be considered voluntary, it provides an important opportunity to establish and/or maintain collaborations and custodianship of the fishery resources for operators. Fishers agree to cooperate with relevant research projects where appropriate and will carry observers by prior arrangement where applicable.

Before carrying observers, fishers should ensure that:

- Appropriate documentation ensuring agreements on confidentiality and non-disclosure are established between the observer, research institution and fishing operators are in place.
- Workers' compensation, public liability and other relevant insurance responsibilities are understood and formalised.
- Vessel survey provisions are not exceeded.
- Observers complete the Workplace Induction Checklist.

Observers must not:

- Be assigned duties other than those that relate directly to their research.
- Receive any payment from the fishing company which hosts them.
- Participate in any watch keeping duties unless approved to do so by the owner/Master of the vessel.

Observers should:

- Where possible, be given access to a level of accommodation and meals equal to that of a crew.
- Reasonable access to email and other available communication methods.
- Contribute to stores bills commensurate with the duration of their voyage.

9. Bycatch

Purse seining carries the risk of sea birds, dolphins, seals, sea lions and possibly whales being entangled in nets and being injured or dying. Fishers should, where possible and safe to do so, take the following measures to reduce the chance of an entanglement occurring:

Net Setting Protocol

Fishers should:

1. Assess school size PRIOR to shooting. Fishers should consider their own capabilities, as well as the capability of the processor to handle all the catch

2. In the event excess catch needs to be released, it should be done in a way that ensures fish are not harmed. For example, the end of square end nets should be released rather than “rolling” fish over the float line.
3. Where possible, maintain a tender ready to respond quickly in the event an entanglement does occur.
4. Maintain the shape of the float line by backing up the vessel and bunching the float line.
5. Haul nets so that folds do not develop underwater.
6. If accidental encirclement of a dolphin, seal or sea lion does occur, sink a small section of the outer edge of the net and herd the animals towards this exit point for release. Or release end of net and rings so animal can swim away freely.

9.1 Reducing Seabird Entanglements and Recording Interactions

Since 2006/07, the SCPSF listed species bycatch mitigation program has undertaken a range of measures to monitor and mitigate interactions and bycatch of flesh-footed shearwater *Ardenna carneipes*.

An “interaction” is when a crew member needs to physically remove a shearwater from the net. This includes entrapment, entanglement, freed with help, death, injured and unharmed (as detailed in the vessel CDR).

The bycatch mitigation measures are reviewed annually and updated as required as potential improvements are identified. The mitigation measures outlined below should be followed in conjunction with the licence holder specific arrangements which have been tailored to individual fishing boats.

Mitigation measures – year round

Please take note of the following mitigation measures employed throughout the year to reduce the risk of these birds becoming entangled in purse seine gear:

1. Nets: Only nets with appropriate specifications should be used, i.e. suitable depth and low hanging ratio (less than 30%).
2. Weighted lines: Weighted lines should be used, where appropriate, to minimise the chance of the net developing a fold. Weighted lines are not appropriate for side hauling boats or smaller nets. The weighted lines keep the nets straight, aided by thruster support, it keeps the line tight (hence not letting birds in and under).
3. Setting and retrieval: Nets should be retrieved as quickly as possible. Care should be taken to ensure nets are kept tight and do not develop folds that can entrap diving birds.
4. Water sprays: Water sprays can be used by deck hands to keep birds at bay by around five metres. Care must be taken at all times not to cause birds harm and only used as a deterrent.
5. Fish waste: fish waste is rare but if it occurs, waste should be strategically managed and disposed of as soon as possible and in a way to prevent birds being attracted to the vessel or net.
6. Attempt to rescue entrapped or entangled animals if safe to do so.

