5 Assessment of the fish processing activity - direct interactions with protected species

5.1 Introduction

There are 241 species (see Appendix 3) protected under the *Environment Protection and Biodiversity Conservation Act 1999* (Cwlth) (EPBC Act) that occur in the area of the Small Pelagic Fishery (SPF). These are comprised of:

- 10 pinniped species
- 44 cetacean species
- Dugong *Dugong dugon*
- 89 species of seabirds
- six marine turtle species
- nine seasnake species
- 13 shark and ray species
- 69 teleost species, of which 66 are syngnathids.

The data compiled by Tuck *et al*. (2013) have been used as the primary source to inform the panel's understanding of the nature and extent of the direct interactions of mid-water trawling and purse seine in the SPF with protected species to date. As discussed in Chapter 5 of the first declaration report the panel considers that the data contained in Tuck *et al*. (2013) understate the level of 'direct interactions' because the definition excludes some elements of what the panel considers constitute 'direct interactions'. However, in the absence of any more comprehensive assessment of historical interaction data, the panel has used those data as indicative of the nature and extent of direct interactions with protected species by previous fishing activities in the SPF.

The panel's Terms of Reference specified the need to assess the likely nature and extent of direct interactions of the fish processing activity (FPA) with seals, dolphins and seabirds. The panel has considered each of these groups and has identified species of particular interest within each. The panel considered the need to assess direct interactions between the FPA and protected species of dugong, turtles, seasnakes, sharks and teleosts, and formed the view that this was not necessary. The rationale for this decision is provided in Appendix 3.

5.2 Pinnipeds

5.2.1 Species assessed

There are three resident pinnipeds that breed in coastal areas and islands off southern Australia in the area of the SPF. These are the Australian fur seal *Arctocephalus pusillus doriferus*, New Zealand fur seal *A. forsteri* and Australian sea lion *Neophoca cinerea*. In addition to the resident species, there are a further seven pinniped species whose ranges are circumpolar throughout the subantarctic and Antarctic regions of the Southern Ocean. These include the Antarctic fur seal *A. gazella,* the subantarctic fur seal *A. tropicalis*, the southern elephant seal *Mirounga leonina*, leopard seal *Hydrurga leptonyx*, crabeater seal *Lobodon carcinophagus*, Weddell seal *Leptonychotes weddelli* and Ross seal *Ommatophoca rossii*. All of these have been recorded as vagrant within the area of the SPF, but the most commonly sighted vagrant pinnipeds include the subantarctic fur seal, southern elephant seal and the leopard seal. The overlap in purse seine and mid-water trawl effort in the SPF (2000–2013) with the distribution of the three resident pinnipeds, and in relation to pinniped species richness is detailed in Figures 5.1 and 5.2 respectively.

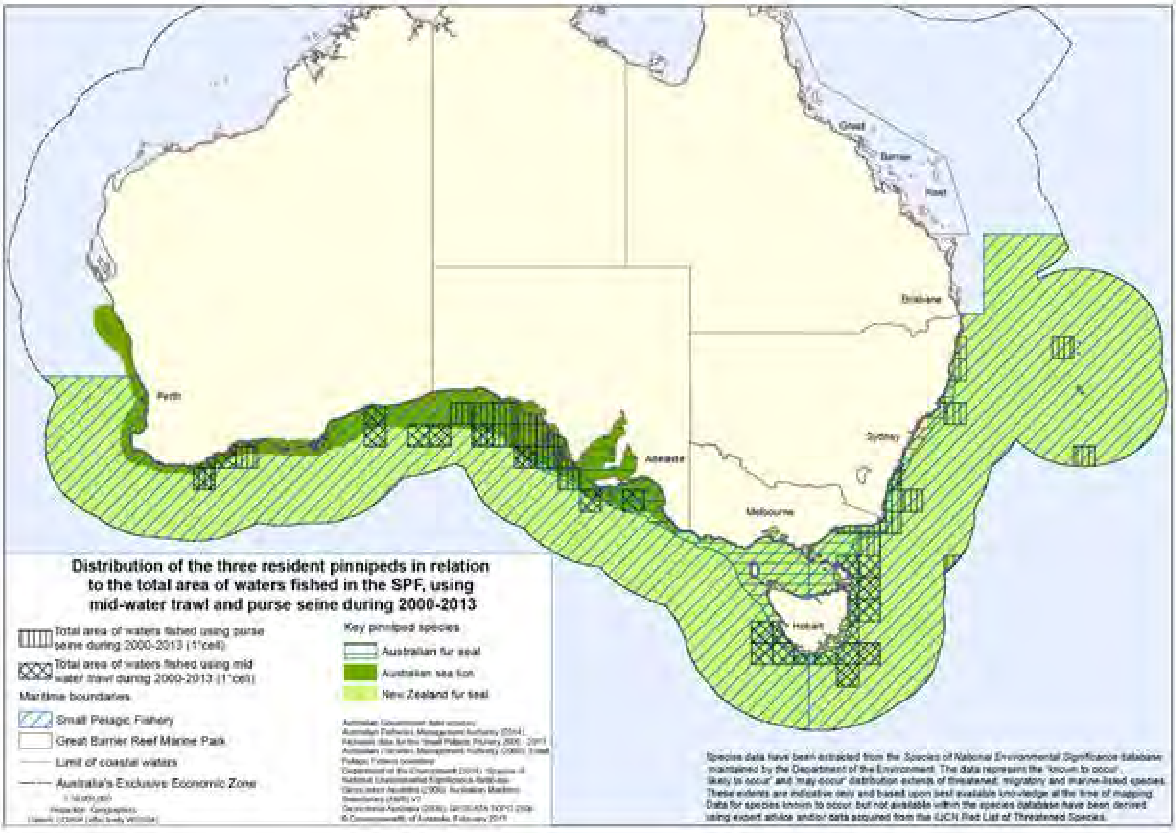

Figure 5.1 Distribution of the three resident pinnipeds in relation to the total area of waters fished in the SPF using purse seine and mid-water trawl during 2000–2013.

Source: Map produced by the Environmental Resources Information Network (ERIN), Department of the Environment, using unpublished Australian Fisheries Management Authority (AFMA) data.

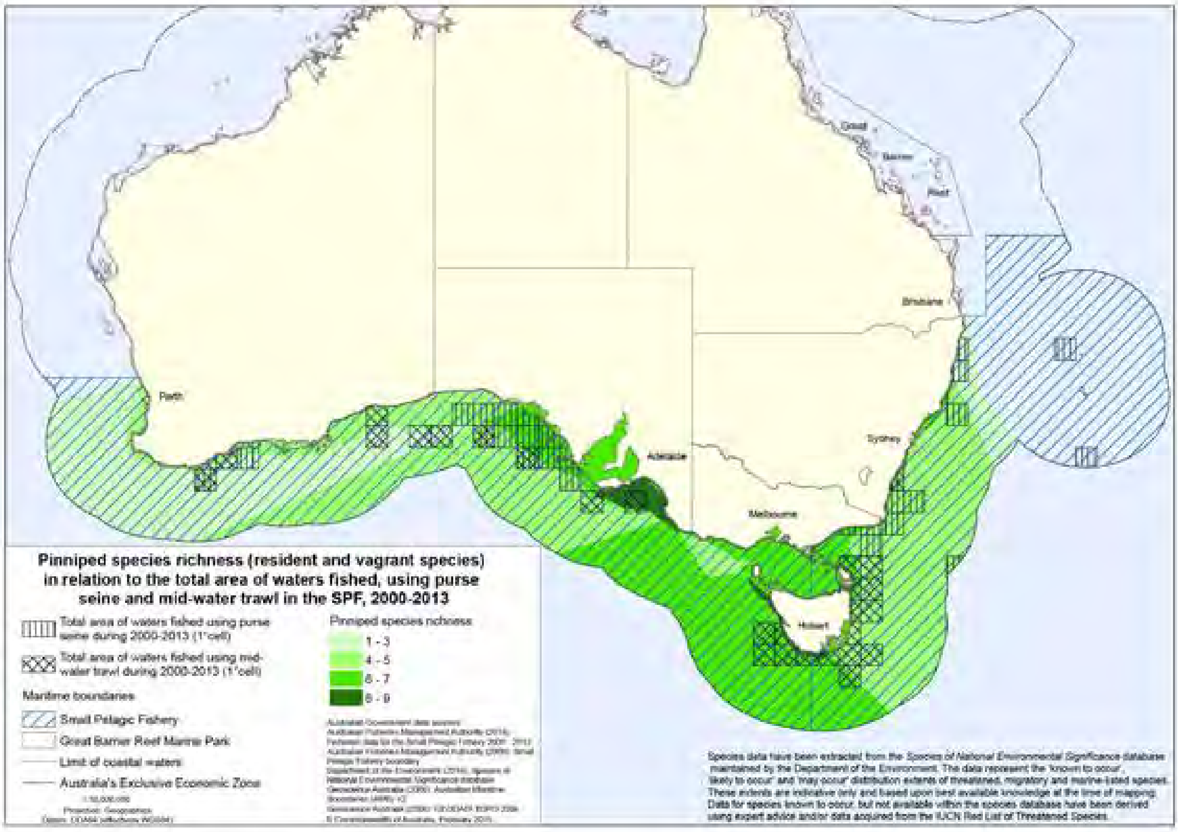

Figure 5.2 Pinniped species richness (resident and vagrant species) in relation to the total area of waters fished in the SPF using purse seine and mid-water trawl during 2000–2013.

Source: Map produced by ERIN, Department of the Environment using unpublished AFMA data.

The Australian Fisheries Management Authority's (AFMA's) ecological risk management reports for the purse seine and mid-water trawl sectors of the SPF (AFMA 2010a, 2010b respectively) identified the six pinniped species in Table 5.1 as either high or medium risk (full details for all pinnipeds are summarised in Appendix 3). The distribution, abundance, status and trends and conservation status of the Australian sea lion, Australian fur seal and New Zealand fur seal were detailed in the first declaration report. This information is provided for the most common vagrant species, the subantarctic fur seal, southern elephant seal and leopard seal. Even though the latter three species are profiled below, the panel notes that interactions between these species and the SPF are likely to be extremely rare. The subsequent assessment therefore focuses on the nature, extent, mitigation and management of interactions between the fish processing activity (FPA) and the Australian sea lion, Australian fur seal and New Zealand fur seal.

Table 5.1 Pinniped species identified at high or medium risk after residual risk assessment

COMMON NAME/S	EPBC ACT LISTING STATUS	RESIDUAL RISK (MID-WATER TRAWL)	RESIDUAL RISK (PURSE SEINE)
Australian sea lion	Vulnerable, Marine	Medium	Medium
Australian fur seal	Marine	High	High
New Zealand fur seal	Marine	Medium	Medium
Subantarctic fur seal	Vulnerable, Marine	Medium	Medium
Southern elephant seal	Vulnerable, Marine	Medium	High
Leopard seal	Marine	Medium	High

Source: AFMA 2010a and 2010b.

Subantarctic fur seal *Arctocephalus tropicalis* (Level 2 Productivity-Susceptibility Analysis (PSA) Residual Risk – Medium)

Distribution and range

Subantarctic fur seals are widely distributed throughout the Southern Ocean and principally breed on subantarctic islands north of the subantarctic front, including: Amsterdam and Saint Paul Islands, Isles Crozet, the Prince Edward Islands, Gough Island, Tristan du Cunha and Macquarie Island (Goldsworthy *et al*. 2009). Macquarie Island represents the only Australian breeding population of the species (Goldsworthy *et al*. 2008, Goldsworthy *et al*. 2009), though three pups have been recorded at Heard Island (Goldsworthy and Shaughnessy 1989, Page *et al*. 2003, Goldsworthy pers. comm. in Woinarski *et al*. 2014). Vagrants are not uncommonly sighted along southern Australia's coasts throughout the SPF area (Tasmania, New South Wales (NSW), Victoria, South Australia (SA) and Western Australia (WA)) and along the Antarctic coastline (Shaughnessy *et al*. 2014). Analyses of 86 records (49 specimens and 37 sightings) of vagrant subantarctic fur seals in South Australia from 1982 to 2012 based primarily on records from the South Australian Museum, indicated that most (83 per cent) were juveniles with the peak sighting period from July to October (77 per cent) (Shaughnessy *et al*. 2014).

Population size and trends

The global population of the subantarctic fur seal was estimated to exceed 400,000 in the early 2000s, with most of the population occurring at three sites: Gough Island (63 per cent), the Prince Edward Islands (25 per cent) and Amsterdam/ Saint Paul Islands (11 per cent) (Scientific Committee for Antarctic Research Expert Group on Seals (SCAR EGS) 2008, Hofmeyr in press). The estimated abundance of these three main subpopulations has increased over the last few decades, and in recent years considered largely stable or decreasing (Hofmeyr in press). At Macquarie Island sealers extirpated fur seals in the early 1800s (Ling 1999). Following the elimination of the endemic population by 19th century sealers, the Macquarie Island population has had a complex recolonisation history, and now consists of three species that hybridise (Antarctic, subantarctic and New Zealand fur seals) although only breeding populations of the Antarctic and subantarctic fur seal have established (Lancaster *et al*. 2006, Goldsworthy *et al*. 2009). Establishment and growth of these small breeding populations has been slow and complex due to their distance from major population centres, differences in the colonisation times of males and females of each species, and extensive hybridisation among all three species (Goldsworthy *et al*. 2008, 2009).

In the 2007–08 breeding season an estimated 43 subantarctic fur seal pups were born at Macquarie Island, but it is likely that many of these will be hybrid (Goldsworthy *et al*. 2008, 2009). Between 1986 and 2007 it is estimated that subantarctic fur seal pup production increased by 8 per cent per year (Goldsworthy *et al*. 2009).

Biology and feeding ecology

Pups are born from November to early January with a peak around 20 December. Males compete for territories prior to the commencement of the breeding season, then fast and defend territories until all females are mated (Goldsworthy 2008). Males hold territories containing up to 20 females who come into oestrus and are mated about a week after giving birth. Females then leave the colony a day or two later to feed, alternating between periods of shore attendance (when they nurse their pup) and foraging trips at sea (Goldsworthy 1999). Foraging trip lengths generally increase throughout lactation and appear to vary in length depending on the availability of food (Goldsworthy 1999). Foraging behaviour and diet vary among breeding sites; at Macquarie Island they feed almost exclusively on myctophids, foraging at night, usually at very shallow depth (10–20 metres (m)), but occasionally dive to about 80 m (Goldsworthy *et al*. 1997, Robinson *et al*. 2002). Dives during twilight hours (dusk and dawn) tend to be deeper than those during darker hours, behaviour consistent with predation on myctophid fish that show marked nocturnal vertical migration (Goldsworthy *et al*. 1997, Robinson *et al*. 2002). Pups are weaned when approximately 300 days old (10 months).

Risks and threatening processes

Most threats to the subantarctic fur seal operate off or adjacent to the breeding colonies (Woinarski *et al*. 2014). At Macquarie Island, pup production, pup growth and diet are correlated with sea surface temperatures (SST) north of the island in a region where fur seals forage (Goldsworthy *et al*. 2008). Cool SSTs in March/April (when the placental phase of pregnancy commences) are correlated with increased natality (percentage of females giving birth) in the following breeding season, whereas cool SSTs during the summer/autumn period are correlated with an increase of one myctophid species *Electrona subaspera* in the diet and increased pup growth rates (Goldsworthy *et al*. 2008). Climate and oceanographic variability may be important in regulating populations of subantarctic fur seals. Pups of the small population at Macquarie Island are subject to predation by New Zealand sea lions *Phocarctos hookeri*, accounting for 50 per cent of all pup deaths to three months, and higher mortality rates (27 per cent) than typical for small low-density populations (3–6 per cent) (Robinson *et al*. 1999, Goldsworthy *et al*. 2008). Subantarctic fur seals have been entangled in fishing gear at Macquarie and Heard Islands, with two deaths from entanglements recorded in WA (Mawson and Coughran 1999, Shaughnessy 1999, Shaughnessy *et al*. 2003).

Prey depletion is a potential threat if fisheries continue to increase, but it is considered unlikely to be an important threat to the Macquarie Island population (Goldsworthy *et al.* 2001, Woinarski *et al.* 2014). Subantarctic fur seals are vulnerable to oil spills and chemical and plastics pollution (Shaughnessy 1999, Evans 2003, Woinarski *et al.* 2014). Disturbance at breeding colonies can cause temporary displacement (Woinarski *et al.* 2014). Hybridisation with Antarctic and New Zealand fur seals at Macquarie Island is likely to be reducing the rate of recovery of the population, reduced fitness of males has been demonstrated and is suspected for females; however, hybridisation levels are declining (Lancaster *et al.* 2006, Lancaster *et al.* 2007, Goldsworthy *et al.* 2008, Goldsworthy *et al.* 2009).

Conservation and listing status

The subantarctic fur seal is listed as Vulnerable based on the low number of individuals breeding in the Australian region, with immigration from extra-limital secure subpopulations, and as a marine species under the EPBC Act. The species was recently assessed as Endangered in Australian waters by Woinarski *et al.* (2014), based on the small population size. This species is listed as Endangered in Tasmania and SA and Vulnerable in Queensland. It is not listed in NSW, Victoria or WA. Globally, the subantarctic fur seal was assessed as Least Concern for the International Union for the Conservation of Nature and Natural Resources (IUCN) Red List in 2012 (Hofmeyr and Kovacs 2008, Hofmeyr in press), and is listed in Appendix II of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES).

Summary: subantarctic fur seal

- *Subantarctic fur seals are widely distributed throughout the Southern Ocean. The main breeding colonies are Amsterdam and Saint Paul Islands, the Prince Edward Islands and Gough Island.*
- *Macquarie Island represents the only Australian breeding population of the species.*
- *Recovery of the Macquarie Island subantarctic fur seal population post-sealing has been slow and complex due to its isolation, sympatry and hybridisation with other fur seal species.*
- *An estimated 43 subantarctic fur seal pups were born at Macquarie Island in the 2007–08 breeding season. The population is estimated to be increasing at 8 per cent per year.*
- *Vagrants are not uncommonly sighted along southern Australia's coasts throughout the SPF area, although interactions with fisheries within the SPF are likely to be rare.*

Leopard seal *Hydrurga leptonyx* (Level 2 PSA Residual Risk – High)

Distribution and range

Leopard seals are principally distributed in pack-ice habitats off Antarctica between 50°S and 80°S. Like southern elephant seals (below), they range throughout the Southern Ocean and northwards to all continents of the Southern Hemisphere (Kirkwood and Goldsworthy 2013). They are the most commonly seen phocid seal on southern Australian shorelines, and are occasionally seen resting on beaches, often in poor condition (Shaughnessy *et al.* 2012). Such sightings are most frequent in late winter and spring (peak in August in SA), with the number of sightings fluctuating between years, peaking periodically, possibly in relation to episodic northward extensions of Antarctic water and seasonal changes in sea-ice distribution (Kirkwood and Goldsworthy 2013, Shaughnessy *et al.* 2012). Individuals may remain ashore for several hours to several days. Some may traverse around the coast for several months, feeding on fish, squid, little penguins *Eudyptula minor* and shearwaters, hauling-out occasionally to rest (Kirkwood and Goldsworthy 2013, Shaughnessy *et al.* 2012). Although the species' breeding range does not overlap with the SPF, their extra-limital distribution and sighting records off southern Australia would suggest they occur regularly throughout the SPF area.

Population size and trends

Leopard seals are considered to be in low density over most of the range, with aerial survey methods being used to estimate abundance. Southwell *et al.* (2008) estimated leopard seal abundance off east Antarctica between longitudes 64°E and 150°E in the 1999–2000 summer. Abundance estimates were 7300 definite to 12,100 definite plus probable leopard seal sightings (95 per cent confidence intervals (CI) of 3700–14,500 and 7100–23,400 individuals). These estimates were considered to be a minimum given their likely negative bias (Southwell *et al.* 2008). The global population abundance has been estimated between 222,000 and 440,000 individuals (Erickson and Hanson 1990).

Biology and feeding ecology

Leopard seals are largely solitary animals, breeding, moulting and resting on pack ice. They breed on the Antarctic pack ice in spring with pups being born between October and December (Siniff and Stone 1985). Females give birth to a single pup which they nurse for about 30 days. Both sexes 'sing' to attract mates and mating events occur in the water soon after the pup is weaned, gestation lasts around nine months (Kirkwood and Goldsworthy 2013, Shaughnessy 1999). Females become sexually mature at around four years, males at around four-and-a half-years (Shaughnessy 1999). Female leopard seals are slightly larger than males (up to 600 kilograms (kg) compared with up to 400 kg) (Kirkwood and Goldsworthy 2013).

Leopard seals are opportunistic, Antarctic top-order predators that feed on a wide range of vertebrate and invertebrate prey including other seals, birds, fish and krill (Green and Williams 1986, Hall-Aspland *et al.* 2004). Krill was the most frequent and numerous prey and also constituted the bulk of the diet; penguins and fish followed in importance by mass (Casaux *et al.* 2009). Stomach and faecal samples from leopard seals hauled-out in SA have mainly contained bird remains including little penguins, cormorant and gull feathers, and some fish (Shaughnessy *et al.* 2012).

Risks and threatening processes

Given proximity of populations to fishing activity, entanglement in marine debris is expected to be uncommon, as is incidental bycatch in fisheries gear (Shaughnessy 1999). If krill fisheries expand prey depletion could become a threat (Siniff and Stone 1985). Changes in climate and oceanographic conditions in the Southern Ocean may influence population trends through altering food webs (Shaughnessy 1999).

Conservation and listing status

The leopard seal is a listed marine species under the EPBC Act (Woinarski *et al.* 2014). Globally, the leopard seal was assessed as Least Concern for the IUCN Red List in 2012 (Southwell and IUCN Species Survival Commission (SSC) Pinniped Specialist Group 2008), and is not listed in any Appendix of CITES.

Summary: leopard seal

- *Leopard seals are widely distributed throughout pack-ice habitats off Antarctica between 50°S and 80°S, and range throughout the Southern Ocean and northwards to all continents of the Southern Hemisphere, including Australia.*
- *They are the most common phocid seals sighted along Australia's southern coast, where they are mostly commonly sighted in late winter and spring.*
- *Although their extra-limital range encompasses the SPF, interactions with fishing activities are likely to be uncommon.*

Southern elephant seal *Mirounga leonina* (Level 2 PSA Residual Risk – High)

Distribution and range

Southern elephant seals breed on sand and shingle beaches on subantarctic islands mostly north of the seasonal pack ice (Kirkwood and Goldsworthy 2013). They range throughout the Southern Ocean and northwards to the coastlines of all Southern Hemisphere continents. Two large breeding subpopulations occur in Australian territory at Heard and Macquarie Islands. Breeding colonies existed on the north-west coast of Tasmania (perhaps eliminated by Aboriginal hunters approximately 2000 years ago), and more recently on King Island, Bass Strait (eliminated by sealers in the early 1800s) (Kirkwood and Goldsworthy 2013). Elephant seals routinely haul-out to moult at sites across their range, including on the coast of Antarctica. This species has been recorded from NSW to Tasmania, SA and WA (Shaughnessy *et al.* 2012, Woinarski *et al.* 2014). Pups are occasionally born along Australia's southern shores, including four records from Tasmania, two from SA, two from Victoria and two from WA (Shaughnessy *et al.* 2012). Its southern Australian range overlaps with the area of the SPF.

Population size and trends

Global southern elephant seal abundance was estimated at 757,000 prior to the 1970s (McCann 1985), declining to 664,000 in 1990 (Laws 1994), and then increasing to 739,000 in 2002 (McMahon *et al.* 2005). Four breeding stocks are recognised: Macquarie Island, Isles Kerguelen (including Heard Island), South Georgia and Peninsula Valdez, Argentina (Campagna 2008, Hindell and Perrin 2009).

At Macquarie Island, the pre-exploitation population has been estimated between 93,000 and 110,000 seals, with an estimated 70 per cent of these killed as a consequence of commercial sealing between 1810 and 1919 (Hindell and Burton 1988). By 1949, the population had fully recovered to 183,000, but declined to 76,000 in 2001 (Hindell and Burton 1988, McMahon *et al.* 2003). The causes of this decline are uncertain but it appears it is associated with juvenile survival and food availability (McMahon *et al.* 2000, McMahon and Burton 2005, McMahon *et al.* 2005). Trend analysis from 1988–1999 estimated an annual decline of 2.1 per cent, changing to a barely positive trend (0.09 per cent) between 1999 and 2004 (van den Hoff *et al.* 2007). The Macquarie Island population has continued to decline at a rate of less than 1 per cent per year (Woinarski *et al.* 2014).