Mitigation measures – special management period

Additional measures adhered to during the special mitigation period from 1 March – 30 April every year include:

1. Dawn closures: During the mitigation period, there will be dawn closures when no setting of net is permitted. This ensures shearwaters have obtained their initial feed at sunrise and will then be far less boisterous and aggressive and therefore a reduced chance of engaging with nets whilst seeking feed when fishers are active later in the morning.
 - 1– 31 March from 5:00am – 9:00am
 - 1 - 30 April from 5:30am – 9:00am

* note additional closures apply below
2. Weekend closures: There is to be no setting of nets from 0530am Saturday until 1300hrs Sunday during the SMP.
3. Public holidays: There is to be no setting of nets during the 24hr period covering any public holiday during the SMP.
4. Voluntary no fishing days: Fishers should consult each other prior to fishing on those days where the level of risk of shearwater interaction may be higher, for example during periods of strong south-westerly winds when birds are more active.
5. Fishers should contact DPIRD to let them know the days they do not fish so this information can be included in the report and on CDRs.
6. Tow-off procedure: Three (3) crew members to be on-board to operate during daylight hours to implement the tow-off procedure, or two (2) crew members if vessels have a thruster.
7. An additional 2 weighted line trials are being tested for the 2019 season to help minimise seabird by-catch.

Reporting interactions and mortalities – year round

These mitigation measures have substantially reduced interactions between shearwaters and the SCPSF. However, if interactions do occur:

1. All mortalities and interactions must be accurately recorded in the CDR and monthly CAES returns.
2. Fishers are to make every effort to retrieve any dead birds. It is standard practice for all vessels to back-track and cross-check the ocean after each shot.
3. Fishers are also to retrieve any other dead shearwaters not caused by their vessel interactions so these mortalities can be recorded for research purposes. These mortalities are to be recorded separately.
4. Details of the mortality (including date, location, and vessel) are to be recorded on a waterproof tag and retained along with the bird to be given to DBCA for necropsy/research purposes.

5. A CDR is to be filled out every time the net is shot during the SMP, even when no catch is retained.

9.2 Handling Trapped Seabirds

Every effort should be made to release seabirds alive. It is recommended that the following releasing guidelines, be performed by two persons, where possible. Safety is a priority, so crew should wear protective equipment, such as thick gloves and eye protection.

Handling and releasing entangled seabirds:

1. Gently and carefully attempt to bring the bird on board without causing further injury. Remain calm, speak quietly and refrain from sudden movements.
2. All attempts at releasing birds must be carried out in an area free of oil based contaminants. Oil will severely affect the birds' chances of survival.
3. Never pull an entangled bird through the mesh; always pull it back through the direction it entered the net.
4. Restrain the bird by holding the bill, as shown in Figure 1. Be careful not to cover the external nostrils (if present – see Figure 1). For birds which do not have external nostrils, such as gannets, allow the bill to stay slightly open.
5. Do not hold birds around the neck. This restricts breathing and can cause muscle damage.
6. Remove any other derelict fishing gear, such as monofilament and hooks, before the bird is released.
7. Consider bringing the injured bird back to port for specialist treatment.

Things to consider before bringing injured birds back to port for treatment:

- **When is the vessel returning to port?** It may not be practical to keep an injured animal on board for an extended period of time.
- **Is there a safe place for the bird?** Seabirds should be placed in a quiet, warm, dark, and confined space, completely free of oil and away from moving parts and human activity.

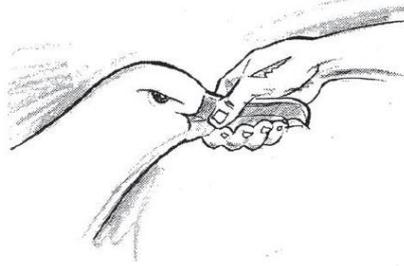


Figure 1

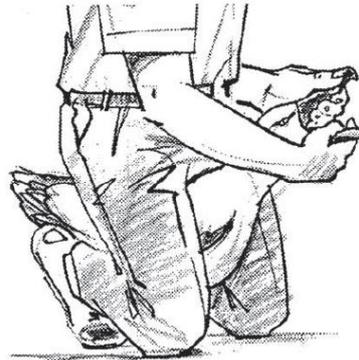


Figure 2

Artwork courtesy of OceanWatch Australia Ltd

9.3 Releasing Seabirds After Treatment

Assessing bird condition before release:

Seabirds will display characteristics that allow you to assess the bird's health condition and readiness to be released. The bird in figure 3 is not ready for release. The bird in figure 4 is ready for release.

Photos courtesy of The Western Pacific Regional Fishery Management Council



Fig 3. Seabird NOT ready for release

This bird is unable to stand upright and maintain a straight neck and legs.

Note that its bill remains slightly open.



Fig 4. Seabird ready for release

This bird is able to stand in an upright position, and maintain a straight neck and legs.

Releasing a bird:

When the bird has been removed from all entangling debris, it can be released by:

1. Where possible, gently lower the bird to the water and allow it to drift away from the boat.
2. Some birds may need additional resting time. These birds should be placed in a quiet spot on the deck to recuperate.

3. Consider releasing a waterlogged bird close to shore.
4. Never throw a bird in the air.

9.4 Reporting Interactions with Banded Birds

Bird banding is one of the main ways that researchers discover fundamental information about birds, such as their lifespan and movements. Better understanding may help long term sustainable management of fisheries. The Australian Bird and Bat Banding Scheme (ABBBS) would like to hear about any interactions between fishers and birds which are carrying bands.

Fishers should record information from all tagged birds encountered, dead or alive and forward this information to ABBBS or the relevant agency that is marked on the band. The ABBBS will welcome hearing from fishers and will advise where and when the bird was banded.

In particular, researchers need:

The band number.

Where the interaction occurred (Lat and Long).

The date of interaction.

The life status of the bird after the interaction.

Notes about any other marks or other unusual observations on the bird.

If the bird is dead:

Take the band off.

Straighten the band and stick it to some cardboard.

Write the band number onto the cardboard.

Write whether you have contacted the ABBBS about this band (see Contacts section).

Send the band to the ABBBS.

Example of Bird Bands

Shearwater Species Bands



9.5 Marine Mammal Encirclement / Entanglement Reaction Protocol

IMPORTANT

Consider crew safety first!

Safety is of utmost importance and must not be compromised under any circumstances. Stressed seals and dolphins can be aggressive and difficult to handle due to their size and strength. If there is a risk to the crew being injured it is far better to try removing or cutting the tangling material from a safe distance, using a specialised line cutter and with the help of

other individuals. Smaller animals may be brought on board if necessary but must be restrained in a manner that eliminates the risk of injury to crew and the animal itself.

No feeding of wild animals

Fishers should never feed any wild animals, particularly in the hope of creating a distraction for troublesome animals during fishing operations. The feeding of wild animals can create greater problems from an increased presence where these animals associate purse seine vessels with a free feeding opportunity.

Entrapment and / or Entanglement:

1. If entrapment of any animals occurs during net deployment, all available hands must assist to aid in the quick release of the trapped animal.
2. If an entanglement has occurred, it is vital the animal is quickly brought to the surface to allow it to breathe.
3. Avoid unnecessary contact with the animal and if possible keep the animal in the water while removing entanglements.

Encirclement:

Where encirclement has occurred, fishers should either:

1. Release the headpiece approximately 10 to 20 metres with a control rope or release purse rings and herd/encourage the animal/s to exit point.

OR

2. Weight the float line with an 8kg weight (approximately) to pull a section of the float line under water and provide an exit point for the animal/s.

9.6 Handling and Releasing Trapped Seals, Dolphins and Whales

Seals and Dolphins:

Seals and dolphins should be handled with extreme caution. They are capable of inflicting severe wounds. Seals may carry contagious diseases, such as tuberculosis.