At Heard Island, the population had recovered to between 80,500 and 110,000 seals (of one plus years) by 1949, but by 1985 had declined by about 50 per cent (Burton 1986, Slip and Burton 1999). The population has been relatively stable between 1985 and 1992 (Slip and Burton 1999) but has not been assessed since (Woinarski *et al.* 2014).

Biology and feeding ecology

Southern elephant seals are largely solitary at sea, but aggregate ashore annually to breed in colonies made up of harems which spread along the coast (Campagna 2008, Hindell and Perrin 2009). Southern elephant seals are the largest pinnipeds, with breeding-sized adult males termed 'beachmasters' weighing up to 3800 kg (more than 10 years old, 3.5–4.5 m in length and 2000–3800 kg). They are up to nine times larger than adult females (more than three years, between 2 and 3 m, 250–800 kg) (Hindell and Perrin 2009). Beachmasters gather at breeding beaches prior to the arrival of the adult females, which come ashore to give birth to a single pup between September and November. Harems may exceed 100 females (Hindell and Perrin 2009). Pups weigh about 45 kg at birth, are nursed for around 23 days and wean at about 110 kg. Prior to leaving their pups, adult females are mated by the beachmaster or opportunistic challengers (Kirkwood and Goldsworthy 2013). After weaning, pups remain ashore fasting for a further five weeks. During this time they moult and convert stored fat into lean tissue (Hindell and Perrin 2009). After the breeding season, there is a constant progression of animals coming ashore to moult through spring, summer and autumn: first juveniles, then subadult males, adult females, and lastly adult males, each taking 30–40 days to complete their moult (Kirkwood and Goldsworthy 2013). During this period they avoid entering the water and do not feed.

The diet of southern elephant seals consists mainly of deep-water squid, and myctophid fish which they forage on at depths usually exceeding 200 m (Kirkwood and Goldsworthy 2013). This species undertakes the deepest (2 kilometres (km)) and longest duration dives (more than 2 hours) of any pinniped, however most dives are less than 500 m and last around 25–30 minutes (Kirkwood and Goldsworthy 2013).

Risks and threatening processes

Southern elephant seals are recorded infrequently as incidental bycatch in fishing gear in the Australian region. Mortalities have occurred in trawl nets, longline gear, and aquaculture nets (Burton and van den Hoff 2002, van den Hoff *et al.* 2002, Shaughnessy *et al.* 2003, Kemper *et al.* 2003, Patterson and Skirtun 2014). Depletion of prey species as a consequence of fishing has been identified as a potential threat (Woinarski *et al.* 2014).

Research has indicated that the species is highly sensitive to small (five per cent) changes in survival and fecundity rates, which appear largely responsible for the major declines recorded in the latter stages of the 20th century (McMahon *et al.* 2005b). Such demographic changes can be strongly influenced by changes in climate and oceanographic conditions in the Southern Ocean, which impact population trends through changes to food webs and foraging and breeding success (McMahon *et al.* 2005a, b).

Conservation and listing status

Under the EPBC Act, Australian populations of the southern elephant seal are listed as Vulnerable (Criterion 1: estimated decline of 45–55 per cent within three generations; and Criterion 5: current rate of decline would cause extinction within Australian territories within 100 years). However, the Action Plan for Australian Mammals 2012 recently assessed the species as Near Threatened in Australian waters (approaches A2ab, B2ab(v)) (Woinarski et al. 2014). This species is listed as Endangered in Tasmania and Rare in SA. It is not listed in NSW, Victoria or WA. Globally, the southern elephant seal was assessed as Least Concern for the IUCN Red List in 2012 (Campagna 2008) and is listed in Appendix II of CITES.

Summary: southern elephant seal

- *Southern elephant seals are widely distributed throughout the Southern Ocean, breed on subantarctic islands and are regularly sighted ashore on all continents of the Southern Hemisphere including Australia.*
- *They are recorded infrequently as incidental bycatch in fishing gear, mostly in Southern Ocean fisheries.*
- *Although their extra-limital range encompasses the SPF, interactions with fishing activities are likely to be uncommon.*

5.2.2 Nature and extent of interactions

Marine mammals and commercial fisheries often target the same food resource, leading to 'operational interactions' between animals and fisheries when they come into direct contact with fishing gear. Globally, the bycatch of marine mammals in fisheries is estimated to be in the hundreds of thousands of individuals per year (Read *et al.* 2006) and currently represents the dominant, recognised threat to global pinniped populations (Kovacs *et al.* 2012). Pinnipeds are readily attracted to, and interact with, trawl fisheries. This can lead to significant levels of pinniped bycatch where pinniped populations overlap with trawl fisheries. Where purse seine fisheries overlap with the range of pinnipeds species, interactions can be common.

The nature and extent of interactions of mid-water trawl fisheries with pinnipeds was addressed in the first declaration report (Expert Panel on a Declared Commercial Fishing Activity 2014, Section 5.2.2). Interactions in global and Australian fisheries are each summarised below.

With respect to purse seine fishing methods, seal interactions can be common where purse seine fisheries overlap with the foraging range of seal populations, but it is rare for these interactions to result in injury or mortality because seals can readily move in and out of the net over the float line and are not usually impeded in accessing the surface to breathe. The nature of purse seine fishery interactions would likely involve seals being attracted to fishing activity, entering the pursed net and feeding on encircled fish. Some seals may become trapped in a purse net as it is being pumped, or clamber onto vessels when the net is being hauled requiring them to be released. On rare occasions some seals could become entangled in the purse seine net and drown, or suffer serious injury or death if they become stuck in the fish pump or pass over the power block. The nature and extent of interactions of purse seine fisheries with pinnipeds in global and Australian fisheries is also considered below.

Nature and extent of trawl fishery interactions: global

- Pinnipeds are readily attracted to and interact with trawl fisheries; they will take fish floating free from the net, 'stickers' (meshed fish) protruding through the net mesh, and discarded fish and offal, and enter trawl nets to feed on fish inside the net.
- Globally, otariids (fur seals and sea lions) are highly susceptible to interactions with trawl fisheries. Key examples include:
  - Cape fur seal *Arctocephalus pusillus pusillus* in South African trawl fisheries
  - South American sea lion *Otaria flavescens* in trawl fisheries off south-central Chile and factory/freezer mid-water and demersal trawl fisheries off northern and central Patagonia (Argentina)
  - Antarctic fur seal in Antarctic krill *Euphausia superba* fisheries
  - Steller sea lion *Eumetopias jubatus* and mid-water freezer trawlers in United States of America (US) Alaskan fisheries
  - New Zealand sea lion and New Zealand fur seal and New Zealand mid-water and demersal trawl fisheries.
- Documentation and enumeration of the extent of interactions (including bycatch mortality) varies greatly. In many instances this is limited to short-term studies where interaction rates (usually only bycatch) have been reported and analysed based on independent fishery observer programs. Annual reporting and estimation of bycatch impacts is most consistent in US and New Zealand fisheries.

Nature and extent of trawl fishery interactions: Australia and the SPF

As noted in the first declaration report (Expert Panel on a Declared Commercial Fishing Activity 2014, Section 5.2.2), all of the breeding distribution of the Australian and New Zealand fur seal in Australia, and most of the breeding distribution of Australian sea lion, occurs within the area of, or adjacent to, the SPF. Seals are common marine predators in southern Australia; they are intelligent and curious animals and will be attracted to any fishing activity that occurs within their foraging range. The greater the level and frequency of fishing activity, or predictability in where and when fishing activity will occur within an area where seals forage, the greater the number of seals that are likely to be attracted to, and interact with fishing operations. This is especially the case if such interactions provide some reward. If fishing is persistent over time and fishing activities provide opportunities for seals to gain nutritional benefits, then sections of the population can become habituated to fishery interactions. The first declaration report noted that the likely nature of direct pinniped interactions with mid-water trawl fisheries includes net feeding, entering the trawl net (during shooting, fishing and hauling), and habituation to fishing activities (Expert Panel on a Declared Commercial Fishing Activity 2014). With these interactions, some level of bycatch mortality is inevitable and in areas of high seal abundance and/or high fishing activity, likely to be common, even with best practice management. The following summary of the nature and extent of trawl fishery interactions with pinnipeds in Australia and the SPF is drawn from Section 5.2.2 of the first declaration report.

- Pinniped interactions with fishing gear appear ubiquitous in southern Australia where their populations overlap with trawl fisheries.
- Pinniped interactions occur predominantly with demersal trawl wet boats and factory/freezer trawlers using mid-water trawl gear in the Commonwealth Trawl Sector (CTS) of the Southern and Eastern Scalefish and Shark Fishery (SESSF) and with mid-water trawlers of the SPF.
- The longest time series of data on bycatch interactions (1993–2010) exists for the wet boat CTS where available Integrated Scientific Monitoring Program data indicate persistent and significant ongoing bycatch mortality of fur seals. Extrapolation of these data suggests bycatch mortality in the order of 600 fur seals per year, or approximately 12,000 over the past 20 years (around 1.9 seals per 100 tows).

- Most research into the nature and extent of interactions (and their mitigation) has occurred in the winter factory/freezer mid-water trawl fishery for blue grenadier *Macruronus novaezelandiae* (in the SESSF) off western Tasmania. Results indicate a subpopulation of fur seals habitually interacting with and foraging in association with fishing operations for many months of the year.
- Information on the nature and extent of pinniped bycatch in the SPF mid-water trawl fishery is restricted to observations between 2006 and 2007, when underwater video monitoring of trawls and seal excluder devices (SEDs) occurred. On-board observers significantly under-reported interactions because all seal mortalities were ejected from the SED opening and were undetectable by observers. Based on 151 observed interactions with a SED in place, bycatch mortality was an order of magnitude higher (19.4 seals per 100 tows) than that observed in non-SED CTS wet boat vessels.
- Seals were observed to enter mid-water trawl SPF nets at every stage of trawling. Numerically, most net entries occurred during fishing (62 per cent), which accounted for most (73 per cent) of the trawl duration. As most fishing occurred in less than 150 m of water, the net was available to seals at all stages of trawling.
- In the US and New Zealand, annual reporting of marine mammal interactions includes routine analysis of the data on protected species interactions to provide an estimated take of these species. No such analysis is available for fisheries interacting with pinnipeds in southern Australia.

Nature and extent of purse seine fishery interactions with pinnipeds: global

Documentation of interactions between purse seine fisheries and pinnipeds is generally limited to short-term studies (most in South America and South Africa) where interaction rates have been reported and analysed based on independent fishery observer programs. Examples are given below by region.

South America

Chilean industrial fishery for jack mackerel

Hückstädt and Antezana (2003) reported on interactions between the purse seine fishery for jack mackerel *Trachurus symmetricus* off central Chile and South American sea lions. They recorded interactions during 31 purse seine sets in October 1999. The main interaction was feeding, with purse seining making the fish more accessible to the sea lions and providing an easy and abundant food source that can be gained with little energetic cost. Sea lions were observed to approach fishing vessels as soon as net-setting began. The number of sea lions observed per net set ranged from 0–50 (mean of 21) and there was no relationship between the number of sea lions and school size of jack mackerel, number of fishing vessels on the fishing ground, whether fishing occurred at night or day, the presence of killer whales *Orcinus orca*, or the fish species being targeted by the fishery. Sea lions were estimated to consume 0.39 per cent of the vessel's catch during the study period or 0.45 per cent of the entire fleet's catch. These are similar to values of fish consumption estimated for interactions between Cape fur seal and purse seine fisheries off South Africa (Shaughnessy *et al.* 1981, Wickens *et al.* 1992, Wickens 1994). The presence of sea lions did not appear to cause the fish to disperse or dive, as reported in other purse seine fisheries (Shaughnessy *et al.* 1981).

Sea lions are regularly caught in purse seine nets, with animals becoming trapped when the net contents are pumped aboard (Hückstädt and Antezana 2003). Most are subsequently released alive, but some mortalities occur. During the study of Hückstädt and Antezana (2003), 20 sea lions were caught or injured (0.64 sea lions per set), two were killed (mortality rate of 0.03 sea lions per set) and 18 captured alive. One of the captured animals suffered serious injuries (dislocated lower jaw and fractured left fore-flipper), which would likely have led to its death (Hückstädt and Antezana 2003).

Chub mackerel purse seine fishery, northern Argentina

Pon *et al.* (2012) assessed the extent of seabird and marine mammal attendance in the Chub mackerel *Scomber japonicus* semi-industrial coastal purse seine fishery in northern Argentina. They observed 82 fishing operations (net hauls) between late spring 2007 and early summer 2008. The most prevalent marine mammal species observed was the South American sea lion (2 per cent of overall individuals and 8 per cent of occurrence). No sea lions were observed to be incidentally taken.

South Africa/Namibia

Off South Africa and Namibia, large purse seine fisheries have existed since the late 1940s and target anchovy *Engrualis capensis*, sardine *Sardinops sagax*, round herring *Etrumeus whiteheadi* and Cape horse mackerel *Trachurus capensis* (Shaughnessy *et al.* 1981, David and Wickens 2003). Cape fur seals eat fish being caught during the purse seine fishery operations. Shaughnessy *et al.* (1981) undertook a study of interaction between fur seals and purse seine fisheries in Namibia (mainly targeting anchovy) and recorded up to 500 seals attending nets at a time, with mean numbers ranging from 149 to 209 between throwing, setting, pursing and pumping the net (Figure 5.3). They recorded a range of impacts on fishing operations including chasing fish from the net after being set but before it is pursed and consuming fish. Seals easily moved in and out of the net by depressing the float line and sliding over it, and some fish may be lost from the net this way. Consumption of fish was not considered a major problem. Shaughnessy *et al.* (1981) reported one seal being caught in a fish pump, blocking it and finally dying; several seals were also recorded clambering up the net and climbing on board, two being chased away but a third dived into the hold and could not be removed until the vessel reached port.

Another study investigated interactions between Cape fur seals and the Cape Horse mackerel purse seine fishery in Namibia, principally with respect to overlap in the utilisation of the mackerel by the fur seals and the purse seine fishery. The study found little overlap between seals and the purse seine fishery but did not indicate if interactions and bycatch were an issue for this fishery (Mecenero *et al.* 2007).

Wickens (1994) studied the operational interactions between Cape fur seals and purse seine fisheries off South Africa where a maximum of 90 seals was seen in any one haul, with mostly between one and five seals being seen. As with the fishery in Namibia, the main issue with seal interactions from a fisher perspective was causing the fish to dive resulting in loss or partial loss of catch. Wickens (1994) estimated that detectable loss of target catch due to fur seals occurs on approximately 5 per cent of hauls, with smaller quantities of fish being lost as seals depress the net float line while moving into and out of the net. Wickens (1994) estimated the cost of the lost fish to be between 1.6 and 4.1 per cent of the landed value of the fishery. Most seals caught in a net are released alive (93 per cent) but incidental mortalities occur by drowning or animals being caught in fish pumps. Wickens (1994) estimated that with 14,221 hauls, 89 seals would die per year. She recorded significant deliberate killing of animals that are brought aboard and are clubbed due to the confines of the vessel and potential danger to crew, and estimated that these may account for 825 seals per year. Wickens (1994) noted that additional animals are shot when they are no threat to crew safety, but was unable to quantify this. At the time of the study it was estimated that probably fewer than 1000 seals a year die interacting with the fishery (Wickens 1994, David and Wickens 2003).

Figure 5.3 Cape fur seals interacting with a purse seine fishery off Namibia.

Source: Reproduced with permission from P.D. Shaughnessy.

Other locations

There is limited information on the interactions between pinniped and purse seine fisheries outside of South America and South Africa. Based on fishery-dependent data collected in the Alaska salmon purse seine fishery since 1990, there is a record of two harbour seal mortalities in 1993, but no further details (Allen and Angliss 2014).

Nature and extent of purse seine fishery interactions: Australia and the SPF

Most mid-water trawl and purse seine operations that have occurred in the SPF area have been in the south-east of Australia (principally Tasmania and Bass Strait area) where the most common seals are Australian fur seals. The major centre of the New Zealand fur seal population in Australia is off SA, with approximately 80,000 occurring in a relatively small geographic area between Kangaroo Island and the south-western Eyre Peninsula (Figure 5.4). It is the panel's view that any mid-water trawl or purse seine fishery operating in shelf waters adjacent to these areas is likely to encounter high levels of interactions. Furthermore, the other main population centre of fur seals is in the Recherche Archipelago off the south coast of WA (Figure 5.4). Again, in the panel's view, seal interactions with fishing activities would be common if a trawl or purse seine fishery was to operate in this region.

a)
b)
c)
d)

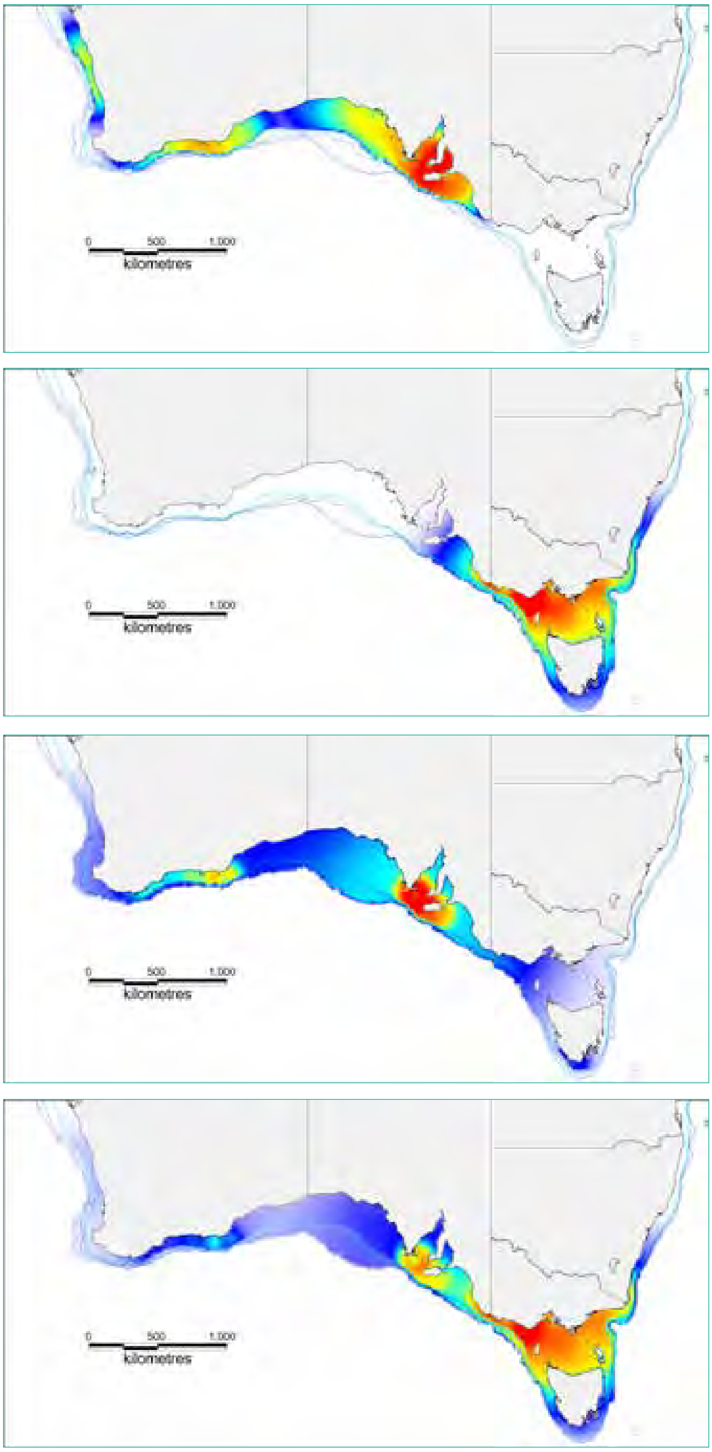

Figure 5.4 Heat plots representing the estimated spatial distribution of consumption effort by Australian sea lion (a), Australian fur seal (b) and New Zealand fur seal (c) populations, and all species combined (d). New Zealand fur seal estimates are only for consumption on shelf waters (oceanic consumption not modelled).

Source: S. Goldsworthy, South Australian Research and Development Institute, unpublished, redrawn from data presented in Goldsworthy *et al.* (2003).

South Australian Sardine Fishery

Australian sea lions have been recorded to be taken in purse seine nets in the South Australian Sardine Fishery (SASF) (D. Farlam *in litt.* April 2001 in Shaughnessy *et al.* 2003). Shaughnessy *et al.* (2003) provide anecdotal reports that the sea lions are attracted to fishing activity and sometimes appear within the perimeter of the purse seine net before fish are encircled, and that firearms have been used to discourage marine mammals, with some being shot in the water, some being killed on deck, while others escape from the net as it is retrieved from the vessel's deck.

Since July 2007, Primary Industries and Regions South Australia (PIRSA) Fisheries has implemented new arrangements requiring licence holders to record and report interactions with threatened, endangered and protected species (TEPS) in all SA commercial fisheries (Tsolos and Boyle 2014). Therefore, interactions with TEPS in the SASF are available for six years; those that pertain to pinnipeds are summarised in Table 5.2. Overall there are 140 records of seal interactions with the fishery, although the species breakdown is ambiguous as 133 (95 per cent) interactions were recorded as 'common seal', four (3 per cent) as Australian sea lions, two (1 per cent) as New Zealand fur seals and one (1 per cent) as an Australian fur seal. It is unclear as to which pinniped the 'common seal' refers to; the most numerous in the area of the fishery would be New Zealand fur seals and Australian sea lions, although it is unclear if the term is universally applied to one species or both. The term 'common seal' should not be confused with the common seal (or harbour seal) *Phoca vitulina*, which is a northern hemisphere species. The panel suspects the 'common seal' referred to by SASF licence holders is principally the New Zealand fur seal.

Most interactions (60 per cent) are classed as 'other' (animals circling the vessel, interacting with fishing gear, discovering dead animals in transit) (Tsolos and Boyle 2014), 39 per cent classed as 'caught' (presumably remaining in the net as it is being pumped), and one per cent 'entangled' (Table 5.2). About 96 per cent of animals are alive after their interaction, 2 per cent are dead and 1 per cent injured (Table 5.2). The overall interaction rate for the six years to 2012–13 is 0.024 seals per shot; the overall mortality rate is 0.001 seals per shot. There was an 11-fold decline in mean interaction rates for the periods 2007–2010 and 2010–2013 from 0.047 to 0.004 seals per shot, respectively (Table 5.2). It's unclear whether this represents a real decline or reflects a change in reporting behaviour among licence holders.

Although seal interactions are common in this fishery, it is rare for these to result in injury or mortality.

Table 5.2 Summary of pinniped interactions in the SASF between 2007–08 and 2012–13

YEAR	EFFORT (SHOTS)	TOTAL INTERACTIONS	INTERACTION RATE	NATURE OF INTERACTION			STATUS			FATE			
				CAUGHT	ENTANGLEMENT	OTHER	ALIVE	ALIVE/INJURED	DEAD	RELEASED	RETAINED	DISCARDED	OTHER
2007–08	876	39	0.045	24	2	13	35	1	3	32	3		4
2008–09	902	75	0.083	11		64	75			21			54
2009–10	1070	14	0.013	14			14			14			
2010–11	1014	1	0.001	1				1		1			
2011–12	1107	5	0.005	4		1	5			4			1
2012–13	857	6	0.007			6	6			6			

Source: Data from Tsolos and Boyle 2014.

Small Pelagic Fishery

Observations on purse seine vessels targeting surface schools of jack mackerel off the east coast of Tasmania in 1986 indicated that fur seals would follow vessels and interact with fishing activities in a manner similar to interactions between Cape fur seals and purse seine fisheries in South Africa (Shaughnessy *et al.* 1981, 2003). Fur seals are reported to cause encircled fish to dive and escape the net before it is pursed, with fur seals readily escaping over the float line (Shaughnessy *et al.* 2003).

No interactions between fur seal and purse seine fisheries have been recorded in observer or Commonwealth logbook databases. However, these reports are based on observer coverage of less than 15 per cent purse seine shots (per annum) since 2001 (Tuck *et al.* 2013). There have been no recorded interactions with TEPS in the purse seine sector of the SPF in the 2011–12 or 2012–13 fishing seasons (Moore *et al.* 2013, Moore and Stephen 2014).