Handling Protocol for dolphins and seals:

1. A thick piece of rope can be used to support the head of a dolphin or seal above water.
 - a. For dolphins, place the rope under the body between the top (dorsal) and the side (pectoral) fins.
 - b. For seals and sea lions, place the rope just behind the fore flippers to support the weight of the animal.

2. Smaller seals can be brought aboard to prepare for release. However, once on board they must be calmed and restrained by covering their eyes with a wet towel or hessian sack.
3. If possible, release dolphins **without** bringing them aboard. If you need to bring a dolphin on board and if it is small enough to lift, then the entangling line can be used to maintain the animal in a horizontal position.
4. If the animal to be released is weak and unable to maintain its own buoyancy, effort must be made to provide support for the animal to increase its chances of recovery and prevent drowning. Where possible, seals should be left on deck undisturbed to recover before release.
5. **Under no circumstances should seals all dolphins be hung upside down by their tails, as this may result in significant spinal injury.**
6. All entangling and derelict gear must be removed before the animal is released. Any material left around the animal can result in a slow death.
7. Report and record the capture/entanglement to Wildcare - refer to the Contacts section for details.

Handling protocol for whales:

Entanglement of whales is generally unlikely. However, if a whale entanglement occurs, fishers must not attempt to release the whale as there is a very high degree of risk that could result in serious injury or death to the persons involved. Contact Wildcare immediately to report the entanglement. Standby the animal whilst Wildcare assess response capability.

Contacts

General industry enquiries:

Southern Seafood Producers (WA) Association.	Southern Sector Body	Administration 0437 459 902 Email: admin@sspwa.org.au
WA Fishing Industry Council (WAFIC)	Peak Industry Body	(08) 9432 7777
Department of Primary Industries and Regional Development (DPIRD)	Compliance/general issues	Head office (08) 6551 4444 Research (08) 9203 0111 Albany office (08) 9845 7400
Department of Parks and Wildlife	Information on threatened species	(08) 9219 9000
WorkSafe	OSH problems and questions	Website: www.commerce.wa.gov.au/WorkSafe/ Email: safety@commerce.wa.gov.au Phone: 1300 307 877
AMSA	Marine Safety	Website: https://www.amsa.gov.au/ Phone: 1800 627 484

Medical:

Medical emergency		000
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St John's First Aid	Great southern contact Purchasing first aid kit	(08) 9841 4212 (08) 9334 1479
Regional hospitals	Albany hospital Esperance hospital	(08) 9892 2222 (08) 9079 8000
Anxiety, depression and mental health help	Lifeline RuralLink BeyondBlue Regional Men's Health	13 11 14 1800 552 002 1300 22 4636 (08) 9690 2277 Email: menshealth@4blokes.com.au

Environment and pollution:

DoT oil spill response coordination	Report pollution and oil spills	(08) 9480 9924
Australian Maritime Safety Authority	Report marine pollution and maritime search and rescue	1800 641 792
Albany Port - Duty Pilot	Oil spill response	0488 929 095

Illegal fishing and aquatic pests:

FishWatch	report sightings or evidence of: illegal fishing; aquatic pests and diseases (including fish kills)	1800 815 507
AFMA CRIMFISH hotline	Illegal fishing – Commonwealth	1800 274 634

Animal identification:

Australian Museum	Animal identification	sand@austmus.gov.au
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Bird bands:

Australian Bird and Bat Banding Scheme	Reporting of banded seabirds	<u>Postal address:</u> The Australian Bird and Bat Banding Scheme Department of the Environment, Water, Heritage and the Arts GPO Box 8 CANBERRA ACT 2601 Phone 02 6274 2407 Fax 02 6274 2455 Email: abbbs@environment.gov.au Web: http://www.environment.gov.au/biodiversity/science/abbbs
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Injured animals:

Wildcare Helpline	For entangled, sick, injured or orphaned native wildlife	(08) 9474 9055
WA Seabird rescue	Advice on injured or entangled seabirds	418 683