Other Australian purse seine fisheries

The main Australian purse seine fisheries operating in the area of the SPF are the Southern Bluefin Tuna Fishery (SBTF), the Western Australian South Coast Purse Seine Managed Fishery (SCPSMF) and the purse seine sector of the NSW Ocean Haul fishery.

In 2013, AFMA reported that there had been some anecdotal reports of seals interacting with tow pontoons and lightly with the purse seine nets in the SBTF and there had been one logbook report of an interaction with a seal (species unidentified) being entangled in a boat propeller. The seal was reported as being alive. Up to 2013 there were no observed fatalities or injuries associated with fishing operations (AFMA 2013). There have been no reported pinniped interactions with the SBTF in the period 2013–14 (AFMA 2014e, Patterson *et al*. 2014). While the purse seine component of the SBTF is regarded as highly selective, resulting in minimal interactions with non-target species, the absence of verified independent observer data on the level of TEPS interactions is noted as an issue (Baker and Finley 2013 cited in Finley *et al*. 2015a).

The SCPSMF targets sardines. There are no records of the fishery having interactions with pinnipeds (Finley *et al*. 2015a).

Three assessments of the NSW Ocean Haul Fishery by the Department of the Environment (in 2003, 2008 and 2013) did not identify any concerns about the interactions of the fishery with any protected species. The 2013 submission to the Department of the Environment (NSW Department of Primary Industries 2013) noted that there were no observer data available but did not report any interactions with pinnipeds.

Summary: nature and extent of direct interactions between pinnipeds and purse seine fisheries

- *Fur seals and sea lions commonly interact with purse seine fisheries in the Southern Hemisphere, especially in Southern Africa (South Africa and Namibia) and South America (Chile and Argentina).*
- *Seals can impact purse seine fisheries by reducing catch by causing fish to dive before they can be pursed. Seals within the net eat some fish but this is typically a very small fraction of the catch.*
- *Seals typically move in and out of a pursed net with ease by depressing the float line and sliding over it. Some fish may be lost from the net this way.*
- *The vast majority of interactions are non-lethal, with seals taking advantage of purse seine fisheries that provide an abundant and easy food source that can be gained with little energetic cost compared to normal foraging.*
- *Interactions between seals and purse seine fishing in the SPF are rare, but are more common in the SASF.*

5.2.3 Management of pinniped interactions

Management of operational interactions with pinnipeds in mid-water trawl fisheries

Management and mitigation of pinniped interactions with trawl vessels can include modifications to fishing gear (such as incorporating SEDs in the trawl net), modifications to fishing behaviour, bycatch trigger limits, move-on rules and spatial closures. Management and mitigation methods used in both global and domestic mid-water trawl fisheries, including the SPF, were assessed in detail in the first declaration report (Expert Panel on a Declared Commercial Fishing Activity 2014, Section 5.2.3). A summary of these assessments is provided below.

Seal excluder devices

- Although excluder devices are commonly used in trawl fisheries globally as a means to mitigate bycatch of marine megafauna, with the exception of one Antarctic fishery, SEDs are mostly used in New Zealand and Australian fisheries.
- SEDs are typically tailored to individual fisheries, fishing vessels and bycatch species because a single design is not suitable for all circumstances.
- A SED functioning under optimal operating conditions should reduce the incidence of bycatch mortality of pinnipeds, but will not eliminate it.
- SEDs leave on-board observers effectively blind to the extent of interactions and to the effectiveness of the devices in ejecting seals in a healthy state from the net. Underwater video monitoring of SEDs is therefore necessary to monitor interaction levels and cryptic mortality and to optimise SED design and efficacy.
- Innovations in SED design are emerging from the winter blue grenadier fishery in the SESSF. These include a hydrostatic net release, an acoustic transponder release grid gate and installation of smaller-sized mesh on the hood. The acoustic SED shows promise for demersal trawling activities that take place below the normal diving range of seals. They are less likely to be effective in shallower, mid-water trawling where seals can access the net at any stage.
- SED trials in the mid-water trawl fishery of the SPF indicated lower seal mortality with a larger SED opening (in a bottom-opening SED). Top-opening SEDs could not be fully evaluated due to operational difficulties.

Other management measures

- Codes of practice have been used to reduce the level of interactions with seals. The most relevant elements of these include:
  - removing all 'stickers' before shooting the trawl
  - undertaking shooting and trawling as quickly as possible
  - suspension of trawling and moving away if seals are observed prior to trawling
  - no discarding of fish, offal or domestic waste on fishing grounds.
- Spatial closures can provide an effective means of reducing or removing fishing activity in locations or at times where direct interactions with seals are likely to be common, or present unacceptable risks to threatened or protected species' populations.
- Bycatch trigger limits are generally utilised to ensure that bycatch levels of protected species do not exceed a threshold that places the species or population at risk of further declines. They have been used to cap incidental mortality of the threatened New Zealand sea lion in the Auckland Island squid trawl fishery, and in Australia, AFMA uses bycatch trigger limits to limit the bycatch of the threatened Australian sea lion in the Gillnet, Hook and Trap (GHAT) Fishery.

Management of operational interactions with pinnipeds in purse seine fisheries

Shaughnessy *et al.* (1981) report that purse seine fisheries off south-west Africa in the 1970s used firearms and weighted firecrackers ('Thunderflashes', 'Belugas' and 'Seal Deterrents') that exploded underwater to scare seals away from purse seine nets. They undertook a range of deterrent trials during fishing operations in the late 1970s to test the effectiveness of firecrackers, killer whale vocalisations, 0.303 rifle shots (fired over the heads of seals and in the water) and an arc-discharge transducer that was designed to produce an underwater shock wave at similar levels to firecrackers and 0.303 bullets. Although seals responded to firecrackers they soon returned. Seals moved away from 0.303 rifle shots fired into the water but not overhead and they responded to killer whale vocalisation and arc-discharge but did not leave the purse seine net. The general conclusion of these trials was that the deterrents tested were ineffective in reducing interactions between seals and purse seine fisheries (Shaughnessy *et al.* 1981).

Wickens (1994) reported that seals that managed to get onto vessels in the South African purse seine fishery when nets were pumped and hauled (and become a potential threat to the safety of the crew), were generally clubbed and dumped. Many others were shot in the water despite no threat to crew safety (Wickens 1994). The panel could not find any recent information to indicate if these practices are continued today.

The panel could not locate any relevant information in relation to the management of seal interactions with purse seine fisheries in South America.

Management of direct interactions with pinnipeds in the SPF

Mid-water trawl

Part 13 accreditation of the SPF under the EPBC Act requires that:

- Prior to fishing, mid-water trawl vessels must have in place effective mitigation approaches and devices to the satisfaction of AFMA to minimise interactions with dolphins, seals and seabirds.
- AFMA requires that at least one observer be deployed on each new mid-water trawl vessel for the first 10 fishing trips with additional observer coverage or other monitoring implemented as appropriate, following scientific assessment of the SPF.

AFMA enforces this by requiring the development and implementation of an approved Vessel Management Plan (VMP) that sets out operational and management approaches to minimise and mitigate interactions with marine mammals and seabirds. These plans are developed by AFMA in consultation with the Department of the Environment and industry and all SPF mid-water trawl operators are required to comply with and enforce them onboard. With respect to onboard-observer coverage, AFMA has an observer coverage target of 20 per cent of shots and, in accordance with the Part 13 accreditation above, observer coverage of the first 10 trips is required for new boats entering the fishery or existing boats moving into significantly new areas.

An AFMA-approved SED is compulsory for all mid-water trawl vessels in the SPF (AFMA 2014d) and management actions under the SPF Bycatch and Discarding Workplan include implementing upward-opening SEDs and developing VMPs for each mid-water trawl vessel operating in the fishery to minimise the risk of interactions with seabirds, seals and dolphins (AFMA 2014b).

Purse seine

AFMA considers that the risk of bycatch of TEPS when using purse seine gear is low noting that there have been no reported purse seine gear interactions with TEPS since the first SPF Bycatch and Discarding Workplan commenced in 2009, and very low levels of reported interactions before that (AFMA 2014b). The observer coverage target for purse seine in the SPF is 10 per cent of shots or the first five trips for new boats entering the fishery or existing boats moving into significantly new areas (AFMA 2014b).

In contrast to mid-water trawl, use of the purse seine fishing method in the SPF does not require a VMP. Instead, the Commonwealth Small Pelagic Fishery Purse Seine Code of Practice (SPF CoP) (Anon. 2008a) includes voluntary operating practices to minimise impacts on the environment, particularly to TEPS. With respect to pinnipeds, Clauses 3.3, 3.4 and 3.5 are most relevant:

"3.3 Fishers will make every reasonable endeavour to return any captured individual of a Threatened, Endangered, or Protected Species (TEPS) alive:

- having priority of consideration for the safety of the vessel crew members engaged in the release of the animal; and
- in a manner that, where appropriate, utilises techniques outlined in the "Protected Species Handling Manual" produced by Ocean Watch Australia Ltd.

3.4 Recognising the wide range of vessel sizes, gear configurations, style, and operational practices of the purse seine fleet, each such vessel shall employ one or more of the following TEPS Mitigation Practices.

3.4.1 Where a TEPS is captured by the fishing operation, when any such TEPS cannot be released by the application of 3.3 and the TEPS exhibits unreasonable distress, the vessel Master shall terminate the shot and release one end of the net to enable release of the contents of the net by towing the net open whilst maintaining tension on the net wall to minimise entanglement opportunities until such time that TEPS have exited the net.

3.4.2 Where a TEPS is observed within the deployed purse seine net the TEPS Mitigation action relevant to the circumstances is undertaken consistent with the premise that early detection and action is the key to successful mitigation of TEPS interactions.

3.5 Purse seine operations are not required to undertake the mitigation actions contained in Clause 3.4 and its sub-clauses above where Marine Birds and/or Seals and Sea Lions are the only TEPS interactions experienced and the animals are not displaying undue distress:

- noting with respect to Seals and Sea Lions that they exhibit rapid habituation with fishing operations and both enter and exit purse seine nets of their own free will, skilfully without difficulty, and with minimal/insignificant mortality as identified in the historical experience of the NSW, S.A. and Tasmanian purse seine industry and independent observations of purse seine operations in the S. Aust Pilchard fishery, as well as the Department of Environment, Water, Heritage & the Arts (DEWHA) risk assessment for the purse seine gear method;
- should a Seal or Sea Lion exhibit undue distress whilst in a purse seine net appropriate action will be undertaken to mitigate the interaction consistent with 3.3 and/or 3.4;
- further noting that access to the air/water interface is available at all times during purse seine operations to any seal or Sea Lion as an inherent nature of purse seine operations; and
- noting that any interactions with seabirds will be consistent with Clause 3.3 above." (Anon. 2008a)

The panel found that the "Protected Species Handling Manual" (Anon. 2008b) referred to in the SPF CoP outlined procedures for handling seals, mainly in relation to disentangling them from fishing gear, and does not provide information that would be most useful for fishermen having to deal with removing live seals from nets that have been pursed or 'dried-out', or for removing them from the decks of vessels.

5.2.4 Nature and extent of direct interactions of the FPA with pinnipeds

The likely nature and extent of pinniped interactions with the FPA, considering the particular impact of fishing methods, fishing effort and transhipment is provided below.

Fishing method

As detailed above and in Section 5.2.2, most pinniped interactions (particularly bycatch mortality) in the SPF have occurred in the mid-water trawl sector of the fishery. Given that the FPA fleet configuration includes more mid-water trawl and less purse seine vessels than the typical SPF fleet, it would likely result in more interactions and greater pinniped bycatch mortality compared with those of the SPF to date.

Fishing effort

As discussed in Section 4.4.2 the panel considered that compared with the typical and particularly the recent SPF fleet, the ability to tranship fish under the FPA would result in increased effort and catch in both the purse seine and mid-water trawl sectors. The panel could not quantify this increase nor could it determine whether fishing effort and catch would be more or less concentrated (see Section 4.4.3). Factors that could influence the number and/or the rate of interactions with pinnipeds under the FPA include the configuration of the fleet in terms of fishing method, any change in the spatial and temporal pattern of fishing, and the process of transhipment.

Spatial and temporal pattern of fishing

The extent of the change in the rate of interaction with pinnipeds will largely be determined by whether the FPA fleet fishes in areas or at times of the year that have not been fished previously. As noted above, the particular potential for mid-water trawl activities to fish in areas of high pinniped density, or in regions that significantly overlap with the distribution of the Australian sea lion, not previously fished could have significant implications on the nature and extent of interactions (including bycatch mortality), of protected and threatened pinnipeds.

The introduction of a processing vessel would extend the range of the catching fleet and thus there is scope for a change in the spatial and temporal pattern of fishing. If this occurred, there may be a change in the number of interactions, the species encountered and the risk profiles of these species from that of the past. The panel believes that the FPA will enable the catching fleet to fish more broadly in the SPF than in the past. However, as discussed in Chapter 4, it is not possible to predict with any certainty the spatial and temporal pattern of fishing under the FPA. As a result there is some uncertainty about the potential rate of direct interactions with pinnipeds under the FPA.

Transhipment

Catches of purse seine vessels fishing under the FPA are at the surface, and therefore more readily available to pinnipeds, while the catch is transhipped/pumped to the processing vessel. The panel noted that such pumping had occurred previously in the earlier Jack Mackerel Fishery (JMF) and the SPF without any significant pinniped interactions and that any pinnipeds attracted to feed on fish in the purse seine net would be able to escape given that the net is open at the surface.

The panel assumed that discarding from purse seine vessels would be allowed under the FPA. This has been the case in the SPF to date and in the earlier JMF where transhipment occurred. Since interactions with pinnipeds in the purse seine sector of the SPF and the JMF have been low, the panel considered that any accidental loss of fish during transfer from purse seine vessels to the processing vessel under the FPA would pose no additional risk to pinnipeds.

As noted in Chapter 4, the panel assumed that the VMPs for mid-water trawl vessels would prohibit the discarding of any biological material while gear (including the pump) was in the water, thus avoiding any increased risk of interaction with, and fatality of, pinnipeds.

The panel concluded that the transhipment of fish to the processing vessel via pumping was unlikely to pose a greater risk to pinnipeds than pumping operations to transfer fish from the net to the vessel in the declared commercial fishing activity assessed under the first declaration (DCFA1) and in the typical SPF, or in the earlier JMF where fish were routinely 'transhipped' between fishing vessels.

Panel assessment: likely nature and extent of direct interactions of the FPA with pinnipeds

- *The extent of interactions of the FPA with pinnipeds will depend on the actual fleet configuration, the fishing practices adopted, the level of fishing effort, the spatial and temporal pattern of fishing and the pinniped mitigation measures used.*
- *While there remains some uncertainty about the possible loss of fish during transhipment and the potential for such loss to increase pinniped interactions, there is no evidence to suggest that the practice of transhipment poses a specific risk to pinnipeds.*
- *Seal interactions with mid-water trawl activities are more likely to result in bycatch mortality compared with interactions with purse seine fisheries, where seals can readily move in and out of the net over the float line and are not usually impeded in accessing the surface to breathe.*
- *Historically, mid-water trawl and demersal trawl operations that have occurred in the SPF area have been in the south-east of Australia where most interactions are with Australian fur seals.*
- *If the presence of the processing vessel allows fishing to extend into areas not previously fished, this could result in a difference in the rate of interactions and the species involved.*

- *If mid-water trawl fishing under the FPA were to operate in areas where threatened Australian sea lions occur, some level of direct interactions with this species, including bycatch mortality, is inevitable.*
- *There is uncertainty about the extent of interactions with pinnipeds if the FPA catching fleet and particularly the mid-water trawl vessels fished off SA and WA. In these regions, New Zealand fur seals and Australian sea lions are most common. Neither species has been exposed to the level of bycatch mortality from trawl fisheries experienced by Australian fur seals, so there is uncertainty about the differential impacts of bycatch on their populations. This is especially significant for the threatened Australian sea lion.*
- *The extent of interactions with the FPA would likely be higher than the DCFA1 and the typical SPF fleet, but while interactions in the purse seine fleet may be higher, mortality in that sector of the FPA is likely to remain low.*
- *Compared to the typical SPF fleet:*
  - *there would be more effort under the FPA and this would likely result in a greater number of interactions*
  - *the FPA scenario would likely result in an increase in pinniped bycatch mortality given that the FPA fleet configuration includes more mid-water trawl and less purse seine vessels*
  - *if the presence of the processing vessel allows fishing to extend into areas not previously fished or more intensive fishing of some areas, it is reasonable to expect that the rate of interactions with pinnipeds might change and potentially involve interactions with all three pinnipeds rather than just fur seals.*
- *Compared to DCFA1:*
  - *The number of interactions with pinnipeds under the FPA may be less, similar or more, depending on the comparative levels of effort and catch under each scenario. For example, if the mid-water trawl wet boat catching fleet of the FPA needs to expend more fishing effort to take the same amount of catch as the DCFA1 fishing vessel, then the number of interactions could be higher. The panel could not predict with any certainty the relative levels of effort in the catching fleets under DCFA1 and the FPA.*
  - *The FPA fleet would be more constrained in terms of the additional area of the fishery that can be fished (wet boats will remain constrained by the need to refuel and return to port regularly). This may mean that they are more likely to fish closer inshore than DCFA1 and potentially have more interactions with protected central place forager (CPF) species such as fur seals and sea lions.*

5.2.5 Assessment of the effectiveness of the proposed measures to mitigate impacts

Mid-water trawl

No specific measures had been proposed for the FPA, but it is assumed that the routine management arrangements for the SPF (AFMA 2014e) would be applied to all purse seine and mid-water trawl vessels in the FPA catching fleet. VMPs would be required for mid-water trawl vessels. The most important element of VMPs, with respect to reducing bycatch mortality of pinnipeds, is the requirement for nets to be fitted with an AFMA-approved SED. The panel notes that while the SPF Bycatch and Discarding Workplan (AFMA 2014b) refers to implementation of upward-opening SEDs, the SPF Management Arrangements Booklet (AFMA 2014d) does not specify that the SED must have an upward-opening escape hatch. In addition, the panel is unable to determine which type of SED would be used. As the VMPs are vessel specific, the type of SED used (e.g. soft-grid vs hard metal grid) may depend on the type of fishing vessel used (see Expert Panel on a Declared Commercial Fishing Activity 2014). With respect to mitigating impacts to pinnipeds using the mid-water trawl method, the panel has identified four key differences between DCFA1 and the FPA/typical SPF fleet. These are discussed below.

Hooded SED with underwater monitoring

Top-opening SEDs enhance the escape of pinnipeds but reduce the incidence of bycatch observed by on-board observers because dead seals typically fall out of the escape hole while fishing, hauling or pumping the net. A hooded SED increases the retention of seal mortalities but is not 100 per cent effective, leading to unobserved 'cryptic' mortality. The first declaration report identified that the underwater video monitoring proposed in the DCFA1 would be essential to monitoring SED efficacy and cryptic mortality, so that overall pinniped mortality rates could be monitored (Expert Panel on a Declared Commercial Fishing Activity 2014). The panel notes that under the FPA, there would be no mandatory requirement for hooded-SEDs or underwater video monitoring, and as such, potentially no capacity to monitor cryptic mortality or assess SED efficacy.

Observer coverage

Under the DCFA1 scenario there was a requirement for 100 per cent observer coverage, whereas under the FPA scenario there is only a target of 20 per cent observer coverage. The panel notes that the reduced level of observer coverage would significantly reduce the capacity to independently verify pinniped interactions. This would be particularly problematic if underwater monitoring was implemented, since it would reduce the ability to monitor cryptic mortalities in near real time.

Bycatch trigger limits and move-on rules

Under the DCFA1, Part 13 accreditation (Condition 1, see Section 3.1) seal bycatch trigger limits were imposed (three or more seals in each of three consecutive shots; or more than 10 seals within a 24-hour period of fishing; or more than 10 seals in one shot), which if exceeded, resulted in a suspension of fishing activity and implementation of move-on rules. Trigger limits are not part of the routine AFMA management arrangements for the SPF and would not necessarily be applied to the FPA catching fleet.

Australian sea lion closures

Under the DCFA1 Part 13 accreditation (Condition 1), fishing was not permitted within the SPF area on the continental shelf that overlapped with the Australian sea lion closure area between 129° 00' E and 140° 05'E out to the 150 m depth contour. This is not part of the routine AFMA management arrangements for the SPF and would not necessarily be applied to the FPA catching fleet.

Purse seine

AFMA does not require VMPs for purse seine vessels nor does the SPF CoP address the issue of discards of biological material. The panel assumed that purse seine vessels operating under the FPA would be permitted to discard fish. As noted above, the panel found that the protected species handling manual referred to in the SPF CoP does not provide information for fishermen on how to safely remove live seals from nets that have been pursed or 'dried-out', or for removing them from the vessel deck.

Panel assessment: effectiveness of proposed measures

- *SEDs are required as part of mid-water trawl VMPs. The implementation of upward-opening SEDs under the SPF Bycatch and Discarding Workplan will, if implemented, enhance the escape of pinnipeds, but reduce the incidence of bycatch observed by on-board observers because dead seals typically fall out of the escape hole while fishing, hauling or pumping the net.*
- *Hooded SEDs increase the retention of seals but are not 100 per cent effective, leading to unobserved 'cryptic' mortality.*
- *The panel notes that, unlike DCFA1, under the FPA and in the typical SPF fleet, there are no mandated requirements for:*
    - *upward-opening SEDs*
    - *100 per cent observer coverage*
    - *hooded-SEDs or underwater video monitoring, and as such, potentially no capacity to monitor cryptic mortality or assess SED efficacy*
    - *bycatch rates/trigger limits and move-on rules*
    - *limiting and managing Australian sea lion mortality through a specific area closure.*
- *The panel notes that the protected species handling manual referred to in the SPF CoP does not provide information for fishermen on how to safely remove live seals from nets that have been pursed or 'dried-out', or for removing them from the vessel deck.*

5.2.6 Actions to avoid, reduce and mitigate adverse environmental impacts of the FPA on pinnipeds

Panel advice: actions to avoid, reduce and mitigate adverse environmental impacts on pinnipeds

The panel considered that the following actions could be taken to manage the risk of adverse environmental impacts arising from direct interactions of the FPA's purse seine and mid-water trawl catching fleet with pinnipeds:

Mid-water trawl

- *VMPs for mid-water trawl vessels should stipulate the use of an upward-opening SED, with hood, with the requirement for underwater monitoring of SED efficacy and cryptic mortality to assess and improve performance.*
- *VMPs should include daily and per-shot trigger limits on fur seals and stipulate move-on rules requiring a vessel to move to an area where interactions with seals are less likely.*
- *Introduce a bycatch rate trigger limit for fur seals for the fishery or fishing areas, or a total mortality trigger for a fishing season and/or fishing areas.*
- *Ensure 100 per cent observer coverage of all mid-water trawl fishing operations and, if daily or per shot trigger limits are used in conjunction with move-on rules or with a requirement to review mitigation measures, provide sufficient observer capacity to ensure that underwater video footage is monitored at the end of each shot to maximise response times to mortalities.*
- *Require 'stickers' to be removed from trawl nets before shooting.*
- *Implement spatial closures for mid-water trawl that mitigate bycatch interactions with fur seals, especially in regions adjacent to breeding colonies where there is high transit and foraging activity by central place foraging lactating adult females.*
- *Implement Australian sea lion closures off SA, as specified in Condition 1 (e) for the DCFA1 (see Section 3.1) amended to include waters out to 183 m depth, consistent with the outer extent of the gillnet component of the GHAT fishery.*
- *If such closures off SA are not implemented, bycatch trigger limits and management arrangements for Australian sea lion in the mid-water trawl sector of the SPF should be introduced consistent with those in the Australian sea lion Management Zones in the GHAT fishery.*
- *Implement mid-water trawl closures and bycatch trigger limits for Australian sea lion colonies occurring within the SPF off WA.*

Purse seine

- *Review the protected species handling manual referred to in the SPF CoP to ensure it provides information on how to safely remove live seals from purse seine nets that have been pursed or 'dried-out', and for removing them from the vessel deck.*

5.2.7 Research and monitoring to reduce uncertainties

For global pinniped populations, as for those in Australia, the most significant source of anthropogenic mortality is from fishery interactions (Shaughnessy 1999, National Seal Strategy Group and Stewardson 2007, Kovacs *et al.* 2012). In Australia, the most significant source of fishery-related pinniped bycatch is from trawl fisheries. A fishery targeting the key prey taxa of pinnipeds in their foraging grounds and within their foraging depth range will inevitably attract many animals, and potentially (as demonstrated in the mid-water trawl fishery of the SPF to date) result in significant levels of bycatch mortality. The panel has proposed a number of ways in which direct interactions of the FPA with pinnipeds might be mitigated. The panel also identified four key uncertainties (questions) relating to potential adverse impacts on pinnipeds resulting from the FPA that could be addressed through further monitoring and research. They essentially follow those detailed in the first declaration report (Expert Panel on a Declared Commercial Fishing Activity 2014).