10. Appendix 1: Species Identification Guide

Species Identification Guide

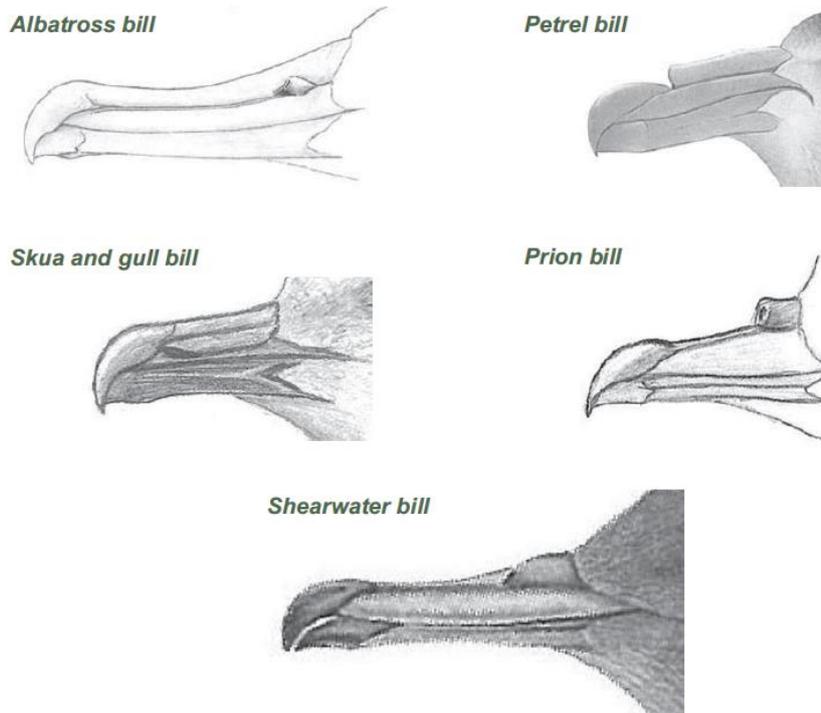
Identifying marine animals at sea is often challenging. Many species only appear for a short period of time or only a small part of them will be visible at any one time. In addition, some species are difficult to tell apart without a series of detailed observations and body measurements. However, there are certain features that will allow identification particularly if recorded along with a sketch or a photograph.

The following guidelines and descriptions of characteristics will help distinguish the different species of marine animals likely to be encountered. This will assist industry to improve identification and reporting of interactions with other wildlife and protected species.

Seabird Bill Profiles

Identifying seabirds can be challenging because many different species have similar characteristics. However, the different bill profiles of seabirds can be used as a guide to distinguish between various species.

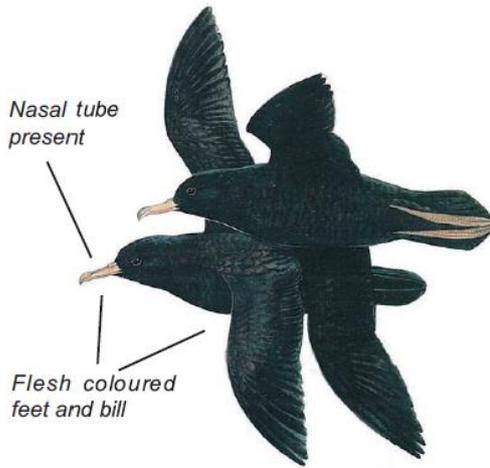
The bill profiles provided below are a general guide only because subtle differences do occur with seabird species belonging to the same scientific family.



Artwork reproduced with permission from *Western Australian Birds*, Johnstone & Storr

Frequently Encountered Bird Species

Flesh-Footed Shearwater (*Ardenna carneipes*)



Length: 40 - 47 cm.
 Wing Span: 1 m.
 Weight: 510 - 740 g

Artwork reproduced with permission from Western Australian Birds, Johnstone & Storr



© Frank O'Connor birdingwa@inet.net.au 2004

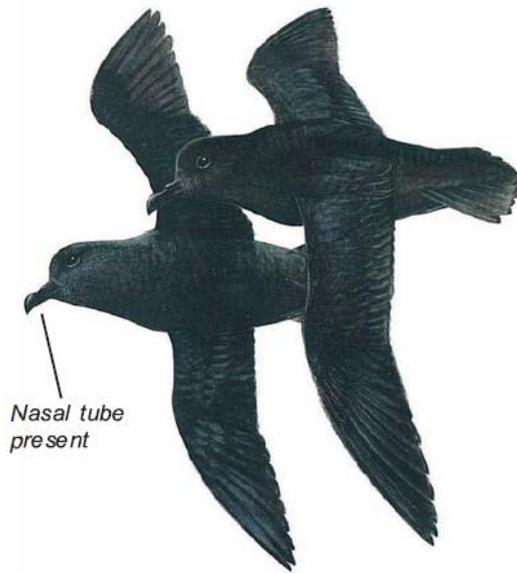
Distribution

Breeding on Islands off south coast from near Cape Leeuwin east to south-west corner of Great Australian Bight; in passage off lower west coast. Breeds on temperate and sub tropical islands in South Indian Ocean. Common breeding visitor early September to late May.

Other Shearwaters visiting south west Australia

Common name	Wedge-tailed Shearwater	Short-tailed Shearwater	Sooty Shearwater
Species name	<i>Ardenna pacifica</i>	<i>Ardenna tenuirostris</i>	<i>Ardenna grisea</i>
			
Range	Mainly West Coast (tropical)	Isolated observations – more common eastern Australia	Isolated observations – more common eastern Australia
Distinguishing features	Dark grey bill Long wedge shaped tail (pointed) Flesh coloured feet (white toenails)	Slender grey bill (<3.5cm) Short round tail Dark grey feet Smokey brown body with pale throat (some white on underwings)	Long slender dark bill Short round tail Dark brown-grey body with white stripe on underwing

Great Winged Petrel (*Pterodroma macroptera*)



Length: 39 - 44 cm.
Wing Span: 1 - 1.1 m.
Weight: 236 - 580 g.

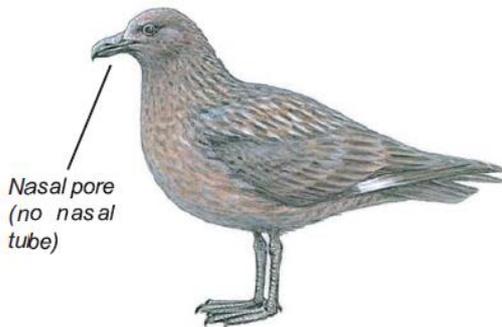


Photo courtesy of Peter Milburn

Distribution

Breeds off south coast on South Indian Ocean temperate and sub Antarctic islands. Common visitor to seas of south Coast - late January to Early December

Great Skua (*Stercorarius skua*)



Length: 60 - 64 cm.
Wing Span: -
Weight: 1.6 - 2 kg.



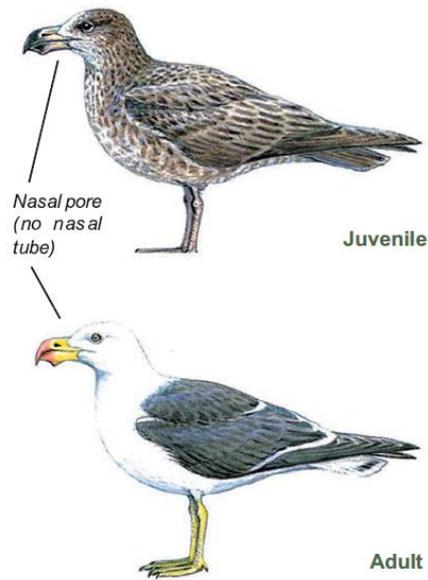
Photo Carl Bevilacqua

Distribution

South and West coasts North to Shark Bay, breeding on Antarctic and sub-Antarctic islands. Visitor from late February to mid December, mainly June to August.