1. What are the individual and cumulative fishery-related bycatch impacts on pinniped populations?

Seals interact with and potentially suffer incidental mortality from a range of different fisheries. A key uncertainty in assessing the potential adverse impacts resulting from any one fishery (such as the FPA in the SPF), is the extent to which that fishery contributes to the total impacts across all fisheries. The panel considered that improved independent monitoring of pinniped bycatch and a requirement for annual reporting of estimated take of pinnipeds by all Australian fisheries is needed. This would enable the estimation of overall cumulative impacts on pinniped populations, and enable assessment of the relative contribution of individual fishery impacts.

2. What levels of fishery-related mortality can pinniped populations sustain?

Improved pinniped population models and ongoing monitoring of status and trends in abundance would provide a means to better evaluate what levels of bycatch mortality are sustainable, and reduce uncertainties about the potential for adverse environmental impacts. It would provide essential biological context to estimates of individual and cumulative fishery impacts (addressed in question one, above), and provide a direct quantitative measure to directly assess a fishery against Part 13 of the EPBC Act which requires that "the fishery does not, or is not likely to adversely impact the conservation status of protected species or affect the survival and recovery of listed threatened species". Such information would not only inform what bycatch levels are sustainable, but also assist in apportioning and setting allowable take and maximum bycatch rate trigger limits for individual fisheries.

3. Where are the regions of critical foraging habitat for pinniped populations where the management of direct interactions with the FPA may be most needed?

The panel considered that research to better understand the foraging distributions and critical habitat of pinnipeds could help identify regions where management of the potential adverse environmental effects of fishing may be most needed. There are two key components to such work.

(a) Knowledge of the locations of key foraging areas where adult females may be particularly vulnerable to bycatch mortality in near-colony waters. Adult female fur seals and sea lions spend most of their lives raising pups. The need to return regularly ashore to nurse a dependent pup requires that females make regular foraging trips to sea to forage. Bycatch of females has a disproportionate effect on populations (loss of mother, pup on teat and one in utero and future reproductive potential) compared to males. Reducing female bycatch can help reduce uncertainties about the potential for adverse impacts on pinniped populations. Such information may inform the location and timing of spatial closures to mitigate bycatch.

(b) Knowledge of the locations of foraging hot-spots (areas of high-density foraging) used by one or more populations of seals could provide important information on which areas could be avoided to reduce the incidence and rate of bycatch.

4. Are there additional modifications to fishing gear and behaviour that can reduce the potential for direct interactions by the FPA with pinnipeds?

The panel considered that additional research and fishing trials could be undertaken to optimise the SED design, or trial alternate SED designs appropriate to different fishing vessel and gear used by mid-water trawl vessels in the FPA. This would include testing of appropriateness of soft vs hard grids, optimising the slope of the grid and configuration of the escape hole, hood and kites with the objective of improving the exit of healthy seals.

On-board observers should be required to monitor seal activity both on the surface and within the net via underwater video monitoring, so that a data base can be developed to improve the understanding of the circumstances under which seal activity and interaction increase and decrease. This would help inform and promote codes of practice to further reduce interactions and maximise survival.

Panel advice: research and monitoring to reduce uncertainties

Research that addresses the following questions could reduce uncertainties about the potential for adverse environmental impacts of the FPA on protected pinniped species:

- *What are the individual and cumulative fishery-related bycatch impacts on pinniped populations?*
- *What levels of fishery-related mortality can pinniped populations sustain?*
- *Where are the regions of critical foraging habitat for pinniped populations where the management of direct interactions with the FPA may be most needed?*
- *Are there additional modifications to fishing gear and behaviour that can reduce the potential for direct interactions by the FPA with pinnipeds?*

5.3 Cetaceans

5.3.1 Species assessed

A total of 47 cetacean species are recorded to occur in Australian waters (Bannister *et al.* 1996, Ross 2006, Woinarski *et al.* 2014), and of these, 44 species are known or are likely to occur in the SPF area (Appendix 3). Of these 44 species, 42 species were assessed in the Ecological Risk Assessment for the Effects of Fishing (ERAEF) process for the purse seine and mid-water trawl sectors of the SPF (Daley *et al.* 2007a, b). The two additional cetacean species recorded to occur in the SPF region (but not assessed in the ERAEF) are Omura's whale *Balaenoptera omurai* and spectacled porpoise *Phocoena dioptrica* (Woinarski *et al.* 2014).

The ERAEF Level 2 productivity-susceptibility analysis (PSA) for the mid-water trawl sector of the SPF identified a total of 20 threatened, endangered and protected cetacean species as High risk, a further 21 cetacean species as Medium risk, and one cetacean species as Low risk (Appendix 3). After Level 2 Residual Risk Guidelines were applied, seven cetacean species remained at High risk for the mid-water trawl sector of the SPF (AFMA 2010b). These are:

- Risso's dolphin *Grampus griseus*
- Fraser's dolphin *Lagenodelphis hosei*
- hourglass dolphin *Lagenorhynchus cruciger*
- southern right whale dolphin *Lissodelphis peronii*
- striped dolphin *Stenella coeruleoalba*
- Indo-Pacific bottlenose dolphin *Tursiops aduncus*
- common bottlenose dolphin *Tursiops truncatus*.

Species summaries of these seven species and 14 other cetacean species known to occur in the SPF and recorded to have interacted with mid-water trawl vessels in Australia and/or internationally, can be found in Section 5.3.1 of the first declaration report (Expert Panel on a Declared Commercial Fishing Activity 2014) which focused exclusively on interactions with mid-water trawl vessels.

The ERAEF Level 2 PSA analysis for the purse seine sector of the SPF identified a total of 27 threatened, endangered and protected cetacean species as High risk and a further 15 cetacean species at Medium risk (Appendix 3). After Level 2 Residual Risk Guidelines were applied, 26 species remained at High risk for the purse seine sector of the SPF (AFMA 2010a). Species summaries for 11 of those species can be found in Section 5.3.1 of the first declaration report (Expert Panel on a Declared Commercial Fishing Activity 2014) since these were included in the 21 cetacean species recorded to remain at High risk for the mid-water trawl sector and/or to have interacted with trawl fisheries in Australia and/or internationally. Summaries of the remaining 15 species are provided below. The first 14 species are odontocete species and the common minke whale *Balaenoptera acutorostrata* is the sole mysticete whale in the group. The area of waters fished by purse seine in the SPF during 2000–2013 in relation to the species richness of the 26 cetacean species assessed as at High risk from purse seine is shown in Figure 5.5.

Across both mid-water trawl and purse seine gear types, the panel has assessed a total of 36 cetacean species (82 per cent of cetacean species known or likely to occur in the SPF area). The total area of waters fished by purse seine and mid-water trawl effort in the SPF during 2000–2013 in relation to the species richness of these 36 species, based on the available distribution data for these species held by the Department of the Environment, is shown in Figure 5.6.

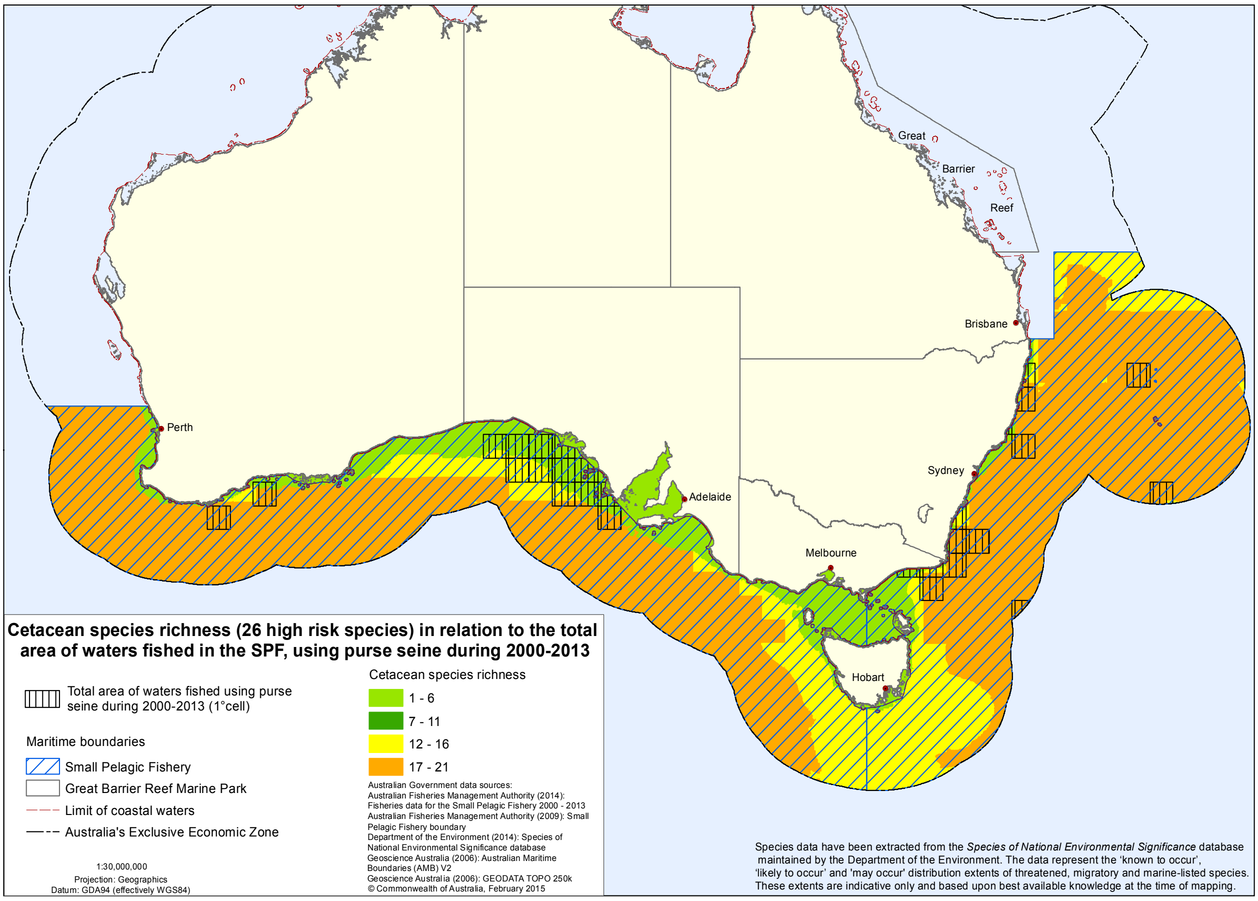

Figure 5.5 Cetacean species richness (26 High risk species) in relation to the total area of waters fished in the SPF using purse seine during 2000–2013. **Source:** Map produced by ERIN, Department of the Environment using unpublished AFMA data.

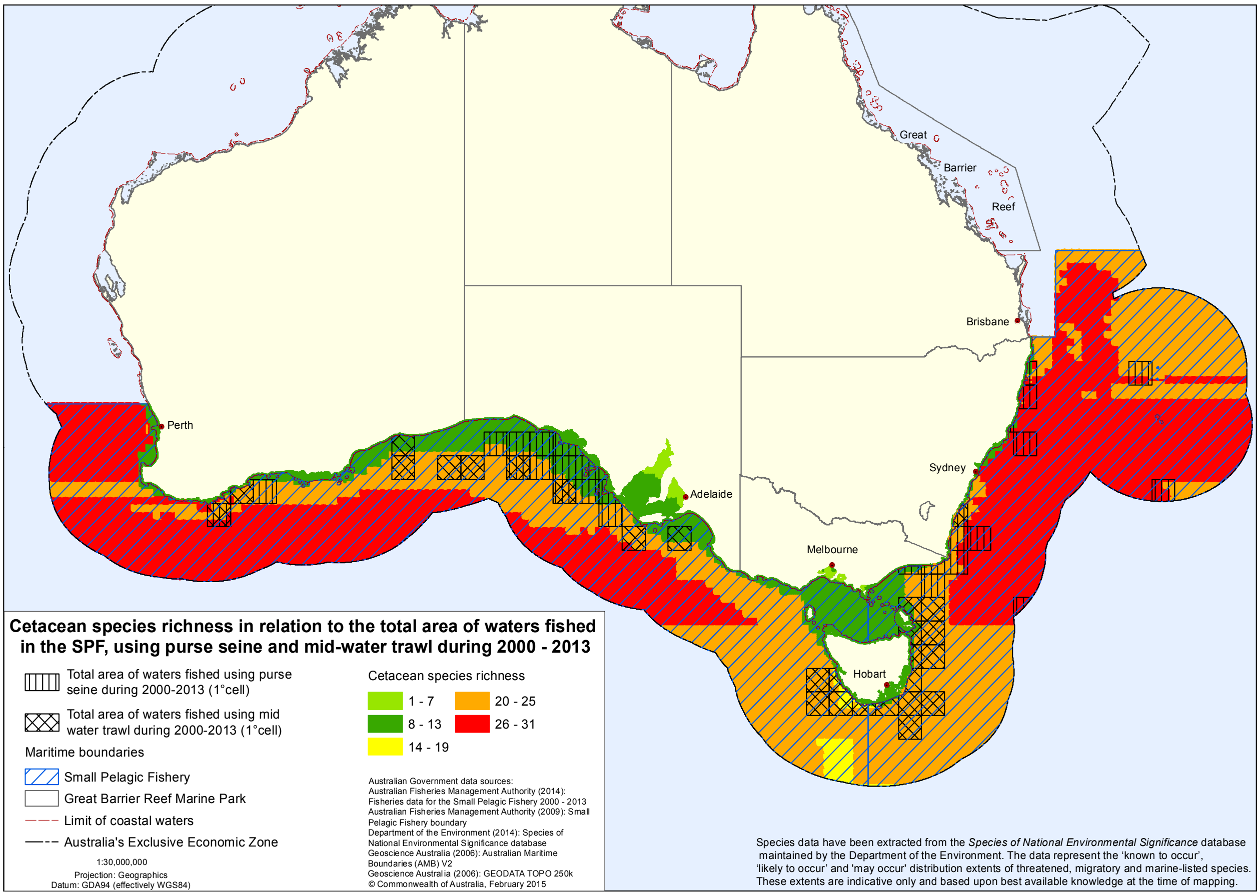

Figure 5.6 Cetacean species richness (36 species) in relation to the total area of waters fished in the SPF using purse seine and mid-water trawl during 2000–2013. **Source:** Map produced by ERIN, Department of the Environment using unpublished AFMA data.

Dwarf sperm whale *Kogia sima* (Level 2 PSA Residual Risk – High)

Distribution and range

Dwarf sperm whales have a broad cosmopolitan distribution in warm temperate to tropical regions of the Pacific, Indian and Atlantic Oceans (Nagorsen 1985, McAlpine 2009). They have also been recorded from the Persian Gulf and the Sea of Japan, with one extra-limital record from the Mediterranean Sea (Taylor *et al.* 2008a, Jefferson *et al.* 2008). They are not commonly observed at sea and their distribution is largely unknown, with most records from stranded animals (Jefferson *et al.* 2008, McAlpine 2009). Molecular analyses have demonstrated that two distinct clades occur within *K. sima*, with one occurring only in the Indo-Pacific region and the other only occurring in the Atlantic Ocean (Chivers *et al.* 2005).

Around Australia, dwarf sperm whales have been recorded as stranded animals from NSW, Tasmania, SA, WA, the Northern Territory, and at Scott Reef off north-western Australia, with one live individual sighted in SA waters (Bannister *et al.* 1996, Chatto and Warneke 2000, Ross 2006). Their southern Australian range overlaps extensively with the SPF area.

Population size and trends

There are no estimates of the Australian regional abundance or global abundance of dwarf sperm whales and the Australian and global population trends are unknown (Ross 2006, Taylor *et al.* 2008a, Woinarski *et al.* 2014). There are estimated to be about 19,170 (coefficient of variation (CV = 66 per cent)) dwarf sperm whales off Hawai'i and about 11,200 (CV = 29 per cent) in the eastern tropical Pacific (Wade and Gerrodette 1993, Taylor *et al.* 2008a).

Biology and feeding ecology

Dwarf sperm whales grow to about 2.5–2.7 m long and can weigh up to 272 kg, and males may be slightly larger than females (Jefferson *et al.* 2008). They occur primarily offshore in deep water over continental shelf edge and slope areas, with older individuals occurring in deeper water habitats (Plön 2008). Relatively little is known about their biology and ecology as they are rarely observed alive and most records are from stranded individuals (Jefferson *et al.* 2008, McAlpine 2009). Dwarf sperm whales tend to be solitary, or occur as mother and calf pairs, with some larger group sizes reported that usually consist of less than six and sometimes up to 10 individuals (Plön 2008, Jefferson *et al.* 2008).

Dwarf sperm whales prey on a wide range of deep-water squid and small continental shelf cuttlefish species, and on some mesopelagic fish and pelagic crustaceans (Ross 1979, Nagorsen 1985, West *et al.* 2009, McAlpine 2009, Staudinger *et al.* 2014). Few data are available on dive times, with a maximum-recorded dive duration of 53 minutes (Plön 2008). There are no known breeding or calving grounds in Australian waters; waters off the southeast coast of South Africa are thought to be a calving ground (Plön 2008). Age at sexual maturity is estimated to be about three years for males and about five years for females; gestation is estimated to be 11 months, with a calving interval of one to two years (Ross 2006, Plön 2008). Males may compete primarily by sperm competition rather than direct aggression (Jefferson *et al.* 2008). In southern African waters, annual ovulation is thought to occur in a high percentage of females, with a seasonal peak in births observed from December to March (Ross 2006, Plön 2008). Maximum age estimates are 17 years for males and 22 years for females (Plön 2008), and generation length is estimated to be 11.7 years (Taylor *et al.* 2007).

Risks and threatening processes

Dwarf sperm whales were occasionally harpooned by whalers during the 1800s, and some are taken in harpoon fisheries in the Caribbean, Japan, Indonesia, Sri Lanka and Taiwan (Reeves *et al.* 2003, Taylor *et al.* 2008a). This species is also occasionally reported as bycatch mortality in fisheries throughout their range and as bushmeat in Ghana (McAlpine 2009, Weir and Pierce 2013, Reeves *et al.* 2013). Segniagbeto *et al.* (2014) reported one stranding in the Gulf of Guinea that was thought to have resulted from capture in a drift gillnet by local fishers.

Dwarf sperm whales have been recorded to ingest plastic debris resulting in intestinal blockage and death, and high levels of anthropogenic noise and acoustic disturbance have been associated with mass stranding of this species (Taylor *et al.* 2008a). Other threats include vessel strikes that have caused mortality, pollution resulting in high levels of contaminants in tissues, and climate and oceanographic variability and change (Taylor *et al.* 2008a, Woinarski *et al.* 2014).

Conservation and listing status

The dwarf sperm whale is listed as a cetacean species (as *Kogia simus*) under the EPBC Act, Rare in SA, Data Deficient in the Northern Territory, but is not listed in other States within its Australian range (Woinarski *et al.* 2014). This species was recently assessed as Data Deficient in Australian waters (Woinarski *et al.* 2014), and similarly in previous Australian conservation status assessments in Australian waters (Bannister *et al.* 1996, Ross 2006). Globally, the dwarf sperm whale was assessed as Data Deficient for the IUCN Red List in 2008 (Taylor *et al.* 2008a) and is listed in Appendix II of CITES.

Southern bottlenose whale *Hyperoodon planifrons* (Level 2 PSA Residual Risk – High)

Distribution and range

Southern bottlenose whales have an extensive circumpolar Southern Hemisphere distribution extending from about 30°S southward to the edge of the Antarctic pack ice (Warneke 2008a, Gowans 2009, Van Waerebeek *et al.* 2010). Most records are between 57°S to 70°S, with known areas of concentration between 58°S and 62°S in the eastern Indian and Atlantic oceans (MacLeod *et al.* 2006, Jefferson *et al.* 2008a). The species description was based on a skull collected in the Dampier Archipelago WA at 20°S (Warneke 2008a), which suggests some occasional dispersal of individuals to warmer waters beyond their main range (Woinarski *et al.* 2014).

The distribution of southern bottlenose whales in Australian waters is poorly known, with stranding records including the type specimen from WA, SA, Victoria, Tasmania, NSW and subantarctic Heard Island (Bannister *et al.* 1996, Kemper *et al.* 2005, Ross 2006, Groom *et al.* 2014). Their Australian range overlaps extensively with the SPF area from NSW across to WA.

Population size and trends

There are no reliable estimates of the abundance of southern bottlenose whales in Australian waters, and Warneke (2008a) noted that they were possibly abundant. Their global abundance is unknown but they are the most commonly sighted beaked whale in Antarctic waters and one estimate of abundance of about 500,000 south of the Antarctic Convergence in January is likely to be an underestimate (Taylor *et al.* 2008b). Australian regional and global population trends are unknown (Taylor *et al.* 2008b, Woinarski *et al.* 2014).

Biology and feeding ecology

Southern bottlenose whales grow to about 6–7.5 m long and are estimated to weigh up to 3.5–4 tonnes (t) (Warneke 2008a, Jefferson *et al.* 2008). They occur primarily offshore in deep oceanic waters in polar to temperate regions beyond the continental shelf and over submarine canyons in habitats deeper than 1000 m (Warneke 2008a, Taylor *et al.* 2008b). These beaked whales can occur as solitary animals or in pairs, or in small social groups of three to ten individuals with some groups containing up to 40 animals (Bastida and Rodriguez 2003, Warneke 2008a).

Southern bottlenose whales are considered to be powerful and active predators of deepwater squid, and can dive for longer than an hour and probably to depths exceeding 1000 m (Warneke 2008a, Jefferson *et al*. 2008). They are also recorded to eat fish including Patagonian toothfish *Dissostichus eleginoides*, and possibly some crustaceans (Jefferson *et al*. 2008). Stomachs of the whales found in Australian waters contained several types of squid beaks. Small amounts of krill in stomachs of subantarctic and Antarctic individuals may have been swallowed incidentally (Ross 2006, a 2008). Bioenergetic models developed to investigate linkages between feeding energetics and the requirements for survival and reproduction for Ziphiidae beaked whales indicate that beaked whale reproduction requires energy dense prey, with poorer resource availability being likely to lead to an extension of the inter-calving interval and lower lifetime reproductive output of females (New *et al*. 2013). The models predict that beaked whales require relatively high quality habitat for successful reproduction, hence disturbances that halt energy acquisition over shorter periods or even small but consistent non-lethal disturbances resulting in displacement from higher-quality habitats could impact on populations (New *et al*. 2013).

Age at sexual maturity is estimated to be about nine–11 years, gestation is about 12 months with calving in spring to early summer, and the interbirth interval is two years (Taylor *et al*. 2007, Warneke 2008a). Maximum age is estimated to exceed 37 years for females and 50 years for males (Ross 2006), and generation length is estimated to be 24 years (Taylor *et al*. 2007).

Risks and threatening processes

Some southern bottlenose whales have been killed during whaling and some have been incidentally killed in driftnets, with several recorded as bycatch in Tasman Sea driftnet fishing (Taylor *et al*. 2008b). These beaked whales are likely to be vulnerable to loud anthropogenic noise and acoustic disturbance (Cox *et al*. 2006). Potential threats include prey depletion from expanding commercial fisheries, ingestion of plastic debris and bioaccumulation of persistent toxic pollutants (Bannister *et al*. 1996, Woinarski *et al*. 2014).

Conservation and listing status

The southern bottlenose whale is listed as a cetacean species under the EPBC Act, Rare in SA, but is not listed in other states within its Australian range (Woinarski *et al*. 2014). This species was recently assessed as Least Concern in Australian waters but its conservation status is poorly resolved (Woinarski *et al*. 2014). This species was assessed as 'No category assigned but possibly secure' in the previous Australian conservation status assessments in Australian waters (Bannister *et al*. 1996, Ross 2006). Globally, the southern bottlenose whale was assessed as Least Concern for the IUCN Red List in 2008 (Taylor *et al*. 2008b) and is listed in Appendix I of CITES.