Artwork reproduced with permission from Western Australian Birds, Johnstone & Storr

Pacific Gull (*Larus pacificus*)



Length: 82 - 95 cm.
 Wing Span: 1.7 - 1.85 m.
 Weight: 1.8 - 2.2 kg.

Artwork reproduced with permission from Western Australian Birds, Johnstone & Storr



Photo courtesy of Chris Chalor

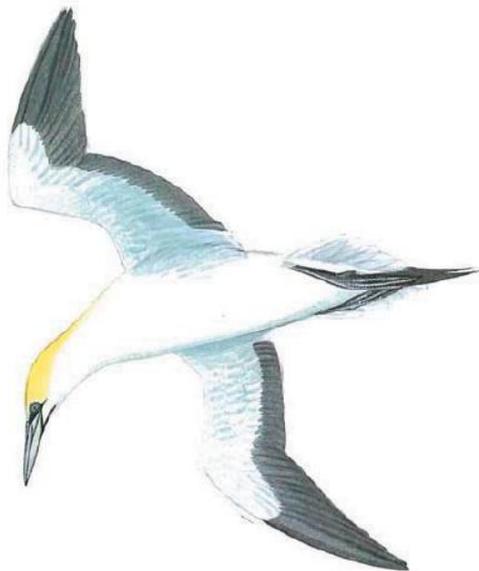


Photo courtesy of Nic Dunlop, Conservation Council WA

Distribution

South Coast west to Cape Leeuwin. Breeding along the South Coast and in the Archipelago of the Recherche, also South East mainland at Twilight cove. Largely sedentary.

Australasian Gannet (*Sula serrator*)



Length: 82 - 95 cm.
 Wing Span: 1.7 - 1.85 m.
 Weight: 1.8 - 2.2 kg.



Photos courtesy of Ashley Bunce, Deakin University

Distribution

Seas of the South and West coasts. Breeding on islands off Victoria, Tasmania and New Zealand and dispersing westward and northward. Visits off the South coast all months, mainly March to December.

Other seabirds possibly encountered during fishing activities

Crested Tern



Photo courtesy of Peter Milburn

Silver Gull



Photo Carl Bevilacqua

Little Penguin



Photo courtesy of Nic Dunlop Conservation Council WA

Marine Mammals

Dolphins:

Fishermen are most likely to encounter either common or bottlenose dolphins, the best way to tell them apart is to look for the distinctive markings of the common dolphins.

Key points to note when identifying dolphins:

1. Approximate length of the animal
2. Colour, and any distinctive markings
3. Presence or absence of a dorsal fin and its position, shape and colour
4. Head shape (type of snout [Beak/Rostrum] if any)
5. Tail fluke shape and markings
6. Characteristics of the 'blow' (e.g. shape, height)
7. Distinctive behaviour such as breaching, spinning
8. If in a pod, the approximate number of animals present
9. Type of habitat (coastal, estuarine, deep ocean)
10. Geographic location

Short-beaked Common Dolphin:

There is one recognised form in Southern Australian waters: the short-beaked common dolphin (*Delphinus delphis*). They prey on schooling fish such as herring and pilchards.

Common Dolphin Field ID

- Fast active swimmer
- Streamlined body
- Up to 2 metres long
- Evident beak
- Single blowhole
- Pointed flippers
- Dark flippers, tail and fin
- Dark cape area of the back around the dorsal fin with hourglass pattern on sides or downward V-shaped dark mark under the dorsal fin
- Black to dark grey back with a variable lighter area behind the dorsal fin and lighter flanks
- Prefers coastal waters

The Short-Beaked Common Dolphin (*Delphinus delphis*)



Artwork Courtesy of Pieter A. Folkens, A Higher Porpoise Design Group © 2004.