Andrews' beaked whale *Mesoplodon bowdoini* (Level 2 PSA Residual Risk – High)

Distribution and range

The global distribution of Andrews' beaked whales is not known, and remarkably this species has not been sighted alive at sea (Pitman 2009). Information on this species is limited to about 40 Southern Hemisphere stranding records, occurring between 32°S from Western Australia and south to 54°30'S, mostly from temperate regions of the Pacific and Indian Oceans with a few records from the Falkland Islands and Tristan da Cunha (Baker 2001, MacLeod *et al*. 2006, Kemper 2008a, Van Waerebeek *et al*. 2010, Otley *et al*. 2012, Groom *et al*. 2014). More than half of the confirmed stranding records are from New Zealand, with 14 from southern Australia (Bannister *et al*. 1996, Baker 2001, Kemper 2008a, Thompson *et al*. 2013, Groom *et al*. 2014).

Within Australian waters, Andrews' beaked whales have been recorded as stranded individuals from NSW, Victoria, Tasmania, SA, WA and from subantarctic Macquarie Island (54°30'S) (Bannister *et al*. 1996, Baker 2001, Kemper *et al*. 2005, Ross 2006, Groom *et al*. 2014). Their Australian range overlaps extensively with the SPF area from southern NSW across to southern WA.

Population size and trends

There are no estimates of the Australian regional abundance or global abundance of Andrews' beaked whales and the Australian and global population trends are unknown (Bannister *et al*. 1996, Ross 2006, Taylor *et al*. 2008c, Woinarski *et al*. 2014). These beaked whales are thought to be relatively rare, with population centres likely to occur offshore (Pitman 2009). Based on their stranding records, New Zealand may be a region of higher abundance (Baker 2001, Thompson *et al*. 2013).

Biology and feeding ecology

Andrews' beaked whales grow to at least 4.5 m long with females slightly larger (4.6 m) and maximum weight is estimated to be about 1 t (Baker 2001, Ross 2006). Very little information is available about the biology and ecology of these beaked whales and their habitat is unknown. However, beaked whales typically occur in deep offshore waters greater than 2000 m depth or over continental slopes (MacLeod and D'Amico 2006, Jefferson *et al*. 2008, Pitman 2009). Southern Australia and New Zealand stranding records are from areas where the continental shelf is relatively narrow or where underwater canyons are present (Baker 2001, Kemper 2008a). The diet of Andrews' beaked whales is not known but they are assumed to be deep divers that prey on mesopelagic and deep-water benthopelagic squid and some fish species occurring between 200 to 2000 m depths, similar to other beaked whale species (Bannister *et al.* 1996, MacLeod *et al.* 2003, Jefferson *et al.* 2008). New *et al.* (2013) developed bioenergetic models to investigate linkages between feeding energetics and the requirements for survival and reproduction for Ziphiidae beaked whales. The models indicate that beaked whales require energy-dense prey and relatively high-quality habitat to meet their requirements for successful reproduction (New *et al.* 2013). Poorer resource availability would be likely to lead to an extension of the inter-calving interval and reduced reproductive output, and even small but consistent non-lethal disturbances resulting in displacement from higher-quality habitats could negatively affect their populations (New *et al.* 2013).

Very little is known about the life history of Andrews' beaked whales. Baker (2001) noted that there is some evidence for a summer-autumn breeding season around New Zealand. Heavy scarring on males probably results from intraspecific fighting possibly using the pair of triangular tusk-like teeth as weapons in agonistic encounters (Kemper 2008a, Dalebout *et al.* 2008). Two pregnant females were 4.2 m in length, whereas one 4.3 m stranded male appeared to be sexually immature (Kemper 2008a, Jefferson *et al.* 2008). The age at sexual maturity, gestation, calving interval, longevity and generation length for these beaked whales are unknown.

Risks and threatening processes

Taylor *et al.* (2008c) considered that some fisheries bycatch was likely to occur from gillnet and longline fisheries throughout the range of Andrews' beaked whales, and concluded that even low levels of bycatch may not be sustainable for these naturally rare beaked whales. This species is thought likely to be vulnerable to anthropogenic noise and acoustic disturbance from naval active sonar and seismic surveys that are known to cause stress and in some cases are associated with strandings of other deep-diving beaked whales (Taylor *et al.* 2008c). Climate change and oceanographic variability are predicted to be unfavourable for the range of this species (MacLeod 2009). Other potential threats include prey depletion from expanding fisheries, particularly for pelagic squid, ingestion of plastic debris and bioaccumulation of persistent toxic pollutants (Bannister *et al.* 1996, Woinarski *et al.* 2014).

Conservation and listing status

Andrews' beaked whale is listed as a cetacean species under the EPBC Act, Rare in SA, but is not listed in other states within its Australian range (Woinarski *et al.* 2014). This species was recently assessed as Data Deficient in Australian waters (Woinarski *et al.* 2014), and similarly in the previous Australian conservation status assessments in Australian waters (Bannister *et al.* 1996, Ross 2006). Globally, Andrews' beaked whale was assessed as Data Deficient for the IUCN Red List in 2008 (Taylor *et al.* 2008c) and is listed in Appendix II of CITES.

Blainville's beaked whale *Mesoplodon densirostris* (Level 2 PSA Residual Risk – High)

Distribution and range

Blainville's beaked whales are the most widely distributed *Mesoplodon* species and are probably the most widely distributed beaked whale species, with a circumglobal distribution in all tropical to warm temperate ocean regions and occasional records in cold-temperate regions (MacLeod *et al.* 2006, Pitman 2009). They have also been recorded from deep-water habitats within some enclosed seas including the Sea of Japan, Gulf of Mexico and Caribbean Sea, with rare vagrant records in the Mediterranean Sea (Taylor *et al.* 2008d). Strandings and sighting records in the eastern Pacific region range from 37°N to 41.5°S (MacLeod *et al.* 2006).

Within Australian waters, these beaked whales are recorded from stranding records from all States and the Northern Territory, with sightings off Point Lookout in southern Queensland (Bannister *et al.* 1996, Ross 2006, Warneke 2008b, Taylor *et al.* 2008d, Groom *et al.* 2014). Blainville's beaked whales have also been recorded from subtropical Lord Howe Island (Hutton and Harrison 2004), and the southernmost stranding record is from northwest Tasmania at 40° 50'S (Warneke 2008b). Their Australian range overlaps extensively with the SPF area from Queensland across to WA.

Population size and trends

There are no estimates of the Australian regional abundance or global abundance of Blainville's beaked whales and the Australian and global population trends are unknown (Bannister *et al.* 1996, Ross 2006, Taylor *et al.* 2008d). Blainville's beaked whales are considered to be relatively common in tropical oceans and seas and are possibly the most abundant beaked whale species (Pitman 2009). Abundance of these beaked whales in waters around Hawai'i was estimated to be about 2100 (Taylor *et al.* 2008d).

Biology and feeding ecology

Blainville's beaked whales grow to about 4.7 m long and can weigh up to 1033 kg, with females larger than males (Jefferson *et al*. 2008). These beaked whales typically occur in offshore deep water habitats or over continental slope or undersea canyon habitats with high bathymetric relief from about 140 to 1000 m depths where nutrient-rich deep currents interact with underwater topography resulting in increased productivity and concentrated prey (MacLeod *et al.* 2004, MacLeod and Zuur 2005, Warneke 2008b). These beaked whales prefer habitats within the 700–1000 m depth range around Hawai'i (Baird *et al*. 2006), and movements of satellite-tagged individuals from Hawai'i showed strong site fidelity (Schorr *et al*. 2009). Groups of four to six Blainville's beaked whales have been sighted closer to shore off Point Lookout on North Stradbroke Island in southern Queensland (Ross 2006). Long-term studies of these beaked whales in the Bahamas have recorded singles or pairs most commonly, with some groups of three to seven individuals (Jefferson *et al*. 2008). Claridge (2006) reported some evidence for age-class specific habitat preference off the coast of the Bahamas. Adults appear to be grouped into 'harems' with a single adult male and several females occupying more productive habitats over continental shelf waters of canyon walls, whereas subadults appear to stay in separate groups in less productive waters (Jefferson *et al*. 2008).

Blainville's beaked whales prey on mesopelagic and deep-water lantern fishes and other fish species and some squid, with recorded dives to 1400 m depth and more than 54 minutes duration (Bannister *et al*. 1996, MacLeod *et al*. 2003, Baird *et al*. 2006, Tyack *et al*. 2006, Jefferson *et al*. 2008). Foraging dives are thought to include both deep dives (greater than 800 m depth) and mid-water dives (100–600 m), and mid-water dives appear to be more common during daylight hours (Baird *et al*. 2008a). These beaked whales also spend long periods at shallow depths of less than 50 m, which may compensate for the physiological demands of their long and deep dives (Jefferson *et al*. 2008). Bioenergetic models developed to investigate linkages between feeding energetics and the requirements for survival and reproduction for Ziphiidae beaked whales indicate that beaked whales require energy-dense prey and relatively high quality habitat to meet their requirements for successful reproduction (New *et al*. 2013). Poorer resource availability would be likely to lead to an extension of the inter-calving interval and reduced reproductive output, and even small but consistent non-lethal disturbances resulting in displacement from higher quality habitats could negatively affect their populations (New *et al*. 2013).

Heavy scarring on older males probably results from fighting using the pair of large, flattened tusk-like teeth as weapons during agonistic encounters between competing males, and scarring on females indicates vigorous sexual encounters during mating (Warneke 2008b, Dalebout *et al*. 2008). Very little is known about sexual reproduction in Blainville's beaked whales, but the birth of a calf was observed in the northern Bahamas region (N. Hauser *pers. comm.* in Woinarski *et al*. 2014). Age at sexual maturity is about eight to nine years (Warneke 2008b, Claridge 2013), but their gestation period, calving interval, maximum longevity and generation length are unknown.

Risks and threatening processes

Blainville's beaked whales have been recorded as bycatch from Japanese tuna fishing off WA and the Seychelles, and in the North Pacific Ocean by Taiwanese fishers. Some are taken in directed fisheries for cetaceans in the Philippines and elsewhere (MacLeod *et al*. 2006, Taylor *et al*. 2008d, Pitman 2009, Reeves *et al*. 2013). Use of military active sonar has been implicated in mass strandings of Blainville's beaked whales (Jepson *et al*. 2003, 2005, Fernandez *et al*. 2005, Yang *et al*. 2008, D'Amico *et al*. 2009, Moretti *et al*. 2014) and loud sounds from seismic surveys and other anthropogenic activities are also considered likely to cause disturbance and stress (Cox *et al*. 2006, MacLeod and D'Amico 2006). Stomach contents of a Blainville's beaked whale stranded in southern Brazil included a large quantity of ingested plastic debris that may have led to starvation and death (Secchi and Zarzur 1999). Potential threats to these beaked whales include prey depletion from expanding commercial fisheries, particularly for pelagic squid, and bioaccumulation of persistent toxic pollutants (Bannister *et al*. 1996, Woinarski *et al*. 2014).

Conservation and listing status

Blainville's beaked whale is listed as a cetacean species under the EPBC Act, but is not listed in any States or the Northern Territory within its Australian range (Woinarski *et al.* 2014). This species was recently assessed as Data Deficient in Australian waters (Woinarski *et al*. 2014), and similarly in the previous Australian conservation status assessments in Australian waters (Bannister *et al*. 1996, Ross 2006). Globally, Blainville's beaked whale was assessed as Data Deficient for the IUCN Red List in 2008 (Taylor *et al*. 2008d) and is listed in Appendix II of CITES.

Ginkgo-toothed beaked whale *Mesoplodon ginkgodens* (Level 2 PSA Residual Risk – High)

Distribution and range

The global distribution of ginkgo-toothed beaked whales is uncertain. Individuals identified as ginkgo-toothed beaked whales have been recorded from about 23 widely-scattered stranding records in the temperate and tropical regions of the Pacific and Indian Oceans, mostly from Japan, with other strandings from Sri Lanka east to New Zealand and the Galapagos Islands and from coastal regions in North America (MacLeod *et al*. 2006, Taylor *et al*. 2008e, Thompson *et* *al*. 2013). However, more recent genetic and morphological analyses have indicated that at least seven specimens from Sri Lanka, Maldives, Seychelles, Kiribati and Hawai'i may represent a distinct species or subspecies, and therefore *M. ginkgodens* may only occur in the Pacific Ocean (Dalebout *et al*. 2007, 2012, Baker *et al*. 2013).

Within Australian waters there is one stranding record of a ginkgo-toothed beaked whale from western Victoria and three strandings from southern NSW, which may have included a mother and calf pair (Bannister *et al*. 1996, Ross 2006, 2008a). Genetic analyses have recently confirmed that the individual that stranded in western Victoria is *M. ginkgodens* (Dalebout *et al*. 2012). The Australian range of this species overlaps partly with the SPF area from coastal Victoria, off NSW and Queensland.

Population size and trends

There are no estimates of the Australian regional abundance or global abundance of ginkgo-toothed beaked whales and the Australian and global population trends are unknown (Bannister *et al*. 1996, Ross 2006, Taylor *et al*. 2008e, Woinarski *et al*. 2014). These beaked whales are thought to be uncommon (Taylor *et al*. 2008e) and this species has not been reliably identified at sea (Jefferson *et al*. 2008).

Biology and feeding ecology

Ginkgo-toothed beaked whales grow to 5.3 m long with females slightly larger on average and maximum weight is about 1.5 t (Bannister *et al*. 1996, Jefferson *et al*. 2008, Ross 2008a). Almost nothing is known about the biology and ecology of these beaked whales and their habitat is unknown, however beaked whales typically occur in deep offshore waters greater than 2000 m depth or over continental slopes or underwater canyons (MacLeod and D'Amico 2006, Jefferson *et al*. 2008, Pitman 2009). The diet of ginkgo-toothed beaked whales is not known but they are assumed to be deep divers that prey on mesopelagic and deep-water benthopelagic squid and some fish species occurring between 200 to 2000 m depths, similar to other beaked whale species (MacLeod *et al*. 2003, Jefferson *et al*. 2008). New *et al*. (2013) developed bioenergetic models to investigate linkages between feeding energetics and the requirements for survival and reproduction for Ziphiidae beaked whales. The models indicate that beaked whales require energy dense prey and relatively high quality habitat to meet their requirements for successful reproduction (New *et al*. 2013). Poorer resource availability would be likely to lead to an extension of the inter-calving interval and reduced reproductive output, and even small but consistent non-lethal disturbances resulting in displacement from higher quality habitats could negatively affect their populations (New *et al*. 2013).

Very little is known about the life history of ginkgo-toothed beaked whales. Based on limited data sexual maturity was estimated to occur at about 4.5 m length (Bannister *et al*. 1996), but the age at sexual maturity, gestation, calving interval, longevity and generation length for ginkgo-toothed beaked whales are unknown.

Risks and threatening processes

Some ginkgo-toothed beaked whales have been taken by Japanese and Taiwanese whalers, and some have been caught in deep-water drift gillnets (Taylor *et al*. 2008e). Ginkgo-toothed beaked whales are vulnerable to anthropogenic noise and acoustic disturbance, and use of military active sonar has been implicated in mass strandings of these beaked whales (Wang and Yang 2006, Yang *et al*. 2008). Potential threats include prey depletion from expanding fisheries, particularly for pelagic squid, ingestion of plastic debris and bioaccumulation of persistent toxic pollutants (Bannister *et al*. 1996, Woinarski *et al*. 2014).

Conservation and listing status

The ginkgo-toothed beaked whale is listed as a cetacean species under the EPBC Act, but is not listed in states within its Australian range (Woinarski *et al*. 2014). This species was recently assessed as Data Deficient in Australian waters (Woinarski *et al*. 2014), and similarly in the previous Australian conservation status assessments in Australian waters (Bannister *et al*. 1996, Ross 2006). Globally, the ginkgo-toothed beaked whale was assessed as Data Deficient for the IUCN Red List in 2008 (Taylor *et al*. 2008e) and is listed in Appendix II of CITES.

Gray's beaked whale *Mesoplodon grayi* (Level 2 PSA Residual Risk – High)

Gray's beaked whales occur primarily in cool temperate to higher latitude regions of the Southern Hemisphere with most records from 30°S to 45°S (MacLeod *et al*. 2006, Ross 2008b, Van Waerebeek *et al*. 2010, Otley *et al*. 2012). These beaked whales have a circumpolar distribution around Antarctica, with many sightings in the austral summer from Antarctic waters and near the Antarctic continent to 65–67°S, with one extra-limital Northern Hemisphere stranding record from the Dutch coast in the North Sea (Bannister *et al*. 1996, Dalebout *et al*. 2004, MacLeod *et al*. 2006, Van Waerebeek *et al*. 2010, Scheidat *et al*. 2011). Sightings at sea indicate that these beaked whales are relatively common southwest of the Chatham Islands in the South Pacific Ocean, with strandings occurring mainly from New Zealand and southern Australia, South Africa, Argentina, Chile and Peru (Dalebout *et al*. 2004, Taylor *et al*. 2008f, Thompson *et al*. 2013, Groom *et al*. 2014).

In Australian waters there is one documented live-sighting of a Gray's beaked whale off the coast of WA (Gales *et al.* 2002). This species is the most commonly recorded beaked whale species in WA waters with 48 individuals recorded in 33 stranding events (Groom *et al.* 2014). Gray's beaked whale has also been recorded from strandings in NSW, Victoria, Tasmania, SA and from subantarctic Heard Island and McDonald Islands (McManus *et al.* 1984, Kemper and Ling 1991, Bannister *et al.* 1996, Kemper *et al.* 2005, Ross 2006). Gray's beaked whales have also been sighted southwest of Tasmania, to the south of WA and in subantarctic waters south of Australia (Van Waerebeek *et al.* 2010). Their Australian range overlaps extensively with the SPF area from NSW across to southern WA.

Population size and trends

There are no estimates of the Australian regional abundance or global abundance of Gray's beaked whales and the Australian and global population trends are unknown (Bannister *et al.* 1996, Ross 2006, Taylor *et al.* 2008f, Woinarski *et al.* 2014). This species is the second most commonly stranded ziphiid in Australian waters and also commonly strands in New Zealand, and sightings indicate that they are relatively common off Tasmania and southern WA (Bannister *et al.* 1996, Van Waerebeek *et al.* 2010, Thompson *et al.* 2013, Groom *et al.* 2014). Gray's beaked whales may be relatively common and widespread in the Southern Ocean (Pitman 2009, Van Waerebeek *et al.* 2010).

Biology and feeding ecology

Gray's beaked whales grow to maximum sizes of about 5.3 m for females and 5.6 m for males and can weigh at least 1100 kg (Jefferson *et al.* 2008). These beaked whales occur mainly in deep-water habitats beyond the edge of the continental shelf, although some sightings are reported from shallow water often associated with individuals that are ill or coming in to strand (Gales *et al.* 2002, Dalebout *et al.* 2004, MacLeod and D'Amico 2006, Taylor *et al.* 2008f). Gray's beaked whales occur near the Antarctic continent during the austral summer with some sightings among sea ice (MacLeod *et al.* 2006, Jefferson *et al.* 2008, Van Waerebeek *et al.* 2010, Scheidat *et al.* 2011). Around southern Australia and New Zealand most strandings occur in summer and autumn, and records of females and calves may indicate some seasonal movements of females to lower latitude inshore habitats for calving and mating (Bannister *et al.* 1996, Dalebout *et al.* 2004, Ross 2008b, Thompson *et al.* 2013). In New Zealand waters, records of pregnant females and females in groups with dependent calves indicate that the calving season occurs during summer (Thompson *et al.* 2013). Sightings and strandings of Gray's beaked whales are usually of individuals or pairs, although mass strandings of up to 25–28 animals have been recorded at the Chatham Islands (Bannister *et al.* 1996, Gales *et al.* 2002, Dalebout *et al.* 2004, Van Waerebeek *et al.* 2010).

The diet of Gray's beaked whales is not well known but they are assumed to be deep divers that prey on mesopelagic and deep-water benthopelagic fish and squid occurring between 200 to 2000 m depths, although only fish remains have been confirmed from stomach contents (Bannister *et al.* 1996, MacLeod *et al.* 2003, Pitman 2009). Bioenergetic models developed to investigate linkages between feeding energetics and the requirements for survival and reproduction for Ziphiidae beaked whales indicate that beaked whales require energy dense prey and relatively high quality habitat to meet their requirements for successful reproduction (New *et al.* 2013). Poorer resource availability would be likely to lead to an extension of the inter-calving interval and reduced reproductive output, and even small but consistent non-lethal disturbances resulting in displacement from higher quality habitats could negatively affect their populations (New *et al.* 2013).

Little is known about the life history of Gray's beaked whales. Older males have heavy tooth-rake scarring that probably results from aggressive interactions between males using their single pair of tusk-like teeth (Ross 2008b, Dalebout *et al.* 2008). The age at sexual maturity, gestation, calving interval, maximum longevity and generation length for Gray's beaked whales are unknown.

Risks and threatening processes

Gillnet and longline fisheries operate throughout the range of Gray's beaked whales, hence some incidental bycatch is considered likely to occur (Taylor *et al.* 2008f). A female with propeller scars was observed in New Zealand waters indicating that a vessel strike had occurred (Dalebout *et al.* 2004). Potential threats include loud anthropogenic noise and acoustic disturbance such as military active sonar and seismic surveys that are known to cause disturbance and stress to other beaked whales (Cox *et al.* 2006), ingestion of plastic debris and bioaccumulation of persistent toxic pollutants, and prey depletion from expanding fisheries (Bannister *et al.* 1996, Woinarski *et al.* 2014). The potential effects of climate and oceanographic variability and change including ocean warming are uncertain but are predicted to be unfavourable for the species' range (MacLeod 2009).

Conservation and listing status

Gray's beaked whale is listed as a cetacean species under the EPBC Act, Rare in South Australia, but is not listed in other states within its Australian range (Woinarski *et al.* 2014). This species was recently assessed as Data Deficient in Australian waters (Woinarski *et al.* 2014), and as 'No category assigned but possibly secure' in the previous Australian conservation status assessments in Australian waters (Bannister *et al.* 1996, Ross 2006). Globally, Gray's beaked whale was assessed as Data Deficient for the IUCN Red List in 2008 (Taylor *et al.* 2008f) and is listed in Appendix II of CITES.

Hector's beaked whale *Mesoplodon hectori* (Level 2 PSA Residual Risk – High)

Distribution and range

Hector's beaked whales occur in cool temperate regions of the Southern Hemisphere from about 35°S to 55°S (Ross 2006), with most records from strandings in New Zealand, southern Australia, South Africa, southern South America, Brazil, the Falkland Islands and South Georgia (MacLeod *et al*. 2006, Ross 2008c, Van Waerebeek *et al*. 2010, Otley *et al*. 2012, Thompson *et al*. 2013).

Within Australian waters, Hector's beaked whales have been recorded from a small number of stranded individuals from Tasmania, SA and WA (Bannister *et al*. 1996, Kemper *et al*. 2005, Ross 2006, Van Waerebeek *et al*. 2010, Groom *et al*. 2014). One Hector's beaked whale with the species identity confirmed by DNA analysis of a skin sample was observed alive near Perth (32°S) in WA (Gales *et al*. 2002). This observation was significant as it was the first record of this species from the eastern Indian Ocean region (Gales *et al*. 2002). The range of Hector's beaked whale overlaps extensively with the SPF area across southern Australia.

Population size and trends

There are no estimates of the Australian regional abundance or global abundance of Hector's beaked whales and the Australian and global population trends are unknown (Bannister *et al*. 1996, Ross 2006, Taylor *et al*. 2008g, Woinarski *et al*. 2014). These beaked whales are thought to be quite rare, with only about 30 records globally (Baker 1999, Pitman 2009, Groom *et al*. 2014). Based on stranding records, Hector's beaked whales may be relatively more abundant around New Zealand (Thompson *et al*. 2013).

Biology and feeding ecology

Hector's beaked whales grow to lengths up to about 4.4 m for females and 4.3 m for males with a maximum weight of about 800 kg (Ross 2006, 2008c). Almost nothing is known about the biology and ecology of these beaked whales and their habitat is unknown, however beaked whales typically occur in deep offshore waters greater than 2000 m depth or over continental slopes (MacLeod and D'Amico 2006, Jefferson *et al*. 2008, Pitman 2009). The small approximately 3 m long male identified near Perth (WA) appeared to be in good condition and swam about 50 m from shore and this individual breached occasionally (Gales *et al*. 2002). Little information is available on the diet of Hector's beaked whales but they are known to prey on squid (Jefferson *et al*. 2008), and are assumed to be deep divers that prey on mesopelagic and deep-water benthopelagic species, similar to other beaked whale species (Bannister *et al*. 1996, MacLeod *et al*. 2003, Pitman 2009). New *et al*. (2013) developed bioenergetic models to investigate linkages between feeding energetics and the requirements for survival and reproduction for Ziphiidae beaked whales. The models indicate that beaked whales require energy dense prey and relatively high quality habitat to meet their requirements for successful reproduction (New *et al*. 2013). Poorer resource availability would be likely to lead to an extension of the inter-calving interval and reduced reproductive output, and even small but consistent non-lethal disturbances resulting in displacement from higher quality habitats could negatively affect their populations (New *et al*. 2013).

A female and calf pair were recorded from northern Tasmania during early April (Van Waerebeek *et al*. 2010), but very little is known about reproduction in these beaked whales. Adult males are scarred probably as a result of intraspecific fighting with a pair of small tusk-like teeth that erupt in males (Ross 2008c). Sexual maturity occurs at about 4.0 m length (Ross 2006), but the age at sexual maturity, gestation, calving interval, longevity and generation length for these beaked whales are unknown.

Risks and threatening processes

Little information is available to assess threats for this species, but Taylor *et al*. (2008g) considered that some fisheries bycatch was likely to occur throughout their range, and noted that even low levels of bycatch may not be sustainable. Like other beaked whales, Hector's beaked whales are considered likely to be vulnerable to anthropogenic noise and acoustic disturbance from naval active sonar and seismic surveys that are known to cause stress and in some cases are associated with strandings of other beaked whales (Cox *et al*. 2006). Climate change and oceanographic variability are predicted to be unfavourable for the range of this species (MacLeod 2009). Other potential threats for Hector's beaked whales include prey depletion from expanding fisheries, particularly for pelagic squid, ingestion of plastic debris and bioaccumulation of persistent toxic pollutants (Bannister *et al*. 1996, Woinarski *et al*. 2014).

Conservation and listing status

Hector's beaked whale is listed as a cetacean species under the EPBC Act, Rare in SA, but is not listed in other states within its Australian range (Woinarski *et al*. 2014). This species was recently assessed as Data Deficient in Australian waters (Woinarski *et al*. 2014), and similarly in the previous Australian conservation status assessments in Australian waters (Bannister *et al*. 1996, Ross 2006). Globally, Hector's beaked whale was assessed as Data Deficient for the IUCN

Red List in 2008 (Taylor *et al.* 2008g) and is listed in Appendix II of CITES.

Strap-toothed beaked whale *Mesoplodon layardii* (Level 2 PSA Residual Risk – High)

Distribution and range

Strap-toothed beaked whales have a circumpolar distribution in cold temperate waters in the Southern Hemisphere, with most records between 32°S to 60°S, with the southernmost record at 63°S (MacLeod *et al.* 2006, Jefferson *et al.* 2008, Van Waerebeek *et al.* 2010, Scheidat *et al.* 2011). Stranding records include Australia, New Zealand, the Kerguelen Islands, Heard Island, Argentina, the Falkland Islands, Uruguay and Brazil (MacLeod *et al.* 2006).

There have been more than 70 stranding records from Australian waters, making the strap-toothed beaked whales the most commonly stranded beaked whale species in the Australian region (Bannister *et al.* 1996, MacLeod *et al.* 2006, Ross 2008d, Groom *et al.* 2014). Australian stranding records include the most northern record for this species at 20°S in Queensland, with other strandings from NSW, Victoria, Tasmania, SA and WA, and two records from subantarctic Macquarie Island and one from Heard Island (Dixon 1980, Kemper and Ling 1991, Bannister *et al.* 1996, Baker and van Helden 1999, Kemper *et al.* 2005, Ross 2006, 2008, Van Waerebeek *et al.* 2010, Groom *et al.* 2014). Additional records of strap-toothed beaked whales occur in the Southern Ocean south of Australia (Van Waerebeek *et al.* 2010). Their Australian range overlaps completely with the SPF area from Queensland across to southern WA.

Population size and trends

There are no estimates of the Australian regional abundance or global abundance of strap-toothed beaked whales and the Australian and global population trends are unknown (Ross 2006, Taylor *et al.* 2008h, Woinarski *et al.* 2014). This species may not be rare compared with other *Mesoplodon* species (Taylor *et al.* 2008h), and they may be more common seasonally off southern Australia than other beaked whales based on their relatively high frequency of strandings (Bannister *et al.* 1996, Ross 2006, Groom *et al.* 2014).

Biology and feeding ecology

Strap-toothed beaked whales are one of the largest mesoplodont species with adult males growing to about 6.1 m long and females up to 6.2 m long, and they are estimated to weigh more than 1300 kg (Jefferson *et al.* 2008). These beaked whales are not well understood but are thought to occur mostly in cold temperate oceanic waters beyond the edge of the continental shelf, and feed seasonally in deep water areas with higher productivity over continental slope and submarine canyon habitats (MacLeod and D'Amico 2006, Ross 2008d, Pitman 2009). Increased strandings from January to April in Australian waters may indicate seasonal movements to lower latitude habitats in summer (Bannister *et al.* 1996, Ross 2008d).

Analyses of stomach contents indicate that strap-toothed beaked whales feed primarily on deep sea pelagic squid species with some fish and crustacean remains also recorded (Bannister *et al.* 1996, MacLeod *et al.* 2003, Pitman 2009). They are thought to be deep divers that prey on mesopelagic and deep-water species occurring between 200 to 2000 m depths, like other mesoplodont species (MacLeod *et al.* 2003, Pitman 2009). Bioenergetic models developed to investigate linkages between feeding energetics and the requirements for survival and reproduction for beaked whales indicate that they typically require energy dense prey and relatively high quality habitat to meet their requirements for successful reproduction (New *et al.* 2013). Poorer resource availability would be likely to lead to an extension of the inter-calving interval and reduced reproductive output, and even small but consistent non-lethal disturbances resulting in displacement from higher quality habitats could negatively affect their populations (New *et al.* 2013).

Strap-toothed beaked whales have been recorded in small groups of up to four animals (Bannister *et al.* 1996, Jefferson *et al.* 2008). Adult males develop a pair of highly distinctive and unusual 30 cm long, flattened tusk-like teeth that grow over the rostrum and prevent the jaw from opening widely (Dalebout *et al.* 2008). These teeth may be used in agonistic encounters among males, with older males becoming heavily scarred (Dalebout *et al.* 2008, Jefferson *et al.* 2008). Calves are recorded from summer months through to early autumn in Australian and New Zealand waters, and gestation is estimated to be about nine-12 months (Bannister *et al.* 1996, Thompson *et al.* 2013). The age at sexual maturity, calving interval, maximum longevity and generation length are unknown.

Risks and threatening processes

Taylor *et al.* (2008h) noted that gillnet and longline fisheries occur throughout the range of strap-toothed beaked whales, and considered that some incidental bycatch was likely to occur. These beaked whales are considered likely to be vulnerable to anthropogenic noise and acoustic disturbance from naval active sonar and seismic surveys, which are known to cause disturbance and stress in other beaked whales (Cox *et al.* 2006). Climate variability and change and ocean warming are predicted to be unfavourable for the range of this species (MacLeod 2009). Other potential threats for strap-toothed beaked whales include prey depletion from expanding fisheries, particularly for pelagic squid, ingestion of plastic debris and bioaccumulation of persistent toxic pollutants (Bannister *et al.* 1996, Woinarski *et al.* 2014).

Conservation and listing status

The strap-toothed beaked whale is listed as a cetacean species under the EPBC Act, but is not listed in any states within its Australian range (Woinarski *et al.* 2014). This species was recently assessed as Data Deficient in Australian waters (Woinarski *et al.* 2014), and as 'No category assigned but possibly secure' in the previous Australian conservation status assessments in Australian waters (Bannister *et al.* 1996, Ross 2006). Globally, the strap-toothed beaked whale was assessed as Data Deficient for the IUCN Red List in 2008 (Taylor *et al.* 2008h) and is listed in Appendix II of CITES.

True's beaked whale *Mesoplodon mirus* (Level 2 PSA Residual Risk – High)

Distribution and range

True's beaked whales appear to have an unusual disjunct, anti-tropical distribution with isolated populations in the Northern Hemisphere in the North Atlantic Ocean, and in the Southern Hemisphere (MacLeod *et al.* 2006, Jefferson *et al.* 2008, Taylor *et al.* 2008i). These disjunct populations have some differences in colouration and cranial characteristics (Jefferson *et al.* 2008), and a deep mitochondrial DNA divergence that is similar to the differences between some other *Mesoplodon* species, but further research is needed to determine whether these divergent populations represent distinct species or subspecies (MacLeod *et al.* 2006, Dalebout *et al.* 2007). In the Southern Hemisphere, stranding records are from temperate regions of the southern Indian Ocean from South Africa, from southern Australia, New Zealand and in southern Brazil, with sightings off Madagascar (MacLeod *et al.* 2006, Constantine *et al.* 2014).

Within Australian waters, True's beaked whales have been recorded from some stranded individuals from Tasmania, Victoria and WA (Bannister *et al.* 1996, Ross 2006, 2008e, Groom *et al.* 2014), with live sightings off southern NSW noted in Ross (2008e). Their Australian range overlaps extensively with the SPF area from southern NSW across to southern WA.

Population size and trends

There are no estimates of the Australian regional abundance or global abundance of True's beaked whales and the Australian and global population trends are unknown (Bannister *et al.* 1996, Ross 2006, Taylor *et al.* 2008i, Woinarski *et al.* 2014). Observations of True's beaked whales are extremely rare (Ross 2008e). Taylor *et al.* (2008i) noted that this species might not be rare in the North Atlantic Ocean.

Biology and feeding ecology

True's beaked whales grow to about 4.9–5.3 m long and weigh up to 1.4 t (Ross 2006, 2008e). Little information is available on the biology and ecology of True's beaked whales and their habitat is largely unknown, however beaked whales typically occur in deep offshore waters greater than 2000 m depth or over continental slopes and this species has been sighted over deep water greater than 1000 m depth near a steep drop-off (Tove 1995, MacLeod and D'Amico 2006, Jefferson *et al.* 2008, Pitman 2009). Stranded True's beaked whales have had *Loligo* spp. and other squid beaks and fish remains in their stomachs and they are thought to prey on mesopelagic and deep-water benthopelagic squid and some fish species occurring between 200 to 2000 m depths, similar to other beaked whale species (Bannister *et al.* 1996, MacLeod *et al.* 2003, Jefferson *et al.* 2008, Constantine *et al.* 2014). New *et al.* (2013) developed bioenergetic models to investigate linkages between feeding energetics and the requirements for survival and reproduction for Ziphiidae beaked whales. The models indicate that beaked whales require energy dense prey and relatively high quality habitat to meet their requirements for successful reproduction (New *et al.* 2013). Poorer resource availability would be likely to lead to an extension of the inter-calving interval and reduced reproductive output, and even small but consistent non-lethal disturbances resulting in displacement from higher-quality habitats could negatively affect their populations (New *et al.* 2013).

True's beaked whales have been observed in small groups of up to three individuals (e 2008, Jefferson *et al.* 2008). Little is known about reproduction in these beaked whales, but stranding records from WA included two mother and calf pairs and two individual calves, which Groom *et al.* (2014) considered might indicate that breeding occurs in waters off the WA coast. Weaning is thought to occur at about one year of age (Ross 1984), but age at sexual maturity, gestation, calving interval, longevity and generation length are unknown.

Risks and threatening processes

Very little information is available on threats to this species, however Taylor *et al.* (2008i) considered that fisheries bycatch from gillnets in deep water was probably the most significant threat. True's beaked whales are likely to be vulnerable to anthropogenic noise and acoustic disturbance from naval active sonar and seismic surveys that are known to cause stress and in some cases are associated with strandings of other deep-diving beaked whales (Cox *et al.* 2006, Taylor *et al.* 2008i). Some stranded individuals had swallowed plastic debris that may have led to their death (Taylor *et al.* 2008i, Constantine *et al.* 2014). Climate change and oceanographic variability are predicted to be unfavourable for the range of this species (MacLeod 2009). Other potential threats include prey depletion from expanding fisheries, particularly for pelagic squid, and bioaccumulation of persistent toxic pollutants (Bannister *et al.* 1996, Woinarski *et al.* 2014).

Conservation and listing status

True's beaked whale is listed as a cetacean species under the EPBC Act, but is not listed in states within its Australian range (Woinarski *et al.* 2014). This species was recently assessed as Data Deficient in Australian waters (Woinarski *et al.* 2014), and similarly in the previous Australian conservation status assessments in Australian waters (Bannister *et al.* 1996, Ross 2006). Globally, True's beaked whale was assessed as Data Deficient for the IUCN Red List in 2008 (Taylor *et al.* 2008i) and is listed in Appendix II of CITES.

Cuvier's beaked whale *Ziphius cavirostris* (Level 2 PSA Residual Risk – High)

Distribution and range

Cuvier's beaked whale are the most widely distributed species of beaked whale with an extensive distribution in all oceans and most seas including the Mediterranean Sea, extending from tropical to temperate regions and some polar regions in both hemispheres (MacLeod *et al.* 2006, Heyning and Mead 2009, Van Waerebeek *et al.* 2010). Their distribution in Australian waters is poorly known but they have been recorded from all states and the Northern Territory (Bannister *et al.* 1996, Warneke 2008c, Groom *et al.* 2014). Cuvier's beaked whales have also been recorded from Macquarie Island (Ross 2006) and Christmas Island (Brewer *et al.* 2009), and with some sightings from eastern Australia (MacLeod *et al.* 2006). Their Australian range overlaps completely with the SPF area from Queensland across to southern WA.

Population size and trends

There are no reliable estimates of the Australian regional abundance or the total global abundance of Cuvier's beaked whales, and the Australian and global population trends are unknown (Ross 2006, Taylor *et al.* 2008j, Woinarski *et al.* 2014). However, worldwide abundance was suggested to be well over 100,000 individuals with about 80,000 in the eastern tropical Pacific, and about 15,000 in waters around Hawai'i (Taylor *et al.* 2008j). Dalebout *et al.* (2005) estimated the global population to be larger with about 456,000 to 916,000 breeding adults, based on levels of genetic variation. Warneke (2008c) noted that their abundance in Australian waters was unknown but they may be abundant, and acoustic surveys in the Coral Sea indicate that beaked whales (most likely including Cuvier's beaked whales) may be much more abundant than indicated by their infrequent sightings and strandings records (Parnum *et al.* 2011).

Biology and feeding ecology

Cuvier's beaked whales grow to an average size of about 6.1 m with the longest reliably measured individual recorded to be 6.9 m long, and maximum weight is nearly 3000 kg (Jefferson *et al.* 2008, Heyning and Mead 2009). These beaked whales are pelagic and primarily occur in offshore waters greater than 200–1000 m deep near the continental slope and submarine canyon habitats, around oceanic islands and in some enclosed seas (Jefferson *et al.* 2008, Taylor *et al.* 2008j). Dalebout *et al.* (2005) analysed global genetic structure of Cuvier's beaked whales and found a high degree of isolation and low maternal gene flow among oceanic populations and also in some regional populations, particularly in the Mediterranean Sea where the population was highly differentiated from the North Sea.

Cuvier's beaked whales are extraordinary divers with recent dive records including dives to 2992 m depth and a duration of 137 minutes, which are both new mammalian dive records (Schorr *et al.* 2014). These beaked whales have a stereotypic pattern of deep and shallow dives, with deep dives having a mean depth of 1400 m and duration of 67 minutes, and many of the deep dives exceed their aerobic dive limit by a factor of two or more (Schorr *et al.* 2014). Stomach contents from relatively few individuals have been analysed but they appear to feed primarily on mesopelagic and deep-sea squid and fish, and occasionally take crustaceans (MacLeod *et al.* 2003, Taylor *et al.* 2008j, Heyning and Mead 2009). They appear to feed both in the water column and near the bottom (Jefferson *et al.* 2008). Bioenergetic models developed to investigate linkages between feeding energetics and the requirements for survival and reproduction for Ziphiidae beaked whales indicate that these whales require energy dense prey and relatively high quality habitat to meet their requirements for successful reproduction (New *et al.* 2013). Poorer resource availability would be likely to lead to an extension of the inter-calving interval and reduced reproductive output. New *et al.* (2013) concluded that even small but consistent non-lethal disturbances resulting in displacement from higher-quality habitats could negatively affect beaked whale populations.

Cuvier's beaked whales strand relatively frequently, with most strandings from Australian waters occurring from January to July, which suggests that these beaked whales make some seasonal movements to the edge of the continental shelf (Bannister *et al.* 1996, Warneke 2008c). These whales are mostly observed in small groups of two to seven individuals or alone, with some larger groups containing up to 25 individuals occasionally recorded (Warneke 2008c, Jefferson *et al.* 2008). Adult males are thought to use their single pair of conical teeth as weapons in agonistic encounters, resulting in heavy scarring in older males (Warneke 2008c, Heyning and Mead 2009). Relatively little is known about the reproductive biology of Cuvier's beaked whales. Age at sexual maturity is about 11 years for both sexes, with maximum longevity of at least 28 years for females and 47 years for males (Warneke 2008c). Generation length may be about 25 years for this species (Woinarski *et al.* 2014).

Risks and threatening processes

Cuvier's beaked whales have been taken as bycatch in some cetacean fisheries, including opportunistic catches in the Japanese beaked whale fishery (Taylor *et al*. 2008j). Bycatch of these beaked whales has been reported in some drift gillnet fisheries, the Italian swordfish fishery and in some other fisheries, and assessments of regional stranding data indicate that the most common human-related cause of mortality for these beaked whales was entanglement and incidental captures, followed by shooting or spearing (Taylor *et al*. 2008j, Weir and Pearce 2013). This species was listed as a cetacean interaction in the Western and Central Pacific Fisheries Commission (WCPFC) tropical purse seine fishery during 2007–2009, with one individual encountered and zero mortalities in 2010 (WCPFC-SC8-2012). Cuvier's beaked whales appear to be exceptionally sensitive to anthropogenic noise disturbance, acoustic trauma and diving-related pathologies, particularly associated with the use of military mid-frequency active sonar which has been implicated in mass strandings of this species and some other deep-diving whales (Frantzis 1998, Jepson *et al*. 2003, Fernandez *et al*. 2005, Cox *et al*. 2006, MacLeod and D'Amico 2006, D'Amico *et al*. 2009). Other potential threats include prey depletion from expanding commercial fisheries, and bioaccumulation of persistent toxic pollutants (Bannister *et al*. 1996, Ross 2006, Woinarski *et al*. 2014).

Conservation and listing status

Cuvier's beaked whale is listed as a cetacean species under the EPBC Act, Rare in SA, Data Deficient in the Northern Territory, but is not listed in other states in its Australian range (Woinarski *et al*. 2014). This species was recently assessed as Least Concern in Australian waters but its conservation is poorly resolved (Woinarski *et al*. 2014). In the previous Australian conservation status assessments in Australian waters this species was assessed as 'No category assigned but possibly secure' (Bannister *et al*. 1996, Ross 2006). Globally, Cuvier's beaked whale was assessed as Least Concern for the IUCN Red List in 2008 (Taylor *et al*. 2008j) and is listed in Appendix II of CITES. A proposal to list the Mediterranean subpopulation of Cuvier's beaked whale on Appendix I of the Convention on the Conservation of Migratory Species of Wild Animals was endorsed at the eleventh Conference of the Parties in Ecuador in November 2014.

Pygmy killer whale *Feresa attenuata* (Level 2 PSA Residual Risk – High)

Distribution and range

The pygmy killer whale has an extensive circumglobal distribution in tropical to subtropical regions in the Pacific, Indian and Atlantic oceans (Jefferson *et al*. 2008, Donahue and Perryman 2009). Most records of pygmy killer whales occur between 35°S and 40°N, with a few higher latitude sightings and stranding events that are considered to be mostly extra-limital records that may be associated with unusual warm water conditions (Taylor *et al*. 2008k, Donahue and Perryman 2009, Owen and Donnelly 2014, Ender *et al*. 2014). In Australian waters, pygmy killer whales have been sighted near the edge of the continental shelf off Wollongong in NSW and off Eden near 37°S and in the area to the northeast of Australia, with stranding records from northern NSW and WA (Bryden 1976, Bannister *et al*. 1996, Ross 2006, Owen and Donnelly 2014). One beach cast individual was reported from Denial Bay in SA (Kemper 2008b). Its southern Australian range overlaps partly with the SPF area off NSW and southern Queensland and southern WA.

Population size and trends

There are no estimates of the Australian regional abundance or global abundance of pygmy killer whales and the Australian and global population trends are unknown (Ross 2006, Taylor *et al*. 2008k, Woinarski *et al*. 2014). These whales are considered to be uncommon or rare throughout their range and are one of the least known small delphinid species (Ross 2006, McSweeney *et al*. 2009, Donahue and Perryman 2009). Sightings are more frequent in the eastern tropical Pacific, Hawai'i and Japan (McSweeney *et al*. 2009). Wade and Gerrodette (1993) estimated the abundance of pygmy killer whales in the eastern tropical Pacific region to be about 38,900 (CV = 0.31) and noted that this was the second lowest abundance of the delphinid species documented in that region. A small population of island-associated pygmy killer whales occurs off Hawai'i (Taylor *et al*. 2008k).

Biology and feeding ecology

Pygmy killer whales grow to about 2.6 m long and can weigh up to 225 kg (Jefferson *et al*. 2008). They typically occur in deep offshore warm-water oceanic habitats and have been observed near the edge of the continental shelf (Taylor *et al*. 2008k, Owen and Donnelly 2014). They are rarely observed in nearshore waters except around some oceanic islands such as Hawai'i where sightings occur from about 3 to 16 km offshore in habitat depths ranging from 113 m to greater than 2800 m (McSweeney *et al*. 2009). Long-term resighting records off Hawai'i over a 21-year period indicate year-round use of the area by a small population with high site-fidelity and stable long-term associations in mixed-sex groups (McSweeney *et al*. 2009). Group size usually ranges from a few to about 50 individuals although larger groups containing several hundred whales have been observed (Ross 2006, Jefferson *et al*. 2008, Donahue and Perryman 2009, Owen and Donnelly 2014).

Little is known about the diet and other aspects of the biology of pygmy killer whales. They have been reported to feed on cephalopods, fish and some other cetaceans, and stomach contents of individuals that were caught as bycatch in fisheries or stranded contained remnants of small fish and squid (Zerbini and Santos 1997, Donahue and Perryman 2009). These small whales have been reported to attack and occasionally eat other small cetaceans including spinner and common dolphins involved with tuna fishery interactions in the eastern tropical Pacific and in the South Atlantic Ocean (Ross 2008f, Taylor *et al*. 2008k). Females are sexually mature at about 2.3 m length (Ross 2008f), but the breeding season, gestation period, calving interval, longevity and generation length for pygmy killer whales are not known.

Risks and threatening processes

The relatively low abundance and apparent small subpopulation sizes of pygmy killer whales make them particularly susceptible to human impacts and small takes (Taylor *et al*. 2008k). Ross (2006) considered that this species is likely to be taken in illegal and incidental catches in northern Australian waters. Two pygmy killer whales were reported killed as bycatch in WCPFC tropical purse seine fishery, in 2009 (WCPFC SC8 2012). Directed catch in harpoon and driftnet fisheries and incidental bycatch in fisheries operations in Indonesia, the Philippines, Sri Lanka, Taiwan, Japan, Ghana and the Caribbean region are reported (Reeves *et al*. 2003, 2013, Taylor *et al*. 2008k, Donahue and Perryman 2009, Weir and Pierce 2013). Ender *et al*. (2014) noted that interactions with fisheries and entanglement in marine debris are emerging threats for this species in Indonesian waters.

Recent records of mass strandings, mostly from Taiwan, have been associated with increased anthropogenic noise and acoustic disturbances particularly involving loud sounds from seismic surveys and use of military active sonar (Brownell *et al*. 2009). Other threats include pollution and climate change and oceanographic variability, with prey depletion due to fisheries noted as a potential threat (Taylor *et al*. 2008k, Woinarski *et al*. 2014).

Conservation and listing status

The pygmy killer whale is listed as a cetacean species under the EPBC Act, but the species is not listed in any states in its Australian range (Woinarski *et al*. 2014). This species was recently assessed as Data Deficient in Australian waters (Woinarski *et al*. 2014), and similarly in previous Australian conservation status assessments in Australian waters (Bannister *et al*. 1996, Ross 2006). Globally, the pygmy killer whale was assessed as Data Deficient for the IUCN Red List in 2008 (Taylor *et al*. 2008k) and is listed in Appendix II of CITES.