Bottlenose Dolphin:

There are two forms of bottlenose dolphins in southern Australian waters: an inshore form (*Tursiops aduncus*), and an offshore form (*Tursiops truncatus*). Fishermen may encounter either but there is no practical way to tell the two apart; animals do tend to get bigger and more robust the further offshore they go.

Bottlenose dolphins are distinctly social species, usually travelling in groups of up to a dozen, though they have been seen in aggregations of several hundred.

Bottlenose Dolphin Field ID:

A bottlenose dolphin is easily recognised by its dark and curved-back dorsal fin. Their grey colour is also different from common dolphins. Other aspects to look for include:

- Fast active swimmer, often bow-rides
- Robust head and body with short beak
- Single blowhole
- Grey to brown-black with lighter flanks
- *T. truncatus* up to 3.8 metres long
- *T. aduncus* up to 2.5 metres long
- Coastal and offshore waters
- Pointed flippers, dark cape (area of the back around the dorsal fin)
- Lighter under-side/belly

Bottlenose Dolphins (*Tursiops aduncus*)



Artwork Courtesy of Pieter A. Folkens, A Higher Porpoise Design Group (c) 2004.



Artwork Courtesy of Pieter A. Folkens, A Higher Porpoise Design Group (c) 2004.

Fur Seals and Sea Lions:

The nose is the key to distinguishing between sea lions and fur seals. Fur seals have a more pointed nose while sea lions have a flatter nose, more like a dog.

Australian Sea Lion Identification:

Males display a blackish brown colour with manes around the shoulders. The head is generally cream coloured. Females are silver-grey in colour for a period after the moult, then slowly fade to brown. Pups are born chocolate-brown with a pale crown. Adult males may reach up to 2.5 metres in length and weigh approximately 400 kg. Females may reach up to 2 metres long and weight approximately 100 kg. New born pups are 75 cm long and weigh approximately 6.5 kg.

Distribution and Breeding:

Australian sea lions can be found on sandy beaches and on smooth rocky areas. They live on offshore Australian islands from Houtman's Abrolhos (28°S, 112°E) in Western Australia to Kangaroo Island (34°S, 138°E) in South Australia.

The Australian sea lion exhibits low fecundity compared with other pinnipeds, due to a prolonged 17 to 18 month breeding cycle. Breeding populations are typically small and breeding colonies are unlikely to receive female immigrants due to breeding site fidelity (i.e. philopatry), suggesting that re-colonisation of extinct breeding colonies is unlikely and many breeding colonies (or clusters of colonies) have become genetically distinct as a result.

These characteristics mean that the unnatural death of even one sea lion (particularly a female) can have a large impact on a colony's survival. The smaller the population, the higher the impact a death is.

Photo Jessica Leask



Australian Sea Lion *Neophoca cinerea*



Artwork Courtesy of Pieter A. Folkens, A Higher Porpoise Design Group (c) 2004.

New Zealand Fur Seal (*Arctocephalus forsteri*):

Male New Zealand fur seals measure between 145 and 250 cm and weigh between 120 and 185 kg. Females are approximately 125 to 150 cm and weigh between 40 and 70 kg. Pups measure between 40 to 45 cm at birth and weigh, on average, 4.3 kg.

There are marked physical differences in the appearance of the sexes of this species:

- Males have thick manes and are much darker in colour than females
- Males have a dark brown to black dorsal side and a lighter underside
- Females are generally brown to dark brown with greyish tones
- Pups are black at birth, turning grey-brown after moult

Distribution:

New Zealand fur seals are usually found on rocky coasts on the southern coast of Australia, from approximately 117°E (Western Australia) to approximately 136°E (South Australia).



New Zealand Fur Seal (*Arctocephalus forsteri*)



Artwork Courtesy of Pieter A. Folkens, A Higher Porpoise Design Group (c) 2004.