False killer whale *Pseudorca crassidens* (Level 2 PSA Residual Risk – High)

Distribution and range

The false killer whale has an extensive circumglobal distribution in tropical to warm temperate regions between latitudes 45°N and 45°S with some individuals moving to higher latitude cold temperate habitats occasionally (Ross 2006, Warneke 2008d, Taylor *et al*. 2008l). Their distribution in Australian waters is poorly known but they have been recorded from numerous strandings from all states and the Northern Territory and have been sighted in many locations in tropical and temperate seas (Bannister *et al*. 1996, Chatto and Warneke 2000, Kemper *et al*. 2005, Ross 2006). This species has also been reported from Scott Reef off north-west WA and the Cocos (Keeling) Islands (Brewer *et al*. 2009). Their Australian range overlaps completely with the SPF area from Queensland across to southern WA.

Population size and trends

There are no estimates of the Australian regional abundance or global abundance of false killer whales and the Australian and global population trends are unknown (Taylor *et al*. 2008l, Woinarski *et al*. 2014). Although this species is widely distributed and there have been numerous strandings, they are considered to be naturally uncommon throughout their range (Baird 2009). Between 1970 and 1996 mass strandings occurred on average every two-and-a-half years and involved about 20–250 individuals hence the population size in Australian waters was suggested to be greater than 10,000 individuals (Bannister *et al*. 1996, Woinarski *et al*. 2014). Wade and Gerrodette (1993) estimated the abundance of false killer whales in the eastern tropical Pacific region to be about 39,800 (CV = 0.64), with other regional estimates including about 16,000 (CV = 0.26) in coastal waters of Japan and China (Taylor *et al*. 2008l), 1552 (CV = 0.66) for the Hawaiian pelagic stock and 552 (CV = 1.09) for the Northwestern Hawaiian Islands (Bradford *et al*. 2014).

Biology and feeding ecology

False killer whales grow to about 5 m long for females and up to 6 m long for males, which can weigh up to 2000 kg (Jefferson *et al*. 2008, Baird 2009). False killer whales from Japan are about 10–20 per cent larger than those in South Africa (Ferreira *et al*. 2014). They generally occur in deep oceanic habitats but will approach closer to shore and use shallow-water areas around oceanic islands and sometimes over the continental shelf (Jefferson *et al*. 2008, Baird 2009). These whales are regularly sighted in the semi-enclosed Port Essington harbour in the Northern Territory

(Palmer *et al*. 2010). Seasonal movements are known in some areas and may be associated with movements of warm currents and prey availability (Warneke 2008d). Strandings in southern Australia mostly occur from May to September and may indicate some seasonal movement inshore or dispersal along the continental shelf (Bannister *et al*. 1996).

These whales are highly social and typically occur in groups of 10–100 individuals but can aggregate to form large herds containing about 100 up to 1000 whales that appear to be temporary associations of smaller groups that aggregate to feed on locally abundant prey (Ross 2006, Warneke 2008d, Baird 2009). Long-term associations of some individuals have been documented over 15 years in Hawaiian waters, and strong social bonds are evident among identified individuals, which may influence their propensity for mass stranding (Baird 2009). They are one of the species most commonly involved with mass-stranding events with the largest stranding event recorded involving 835 individuals (Jefferson *et al*. 2008, Baird 2009). False killer whales prey mainly on large pelagic fish, including tunas and sailfish, and squid, but also feed on smaller dolphins released from tuna purse seine fisheries in the eastern tropical Pacific, and have been recorded to prey upon a humpback whale calf *Megaptera novaeangliae* and attack sperm whales *Physeter macrocephalus* (Baird *et al*. 2008b, Baird 2009). Age at sexual maturity is thought to be about eight–10 years for females and 10–18 years for males from Japan, gestation is about 15.5 months and calving interval is about 6.9 years in Japan and increases with age (Warneke 2008d, Baird 2009, Ferreira *et al*. 2014). Maximum age is estimated to be about 57 years for males and 62 years for females (Baird 2009), and generation length may be about 35 years (Woinarski *et al*. 2014).

Risks and threatening processes

Large numbers of false killer whales have been taken in drive fisheries in Japan and Taiwan, and they are hunted opportunistically in Japan, Taiwan, Indonesia and the West Indies (Taylor *et al*. 2008l). Their depredation of fish from commercial longlines and sport fishing has resulted in considerable bycatch and deliberate culling in some regions (Hamer *et al*. 2012). The rate of bycatch mortality or serious injury from longline interactions in Hawaiian waters exceeds their Potential Biological Removal limit and is biased towards females which is likely to have an increased impact on population growth (Baird *et al*. 2014), and considerable declines in abundance of false killer whales have been reported around Hawai'i since the 1980s (Reeves *et al*. 2009). Bycatch mortality of false killer whales was reported in the offshore gillnet fishery in northern Australia in the 1980s (Harwood and Hembree 1987), and bycatch occurs in purse seine nets in the eastern tropical Pacific, and in trawl, gill and other nets in Chinese coastal fisheries (Taylor *et al*. 2008l, Reeves *et al*. 2013). False killer whales are known to ingest discarded plastic, and high levels of cadmium and other toxins have been recorded in stranded animals (Kemper *et al*. 1994, Baird 2009). Potential threats include prey depletion from commercial fisheries, and false killer whales are considered likely to be vulnerable to anthropogenic noise and acoustic disturbance, particularly from military active sonar and seismic surveys (Cox *et al*. 2006, Woinarski *et al*. 2014).

Conservation and listing status

The false killer whale is listed as a cetacean species under the EPBC Act, Rare in South Australia, Least Concern in the Northern Territory, but is not listed in other states within its Australian range (Woinarski *et al*. 2014). This species was recently assessed as Data Deficient in Australian waters (Woinarski *et al*. 2014), and as 'No category assigned but possibly secure' in the previous conservation status assessments in Australian waters (Bannister *et al*. 1996, Ross 2006). Globally, the false killer whale was assessed as Data Deficient for the IUCN Red List in 2008 (Taylor *et al*. 2008l) and is listed in Appendix II of CITES.

Australian humpback dolphin *Sousa sahulensis* (formerly Indo-Pacific humpback dolphin *Sousa chinensis*) (Level 2 PSA Residual Risk – High)

Distribution and range

The Australian humpback dolphin is a recently described new species resulting from a comprehensive taxonomic revision of the humpback dolphin genus *Sousa* based on evidence from skeletal and external morphology, phylogenetic analyses and colouration (Jefferson and Rosenbaum 2014). The Australian humpback dolphin species was previously included within the Indo-Pacific humpback dolphin species *Sousa chinensis*, but their distribution ranges are now recognised to be separated by a wide distribution gap coinciding with Wallace's Line (Jefferson and Rosenbaum 2014). The Australian humpback dolphin occurs in Australian waters ranging from subtropical regions in southern Queensland and northern NSW (31°27'S) across northern Australia and along the coast of WA south to Shark Bay (25°S), as well as in waters of the Sahul Shelf off northern Australia extending to southern New Guinea (Chatto and Warneke 2000, Parra *et al*. 2004, Ross 2006, Parra and Ross 2009, Cagnazzi *et al*. 2011, Allen *et al*. 2012, Jefferson and Rosenbaum 2014, Palmer *et al*. 2014a). Their Australian range overlaps slightly with the SPF area in northern NSW and southern Queensland.

Population size and trends

The population size and trends of Australian humpback dolphins in Australian and New Guinea waters are not reliably known, however Woinarski *et al*. (2014) considered that the Australian population may be about 10,000 mature individuals (plausible range 5000 to 20,000). Population trends have been assessed at only a few Australian sites and only over relatively short periods, and most of these sites include areas with intensive coastal and port development pressures, hence subpopulation declines reported from two of these sites may not be representative of other subpopulations across northern Australia (Woinarski *et al*. 2014).

Abundance estimates are available for four subpopulations along the east coast of Queensland. In Moreton Bay, southeastern Queensland abundance estimates were 163 (95 per cent confidence interval (CI) = 108–251) for 1984–1986, and 119 (95 per cent CI = 81–166) for 1985–1987, with an overall density estimated to be about one dolphin per 10 square kilometres (km^2) in the bay (Corkeron *et al*. 1997). Further north, abundance in the Great Sandy Strait region was estimated to be about 150 Australian humpback dolphins (95 per cent CI = 132–165), and association patterns and resighting data indicated that the subpopulation consists of two largely geographically distinct communities with the southern community consisting of about 75 individuals (95 per cent CI = 66–83) and the northern community about 76 individuals (95 per cent CI = 71–86) (Cagnazzi *et al*. 2011). Extensive surveys along the central Queensland coast during 2006–2011 identified three subpopulations of humpback dolphins occurring in Port Curtis, Keppel Bay and in the northern region of the study area, with some movement of individuals evident between the three areas (Cagnazzi 2011). Abundance estimates from the industrialised Port Curtis declined from 84 dolphins in 2007 to 76 dolphins in 2010, and declined significantly to about 45 dolphins after 2010 following a large flood and substantial port expansion and development (D. Cagnazzi pers. comm. in Woinarski *et al*. 2014). Abundance in Keppel Bay declined from about 114 to about 104 dolphins after the flood. This subpopulation had significantly higher juvenile survival compared with the Port Curtis subpopulation. Abundance in the northern region was estimated to be about 64 dolphins (Cagnazzi 2011). These data indicate that the combination of flood impacts and habitat disturbance from large-scale port development can significantly reduce the abundance of Australian humpback dolphin subpopulations that use tropical coastal habitats (D. Cagnazzi pers. comm. in Woinarski *et al*. 2014). Abundance in Cleveland Bay, in north-east Queensland was estimated at 59 (95 per cent CI = 44–78) dolphins, but most individuals were not permanent residents, but used the area regularly and temporarily emigrating then re-immigrating into the bay (Parra *et al*. 2006a). This species also occurs further north along the northern Queensland coast but abundance estimates are not available for that region.

In Northern Territory waters, minimum subpopulation sizes were estimated to vary from 133 to 145 individuals in Darwin Harbour, and total abundance estimates in Port Essington were highly variable among sampling periods, ranging from 48 to 207 humpback dolphins (Palmer *et al*. 2014a, 2014b). Bejder *et al*. (2012) estimated that the total abundance of humpback dolphins in WA waters was likely to be less than 5000 individuals. Brown *et al*. (2012) photo-identified 54 humpback dolphins around North West Cape and suggested that this area may represent an important habitat, and Allen *et al*. (2012) documented high encounter rates with humpback dolphins in the Dampier Archipelago and off Port Hedland.

Corkeron *et al*. (1997) speculated that humpback dolphins may be in decline in Australian waters, but noted that the conservation status of subpopulations was largely unknown throughout their Australian range.

Biology and feeding ecology

Australian humpback dolphins grow to about 2.7 m long (Jefferson and Rosenbaum 2014), and typically occur in protected coastal habitats mostly in shallow waters less than 15 m deep near estuarine river mouths, tidal channels and mangroves, and in some inshore reef habitats (Parra *et al*. 2002, 2006b, Parra 2006, Allen *et al*. 2012, Palmer *et al*. 2014a). Aerial surveys along the Great Barrier Reef (GBR) demonstrated that most humpback dolphins occurred within 10 km of the coast, but in the northern GBR they have been recorded further offshore in sheltered waters (Corkeron *et al*. 1997). In Northern Territory waters, all 138 records of humpback dolphins from a collated database were within 10 km of the coast and within 20 km of river mouths, and nearly 25 per cent of records were in tidal rivers with some individuals sighted in tidal sections of rivers up to 50 km upstream from the river mouth (Palmer *et al*. 2014a). In northwestern Australia, humpback dolphins also occur around islands and near steep coastal cliffs away from their typical shallow coastal habitat (Allen *et al*. 2012).

Australian humpback dolphins are often sympatric with Australian snubfin dolphins *Orcaella heinsohni*, but they can occur further away from estuaries and river mouths and in slightly deeper waters than snubfin dolphins in northeastern Australian regions (Parra 2006, Parra *et al*. 2006b). Australian humpback dolphins and snubfin dolphins interact frequently; occasional interbreeding and hybridisation has been recorded (Jefferson and Rosenbaum 2014). Humpback dolphins also frequently occur with Indo-Pacific bottlenose dolphins *Tursiops aduncus* in Western Australian waters (Allen *et al*. 2012, Brown *et al*. 2012). Australian humpback dolphins appear to have a fission-fusion society characterised by mostly short-term interactions between individuals apart from mothers and calves, and they usually occur in small groups ranging in size from one–12 dolphins with a mean group size of about 3.5 dolphins, although larger groups have been recorded foraging behind fishing trawlers (Parra *et al*. 2002, 2006b, 2011, Cagnazzi 2011). These humpback dolphins appear to be opportunistic and generalist feeders that prey on a wide variety of coastal, estuarine and some reef-associated fish species, and some cephalopods and crustaceans (Ross 1984, Hale 1997, Parra and Ross 2009, Parra *et al*. 2011). Stomach contents from six humpback dolphins killed in shark nets or stranded along the Queensland coast between 1970 and 2008 were dominated by teleost fish, particularly grunt fish *Pomadasys* sp., cardinal fish *Apogon* sp., and smelt-whiting *Sillago* sp., with low numbers of cephalopods and bivalves present in one stomach (Parra and Jedensjo 2014).

No detailed studies have been completed on the life history of Australian humpback dolphins, but the available information suggests that it may be similar to its congener *S. chinensis* (Jefferson and Rosenbaum 2014). Studies of *S. chinensis* indicate that sexual maturity occurs at about nine–14 years for females and 13–16 years for males, gestation is about 10–12 months, and the interbirth interval is about 3–5 years (Taylor *et al*. 2007, Porter 2008, Parra and Ross 2009). A captive individual held at the SeaWorld theme park in southern Queensland was estimated to be at least 48 years of age (Jefferson and Rosenbaum 2014), and generation length is estimated to be 20.4 years for *S. chinensis* (Taylor *et al*. 2007).

Risks and threatening processes

Australian humpback dolphins have small subpopulation sizes that appear to be relatively isolated and genetically differentiated, they have a relatively slow reproductive rate, and they rely on coastal habitats that are increasingly being altered by human activities, which makes them highly vulnerable to local population decline or extirpation (Parra *et al*. 2006a, 2011, Cagnazzi 2011, Allen *et al*. 2012). In Australian waters, humpback dolphins are subject to entanglement and bycatch mortality in shark nets deployed for protection of bathers and in various types of fishing nets including gillnets, which could lead to local depletion of subpopulations (Paterson 1990, Hale 1997, Gribble *et al*. 1998, Parra *et al*. 2004, Cagnazzi *et al*. 2011). Increasing coastal development and port expansion with associated increases in catchment run-off and reduced water quality, increased vessel movements and anthropogenic noise disturbance are all likely to cause disturbance, stress and disrupt behaviour, and will degrade important coastal habitats for humpback dolphins in Australian waters (Bannister *et al*. 1996, Woinarski *et al*. 2014). Elevated levels of organochlorine compounds and polycyclic aromatic hydrocarbons have been detected from biopsy samples of Australian humpback dolphins in the central and southern GBR region (Cagnazzi *et al*. 2013) that could impair the function of their immune, endocrine and nervous systems, health status or reproduction (Evans 2003). Toxoplasmosis infection was recorded in this species from Townsville, north Queensland following flood events and possibly contaminated run-off from urban coastal areas (Bowater *et al*. 2003). Prey depletion from commercial fisheries is a potential threat for humpback dolphin subpopulations and may be exacerbated by other forms of habitat degradation (Bannister *et al*. 1996, Woinarski *et al*. 2014). Predicted increases in severe cyclones and flood events associated with climate variability and change could affect key coastal habitats for these dolphins (Woinarski *et al*. 2014).

Conservation and listing status

The recently described *Sousa sahulensis* humpback dolphin species in Australian waters is not currently listed under the EPBC Act, however, the humpback dolphin is listed under its former name *Sousa chinensis* as a cetacean species and as a listed migratory species under the EPBC Act, Near Threatened in Queensland, Data Deficient in the Northern Territory, Priority 4 in WA, but the species is not listed in NSW (Woinarski *et al*. 2014). The humpback dolphin was recently assessed as Near Threatened in Australian waters by Woinarski *et al*. (2014), who noted that its conservation status was difficult to categorise due to uncertainty about population size and trends, and that a categorisation of Data Deficient may also be appropriate. The humpback dolphin was previously assessed as 'Insufficiently known' in Australian waters (Bannister *et al*. 1996, Ross 2006). Due to the recent recognition and separation of this species from *S. chinensis*, there is no global assessment of *Sousa sahulensis* for the IUCN Red List. The congener *S. chinensis* was assessed as Near Threatened in 2008 (Reeves *et al*. 2008) and is listed in Appendix I of CITES.

Rough-toothed dolphin *Steno bredanensis* (Level 2 PSA Residual Risk – High)

Distribution and range

Rough-toothed dolphins occur in tropical to warm temperate regions of the Pacific, Indian and Atlantic Oceans and in many semi-enclosed seas, with a latitudinal range mostly between 40°N and 35°S (Jefferson *et al*. 2008, West *et al*. 2011). Their distribution in Australian waters is poorly known, with records from southern NSW, Queensland, Northern Territory and Barrow Island off WA (Bannister *et al*. 1996, Ross 2006). Their Australian range overlaps partly with the eastern SPF area from southern NSW to Queensland.

Population size and trends

There is no robust estimate of the Australian regional population size of rough-toothed dolphins and the Australian and global population trends are unknown (Hammond *et al*. 2008, Woinarski *et al*. 2014). Ross (2008g) considered that this species was common in Australian waters, and globally it is considered to be abundant with no reported population declines (Hammond *et al*. 2008). The population size and status of rough-toothed dolphins is poorly known throughout most of their range (West *et al*. 2011). Wade and Gerrodette (1993) estimated the abundance of rough-toothed dolphins in the eastern tropical Pacific region to be about 145,900 (CV = 0.32), with other regional estimates including about 2223 (CV = 0.41) in the northern Gulf of Mexico, and 8709 (CV = 0.45) for the United States Exclusive Economic Zone (EEZ) around the Hawaiian Islands (Barlow 2006, West *et al*. 2011).

Biology and feeding ecology

Rough-toothed dolphins are slightly sexually dimorphic with females growing to about 2.7 m long and males growing to about 2.8 m long, with an average body weight of 130 kg and a maximum recorded weight of 155 kg (West *et al*. 2011). These dolphins are generally found in deep oceanic waters beyond the continental shelf and are commonly sighted in deep water habitats greater than 500-2000 m depth closer to the coasts of steep volcanic islands, but they also occur in shallow coastal waters in some regions (Ross 2008g, West *et al*. 2011).

These dolphins can be solitary or occur in groups of 10–20 individuals, but can aggregate to form larger groups containing up to 160 dolphins (West *et al*. 2011). They appear to have a fission-fusion type of social organisation, and form dynamic subgroups of two to eight individuals, with strong social bonds between mothers and calves or juvenile dolphins (West *et al*. 2011). Rough-toothed dolphins also form mixed schools with bottlenose dolphins and other cetacean species, and are thought to be capable of deep dives with dive times up to 15 minutes (Jefferson *et al*. 2008, West *et al*. 2011). Solitary and mass stranding events have been recorded in many regions (West *et al*. 2011). The diet of rough-toothed dolphins inferred from stomach contents includes a range of fish and squid, octopus, molluscs and sometimes algae, and these dolphins appear to form small cooperative hunting groups to catch large and fast swimming dolphinfish *Coryphaena hippurus* (Ross 2008g, West *et al*. 2011). Their common name derives from the numerous fine vertical ridges on their teeth, which is unique among extant dolphin species and may be an adaptation for grasping and holding large and slippery prey (Ross 2008g, West *et al*. 2011). Age at sexual maturity is reported to be about six–14 years of age and longevity is at least 32–36 years (Taylor *et al*. 2007, Jefferson *et al*. 2008, West *et al*. 2011) hence generation length may be about 18–23 years (Woinarski *et al*. 2014).

Risks and threatening processes

Rough-toothed dolphins are taken in drive fisheries in Japan, Solomon Islands and Papua New Guinea, and are also targeted in other fisheries in Sri Lanka, West Africa and the Caribbean (West *et al*. 2011). This species is sometimes reported as bycatch in purse seine fisheries in the eastern tropical Pacific, and small numbers are taken as bycatch in gillnet, driftnet and pelagic longline fisheries in Sri Lanka, Brazil, Taiwan, Japan, central North Pacific and probably elsewhere in warm-temperate and tropical habitats (Hammond *et al*. 2008, West *et al*. 2011). Illegal catches in fisheries within the Australian EEZ were considered to be likely (Ross 2006). Rough-toothed dolphins are reported to take bait from fisheries in Hawai'i (West *et al*. 2011). Rough-toothed dolphins are known to ingest discarded plastic bags resulting in compromised health and strandings, and elevated levels of persistent organic pollutants have been recorded in some stranded and immature individuals (West *et al*. 2011). Prey depletion from commercial fisheries is considered to be a potential threat (Bannister *et al*. 1996, Woinarski *et al*. 2014).

Conservation and listing status

The rough-toothed dolphin is listed as a cetacean species under the EPBC Act, Data Deficient in the Northern Territory, but is not listed in other states within its Australian range (Woinarski *et al*. 2014). This species was recently assessed as Data Deficient in Australian waters (Woinarski *et al*. 2014), and similarly in the previous conservation status assessments in Australian waters (Bannister *et al*. 1996, Ross 2006). Globally, the rough-toothed dolphin was assessed as Least Concern for the IUCN Red List in 2008 (Hammond *et al*. 2008) and is listed in Appendix II of CITES.

Common minke whale: *Balaenoptera acutorostrata* (Level 2 PSA Residual Risk – High)

Distribution and range

The common minke whale species has a cosmopolitan distribution extending from about 69°S to 80°N and occurs in all major ocean basins but is not recorded from the northern Indian Ocean region (Rice 1998, Reilly *et al*. 2008, Perrin and Brownell 2009, Acevedo *et al*. 2011). The dwarf minke whale *Balaenoptera acutorostrata* unnamed subspecies *sensu* Best (1985) is the subspecies of common minke whale *Balaenoptera acutorostrata* that occurs in Australian waters and is restricted to the Southern Hemisphere, with two other subspecies recognised in the Northern Hemisphere (Arnold *et* *al*. 1987, Rice 1998, Perrin and Brownell 2009). Arnold *et al*. (2005) concluded that the dwarf minke whale should continue to be recognised as an undescribed subspecies of *B. acutorostrata* but they noted that it might warrant recognition as a separate species. The distribution of the dwarf minke whale is not well known but the subspecies has been recorded in Australia, New Zealand, New Caledonia, South America, South Africa and from the Southern Ocean in the subantarctic and occasionally from higher latitude regions including close to the ice edge at about 65°S (Best 1985, Arnold *et al*. 1987, Zerbini *et al*. 1996, Perrin and Brownell 2009, Acevedo *et al*. 2011).

Their distribution in Australian waters is not well known, but they have been recorded north to 11°S in the northern GBR region and in deeper waters of the Coral Sea, and north to about 14°S along Western Australia (Arnold *et al*. 1987, 2005, Arnold 1997, Birtles *et al*. 2002, Bannister 2008, Birtles and Arnold 2008). Aggregations of these whales occur in the northern GBR during the austral winter, with sightings off Australia mostly from March–April to October (Arnold *et al*. 1987, Birtles and Arnold 2008, Curnock *et al*. 2013). One stranded dwarf minke whale was recorded from SA (Kemper *et al*. 2005). These whales occur in subantarctic waters south of Australia mostly between 55°S and 62°S from December to March, and are occasionally recorded further south to about 65°S (Kasamatsu *et al*. 1993, Bannister *et al*. 1996, Bannister 2008, Pastene *et al*. 2010). Their Australian range overlaps completely with the SPF area from Queensland across to southern WA.

Population size and trends

The population size and trends of dwarf minke whales in Australian waters are unknown (Bannister 2008). Estimates of the numbers of these whales interacting with tourist vessels in the northern GBR were 449 (standard error ± 68) in 2006 and 342 (standard error ± 62) in 2007 (Arnold *et al*. 2005, Sobtzick 2011, A. Birtles and M. Curnock *pers. comm.* in Woinarski *et al*. 2014). It is not possible to estimate abundance of these whales in the Southern Hemisphere, because sighting data do not reliably distinguish dwarf minke whales from the more abundant and partially sympatric Antarctic minke whale *B. bonaerensis* (Reilly *et al*. 2008).

Biology and feeding ecology

Dwarf minke whales grow to about 7.8 m long and can weigh up to 5–6 t (Birtles and Arnold 2008). These whales occur both in deeper offshore oceanic waters and in shallower continental shelf habitats, and in the northern GBR they are regularly observed on or near coral reefs near the shelf edge in waters less than 50 m deep, sometimes over the shelf and offshore in the Coral Sea (Arnold *et al*. 1987, 2005, Birtles and Arnold 2008). Photo-identification data indicate that many individual whales return to the same reef areas in the northern GBR over at least several years, which may indicate that there are local subpopulations in some regions (Birtles *et al*. 2002, Arnold *et al*. 2005, Birtles and Arnold 2008, Sobtzick 2011). There is evidence of seasonal migration of some dwarf minke whales from Antarctic waters to lower latitudes in the western South Pacific Ocean, and the timing of sightings south of Australia and then further north along the Australian coast suggests that these whales may also migrate seasonally in the Australian region (Bannister 2008, Pastene *et al*. 2010). These whales are usually first sighted alone or in pairs, but they are inquisitive and aggregations of more than a dozen whales have been reported near boats and swimmers (Birtles *et al*. 2002, Birtles and Arnold 2008, Mangott *et al*. 2011, Curnock *et al*. 2013).

These whales are thought to feed mainly on fish including myctophid lantern fish but may also lunge feed on euphausiid swarms, and feed on small euphausiid species at lower latitudes (Bannister 2008). Dwarf minke whale calves have been recorded in the northern GBR, with stranding records of some neonates from southern Queensland to Victoria (Birtles and Arnold 2008). The life history characteristics of dwarf minke whales are largely unknown hence information is mostly based on Northern Hemisphere common minke whales. Age at first reproduction is estimated to be about eight years, gestation is about 10 months, and the mean calving interval is estimated to be about one year (Best 1985, Taylor *et al*. 2007 Perrin and Brownell 2009). Generation length is estimated to be 22.1 years (Taylor *et al*. 2007).

Risks and threatening processes

In contrast to most other baleen whale species, dwarf minke whales were not specifically targeted by commercial whaling, and relatively few of these whales were killed in commercial whaling or 'special permit' whaling by Japan in the Southern Hemisphere compared with Antarctic minke whales (Bannister 2008, Reilly *et al*. 2008, Clapham and Baker 2009). Common minke whales have been recorded as bycatch in fisheries gear (Reilly *et al*. 2008, Reeves *et al*. 2013) including in purse seine nets in the western Indian Ocean (Anderson 2014). A relatively high frequency of entanglement scarring has been observed for dwarf minke whales from the GBR region (A. Birtles *pers. comm.* in Woinarski *et al*. 2014). One dwarf minke whale was recorded to have drowned in a shark net off Cairns (Paterson 1990). Other threats to dwarf minke whales include climate and oceanographic variability and change; increasing anthropogenic noise and acoustic disturbance; exposure to persistent toxic pollutants; increasing port expansion and associated vessel movements and risk of vessel strike; disturbance and stress caused by whale-watching and swimming with dwarf minke whales; and potential for prey depletion caused by commercial fisheries (Woinarski *et al*. 2014).

Conservation and listing status

The dwarf minke whale subspecies is not listed under the EPBC Act, however at the species level the common minke whale is listed as a cetacean species and as a migratory species under the EPBC Act and listed as Rare in SA but is not listed in other states within its Australian range (Woinarski *et al.* 2014). The dwarf minke whale subspecies was recently assessed as Data Deficient in Australian waters (Woinarski *et al.* 2014), and similarly in the previous conservation status assessment (Bannister *et al.* 1996). Globally, the common minke whale was assessed as Least Concern for the IUCN Red List in 2008 (Reilly *et al.* 2008), and this species is listed in Appendix I of CITES.

Summary: cetacean species at risk from direct interactions with mid-water trawl and purse seine gear in the SPF

Mid-water trawl

- *The 15 odontocete species described in the first panel report have different distribution ranges that vary in their extent of overlap with the SPF area.*
  - *The species at highest risk of interactions with mid-water trawls in the SPF are bottlenose dolphins and short-beaked common dolphins* Delphinus delphis *whose diet includes small pelagic fish and these dolphins are known to interact extensively with trawl fisheries in Australia and internationally; some common bottlenose dolphins* Tursiops truncatus *and possibly short-beaked common dolphins were previously recorded as bycatch in mid-water trawls in the SPF.*
  - *Although the hourglass dolphin* Lagenorhynchus obscurus *remained at high risk for the mid-water trawl sector of the SPF after the residual risk assessment, its oceanic distribution range may only overlap marginally with the SPF area, the species has not been recorded interacting with trawl fisheries, is not obviously threatened, and is assessed as Least Concern in Australian waters and globally. Therefore, the panel did not consider the hourglass dolphin to be a particularly high-risk species for direct interactions associated with the SPF mid-water trawl sector.*
- *The six baleen whale species described in the first panel report have different distribution ranges and these overlap extensively or completely with the SPF area. Five of these species are listed as threatened species and are therefore matters of national environmental significance requiring a high level of protection under the EPBC Act. Southern right whales* Eubalaena australis *and blue whales* Balaenoptera musculus *are listed as Endangered, while fin whale* B. physalus, *sei whale* B. borealis *and humpback whales* Megaptera novaeangliae *are listed as Vulnerable.*
  - *These six whale species exhibit different biological and ecological characteristics, and their abundance and the extent to which populations are recovering following significant depletion from whaling, varies.*
  - *Their diet and life history traits, and the nature and extent of potential interactions with fisheries' operations also differ between species. Bryde's whales* Balaenoptera edeni *feed mainly on small pelagic schooling fishes, while fin, sei and humpback whales feed mainly on crustaceans but also feed on small pelagic fish species to varying degrees.*
  - *Humpback whale abundance is increasing rapidly and the south-west subpopulation of southern right whales is also increasing, hence there is increased risk of vessel strike and other interactions such as entanglement in fishing gear for these species within the SPF area.*
  - *Vessel strike has also been recorded for the other whale species, particularly for fin whales.*
  - *Entanglement or bycatch in various types of fishing gear has been reported for all six whale species.*
  - *Occasional incidental bycatch in trawl nets and other fishing gear has been reported for humpback, fin and Bryde's whales, and fin whales have been reported feeding behind a trawl codend.*
- *Therefore these whale species have a wide range of known and potential interactions with mid-water trawl and other fisheries.*

Purse seine

- *The 14 odontocete species and the common minke whale described above have different distribution ranges that vary in their extent of overlap with the SPF area. All cetacean species are protected under the EPBC Act and the Australian humpback dolphin and the common minke whale are also listed as migratory species and are therefore matters of national environmental significance requiring a high level of protection under the EPBC Act.*
- *These species exhibit a wide range of biological and ecological characteristics including abundance, diet and life-history traits, and the nature and extent of their interactions recorded with purse seine and other fisheries varies, hence the risks of interactions with purse seine operations in the SPF need to be assessed separately for each species.*

- *Of the 15 cetacean species described above, the pygmy killer whale, false killer whale, rough-toothed dolphin and the common minke whale have been reported to interact with purse seine operations overseas resulting in some incidental bycatch, which suggests that these species may be at increased risk of interactions with purse seine fishing operations in the SPF.*
- *In Australian waters, the short-beaked common dolphin is the species most often reported in interactions with purse seine operations in the SASF resulting in bycatch mortality, and bottlenose dolphins were previously reported as bycatch in the WA purse seine fishery for pilchards. These species were assessed in the first declaration report.*

5.3.2 Nature and extent of interactions

As noted in the first declaration report, entanglement, injury and fisheries bycatch mortality is the major recognised threat to many smaller cetacean species in Australian waters and internationally, particularly from purse seine, gillnet and trawl fishing, as well as from discarded fisheries gear (reviewed in Shaughnessy *et al*. 2003, Zollett and Rosenberg 2005, Read *et al*. 2006, Zollett 2009, Reeves *et al*. 2013, Anderson 2014). The risk of bycatch is influenced by factors such as whether the cetaceans feed on prey species that are also targeted by fisheries, the extent to which cetaceans feed in areas that are used by fisheries, the types of prey species and fisheries activities involved, and the intersection of fishing zones with migratory pathways or habitats regularly used by some cetacean species (Couperus 1997). Although cetacean bycatch rates have been substantially reduced in some fisheries in recent decades, there is potential for increased frequency and intensity of interactions leading to increased bycatch mortality in future as human populations and fisheries' operations increase (Hall *et al*. 2000, Read *et al*. 2006).

Nature and extent of trawl fishery interactions: global

A summary of the panel's assessment of the nature and extent of trawl fishery interactions with cetaceans is provided below. This summary is drawn from the panel's first declaration report.

- The nature and likelihood of interactions between cetaceans and mid-water trawl fisheries varies substantially among species. Bottlenose dolphins and short-beaked common dolphins are likely to be at higher risk based on reported interactions with trawls and bycatch in Australia and internationally.
- Direct interactions with fishing operations include net feeding, foraging behind trawlers, and feeding on discards and fish escaping from nets. Vessel collisions resulting in injury or death of whales and some other cetaceans are thought to be relatively common in Australian waters but are not well documented. Most severe or fatal injuries to whales are caused by collisions from vessels greater than 80 m in length.
- Fisheries bycatch mortality is the major threat to many smaller cetacean species in Australian waters and internationally. Cetacean bycatch occurs in most areas where trawling occurs and they are more often caught in mid-water trawls than in bottom trawls. The risk of bycatch increases where prey species are also targeted by fisheries and where fishing grounds overlap with important habitats used by cetaceans for aggregating, feeding, breeding and as migratory routes.
- Analyses of common dolphin bycatch in New Zealand mid-water trawl fisheries showed that bycatch occurred in vessels longer than 90 m, and bycatch was highest in trawls where the headline depth was between 10–40 m, and during longer tows of two to six hours in duration. Light conditions and fishing location also significantly influenced common dolphin bycatch rates. Sharp vessel turns and changes in speed may increase the risk of bycatch.
- Cetaceans that frequently interact with trawlers and other fisheries can become habituated, leading to altered social interactions and increased risk of bycatch.
- Acoustic disturbance can be important for cetaceans because they have a very highly developed acoustic sense and sounds are vitally important for their ecology and survival.

Nature and extent of trawl fishery interactions: Australia and the SPF

The first panel report summarised interactions between trawl fisheries and cetaceans in Australia as follows:

- The SPF area encompasses the known distribution range of most cetacean species occurring in Australian waters; this area is known to be important to many cetacean species and interactions with mid-water trawl and other fisheries have occurred for many species.
- A total of 25 dolphin mortalities were reported in mid-water trawls in the SPF during 2004 and 2005, comprising some common bottlenose dolphins and possibly short-beaked common dolphins. The absence of reported interactions with cetaceans in this fishery in more recent years coincides with low levels of fishing and observer effort. Therefore, it is difficult to estimate the overall extent of direct interactions with cetaceans by mid-water trawl gear in the SPF.

Nature and extent of purse seine fishery interactions with cetaceans

Purse seine fishing has been the major cause of dolphin bycatch internationally. For example, during the 1960s an estimated 200,000–500,000 dolphins were killed annually in the eastern tropical Pacific Ocean when purse seines were set on groups of spotted dolphins *Stenella attenuata*, eastern spinner dolphins *Stenella longirostris orientalis* and short-beaked common dolphins that were associated with yellowfin tuna *Thunnus albacares* (e.g. Perrin 1969, Wade 1995, Gerrodette and Forcada 2005, Wade *et al*. 2007, Gerrodette *et al*. 2012). This purse seine fishery began in the late 1950s (Hall 1998), and during the period from 1960 to 1972 it is estimated that more than 4 million dolphins were killed in the eastern tropical Pacific Ocean (Wade 1995). This extreme bycatch mortality became known as the 'tuna-dolphin issue' and resulted in significant declines in at least three dolphin stocks—northeast offshore spotted dolphins *S. attenuata attenuata*, coastal spotted dolphins *S. attenuata graffmani*, and eastern spinner dolphins, and these stocks were designated as 'depleted' under the US Marine Mammal Protection Act of 1972 (Wade 1995, Wade *et al*. 2007, Gerrodette *et al*. 2012). Abundances of eastern spinner dolphins were reduced to an estimated one-third of pre-fishery levels while abundances of north-east offshore spotted dolphins were reduced to an estimated one-fifth of pre-fishery levels (Wade *et al*. 2007). Subsequently, there has been a reported 98 per cent reduction in dolphin bycatch mortality in the eastern tropical Pacific Ocean following fisheries management interventions (e.g. Hall 1998, Inter-American Tropical Tuna Commission (IATTC) 2013), which included techniques for releasing dolphins alive after a set (International Seafood Sustainability Foundation (ISSF) 2014). However, as noted below, these dolphin populations have not recovered at the rates expected following reduction in high bycatch levels (Gerrodette and Forcada 2005).

As a result of the high bycatch issue in the Eastern Pacific Ocean tuna fishery (Hall 1998), the US National Marine Fisheries Service (NMFS) started an observer program to estimate mortality on larger vessels in the fishery (Hall and Roman 2013). In 1976, the member nations of the IATTC implemented a tuna-dolphin program and signed onto the Agreement on the International Dolphin Conservation Program (AIDCP) to reduce dolphin mortality. A critically important component of the program was that every vessel had an annual dolphin mortality limit that, if exceeded, would require the vessel to stop fishing on dolphins. Since 1993, the IATTC has had 100 per cent coverage of the trips by seiners larger than 363 t capacity resulting in a very large database of observations on purse seine sets (Hall and Roman 2013).

Despite the currently low levels of dolphin mortality in the eastern Pacific tuna fishery, these depleted populations have not recovered (Gerrodette and Forcada 2005). The fishery has had population-level effects beyond the reported direct bycatch mortality, possibly due to reduced reproductive success brought about by stress from constant chasing and encirclement by purse seiners, or under-reporting of bycatch, ecosystem changes and other species' effects on dolphin population dynamics (Gerrodette and Forcada 2005, Wade *et al.* 2007, Cramer *et al*. 2008). However, more recent studies indicate that some dolphin stocks may be beginning to recover while others are not (Gerrodette *et al*. 2008).

From 1994 to 2004, 27,644 purse seine sets were observed in the Western and Central Pacific Ocean (WCPO) (Molony 2005). A total of 687 marine mammals from 137 sets were reported as captured of which only 49 were identified to species (Molony 2005): 24 short-beaked common dolphins, 18 bottlenose dolphins, four spinner dolphins, two short-finned pilot whales and one pygmy killer whale. Molony (2005 cited in NMFS 2006) estimated that about 900 marine mammals were captured across the whole fishery of which 50 were killed. Most mammals were incidentally captured from 'associated' sets: 11 sets were on live whales and, in fact, the largest number of marine mammal interactions occurred due to deliberate sets on whales (486 sets or 1.76 per cent of all sets) (Molony 2005). Within the WCPO, sei whales were the baleen whale species that was most commonly encircled by purse seines targeting tuna schools feeding on pelagic baitfish though they escaped virtually unharmed (Bailey *et al*. 1996 in NMFS 2006). However fishery interactions with delphinids are much more common than with baleen whales (NMFS 2006). Overall, the WCPO purse seine fishery is thought to have little impact on the sustainability of marine mammal stocks in the WCPO (Molony 2005). Setting on cetaceans has been banned by the European Commission (European Commission 2007) so cetacean bycatch and mortality should be much reduced in the future (Anderson 2014).

Sets made on whale-associated tuna schools in the western Indian Ocean could result in injury and mortality (Romanov 2002, Molony 2005). While the major potential cetacean interactions in the western and central Indian Ocean are with free school sets, fishermen regularly used sightings of Bryde's whales to find tuna schools. During 1981–1999 nearly 10 per cent of all sets were reported to have been made in association with whales, probably Bryde's whale (Anderson 2014). When encircled, the whales often remain in the net until pursing is complete and escape most commonly by diving under the purse line or by ramming through the net (Romanov 2002). Estimates of whale mortality are likely to be underestimated mainly due to unreliability of some observer data and under-reporting (Anderson 2014) and many encircled whales died later from injuries received during escapement and entanglement (IOTC 2012). The true scale of total baleen whale mortality in the western Indian Ocean purse seine area is unknown but may have been of the order of 10s annually (Anderson 2014). Setting on cetaceans has recently been banned by the Indian Ocean Tuna Commission (IOTC 2013) so cetacean bycatch and mortality should be reduced in the future (Anderson 2014).

Other international purse seine fisheries that were identified as reporting incidental capture and mortality of cetaceans were in Alaska where in 1994 a humpback whale was caught in a salmon purse seine net (Allen and Angliss 2014), and in 2008, when a humpback whale was entangled in herring purse seine but was released alive (Allen *et al*. 2014). In New Zealand, the purse seine jack mackerel fishery is known to occasionally catch common dolphins (Richard Wells, Deepwater Group Ltd, New Zealand, pers. comm., 12 October 2014 cited in Finley *et al*. 2015a).

Nature and extent of purse seine fishery interactions with cetaceans: Australia and the SPF

South Australian Sardine Fishery

The short-beaked common dolphin has been the cetacean species subject to the most significant bycatch in the SASF (Finley *et al*. 2015a). An observer program undertaken by Hamer *et al*. (2008) to assess the accuracy of logbook data and measure rates of interaction with short-beaked common dolphins recorded rates of encirclement and mortality of dolphins much higher than those reported in logbooks. During the initial observer program period from November 2004 to June 2005, an estimated 1728 encirclements and 377 mortalities were estimated to have occurred across the entire fleet (Hamer *et al*. 2008). Analysis of data collected through logbook records and the independent scientific observer program indicates that some interactions with dolphins have led to injury and mortality (South Australian Sardine Industry Association (SASIA) 2009). A Code of Practice (SASF CoP) was introduced in 2005 that aimed to mitigate operational interactions with dolphins, and a second observer program from November 2005 until June 2006 revealed significant reductions in the observed rates of dolphin encirclement and mortality (Hamer *et al*. 2008).

PIRSA (2014) report that between 2007–08 and 2012–13, the SASF had interactions with 282 short-beaked common dolphins, of which 257 were caught, four entangled and 21 had some other form of interaction. Around 99 per cent of these animals were released alive. In that period the majority of cetacean interactions occurred in Spencer Gulf and the highest annual number of interactions was in 2011–12, when 273 interactions with cetaceans were reported (Tsolos and Boyle 2014).

Small Pelagic Fishery

The known distribution ranges of 44 cetacean species in Australian waters overlap to some extent with the SPF area, hence there is potential for interactions to occur between these cetaceans and purse seine and mid-water trawl operations in the SPF. The panel recognised that the nature and extent of interactions between cetaceans and the SPF is likely to vary among species and also in relation to purse seine and mid-water trawl operations.

The most comprehensive compilation of data on interactions with protected species in the mid-water trawl and purse seine sectors of the SPF is contained in Tuck *et al*. (2013). They reported that between 2001 and 2011 there were no interactions with dolphins reported by fishers or observers in the purse seine sector of the SPF. Between 2006–07 and 2011–12 the rate of observer coverage in the purse seine fleet varied from 2 per cent to 12 per cent (see Table 2.2). AFMA notes that there were no reported purse seine gear interactions with any TEPS since the first SPF Bycatch and Discarding Workplan commenced in 2009, with very low levels of reported interactions before then (AFMA 2014b). No interactions with cetaceans were reported in logbooks in the mid-water trawl and purse seine sectors of the SPF in the period 2012–2014 (to the end of the third quarter) (AFMA 2014e).

Information available on the purse seine JMF, the forerunner to the SPF, provides no evidence of interactions with cetaceans (Harris and Ward 1999).

Other Australian purse seine fisheries

The main Australian purse seine fisheries operating in the area of the SPF are the SBTF, the Western Australian SCPSMF and the purse seine sector of the NSW Ocean Haul fishery.

There have been no logbook or observer reports of purse seine interactions with cetaceans in the purse seine component of the SBTF (AFMA 2013). While this fishery is regarded as highly selective, resulting in minimal interactions with non-target species, the absence of verified independent observer data on the level of TEPS interactions is noted as an issue (Baker and Finley 2013 cited in Finley *et al*. 2015a).

One short-beaked common dolphin calf was entangled and drowned in King George Sound in the SCMPSF during the observer period, 1 March to 15 April 2007 (Western Australian Department of Fisheries 2008). In the past, bottlenose dolphins, *Tursiops* sp., have been taken in the purse seine fishery for pilchards (Shaughnessy *et al*. 2003).

Three assessments of the NSW Ocean Haul Fishery by the Department of the Environment (in 2003, 2008 and 2013) did not identify any concerns about the interactions of the fishery with any protected species. The 2013 submission to the Department of the Environment (NSW Department of Primary Industries 2013) noted that there were no observer data available and did not report any interactions with cetaceans.

In addition to the three fisheries above, the panel noted that a developmental purse seine fishery for Australian sardines, operating just north of the north-east boundary of the SPF, had significant interactions with dolphins. Between August 1997 and November 1998, 72 dolphins were encircled by fishing operations and nine of these died. All dolphin encirclements and deaths were recorded by the on-board observer and reported to the management authority. As a result, all Queensland waters were closed, and remain closed, to purse seine nets (State of Queensland 2000).

Summary: nature and extent of direct interactions between cetaceans and purse seine fisheries

- *The present rate of interaction of cetaceans in international purse seine fisheries appears to be relatively low although it has previously been much higher.*
- *Higher rates of marine mammal interaction will occur if nets are set on dolphin groups or whales, a practice that is now prohibited in many fisheries*
  - *extremely high and unsustainable levels of dolphin bycatch mortality occurred in the Eastern Pacific Ocean tuna fisheries when purse seines were deliberately set on groups of dolphins, prior to fisheries management interventions that have significantly reduced dolphin bycatch mortality.*
- *Delphinids are likely to suffer stress from frequent encirclement and capture in purse seines while large cetaceans are more able to escape and may have lower mortality, but mortality after escape or release is likely to be underestimated.*
- *There have been no reported interactions with cetaceans in the purse seine sector of the SPF to date and no evidence of interactions in the earlier JMF.*
- *Similarly there have been no reported interactions with cetaceans in the SBTF purse seine fishery.*
- *Reported interactions with cetaceans by purse seine fisheries for Australian sardine in NSW and WA have been very low/nil whereas purse seine fisheries for Australian sardines in Queensland and South Australia had significant interactions with dolphins.*
- *The panel notes that observers were responsible for identifying and reporting the cetacean interaction issues in the Queensland and South Australian fisheries and the panel did not discount under-reporting of interactions in logbooks as an issue in Australian purse seine fisheries.*
- *The panel noted that setting on dolphins does not occur in Australian fisheries. Further, the panel has assumed that the FPA will not target Australian sardines. As a result, the panel concluded that the interaction rates in the Eastern Pacific Ocean tuna fisheries and in Australian sardine fisheries may not be indicative of the likely level of interactions with dolphins by FPA purse seine operation.*

5.3.3 Management of cetacean interactions

Management of cetacean interactions in trawl fisheries

A summary of the panel's assessment of the nature and extent of trawl fishery interactions with cetaceans is provided below. This summary is drawn from the panel's first declaration report.

- Management and mitigation measures that have some potential for reducing direct interactions with and associated bycatch of some species of cetaceans include excluder devices and other gear modifications, acoustic deterrent pingers, modified fishing practices, temporal and spatial closures, bycatch triggers and move-on rules.
- Excluder designs tested to date have not been consistently effective in reducing cetacean bycatch in trawls, and at present there is no solution to filter or deter cetaceans from entering the net opening.
- Excluder devices have reduced bycatch mortality of some marine megafauna in some trawl fisheries in Australian waters and internationally, but these need to be carefully designed and optimised for each fishery and for different species of cetaceans.
  - Underwater cameras have shown very high rates of interaction between dolphins and trawl operations in some fisheries, and further research and monitoring is needed to understand the behaviour of cetaceans in trawl nets. Common dolphins and bottlenose dolphins may behave differently when constrained within nets and may require different excluder designs and location of escape holes, which complicates the development and optimisation of excluder devices in the SPF area where both species occur.
- Acoustic pingers have been effective in reducing bycatch of some cetaceans in some gillnet fisheries, but their effectiveness in reducing cetacean bycatch in relatively noise-saturated pelagic trawl fisheries is unclear, with mixed results reported in different studies in Australia and overseas.

  - Some studies have reported significant reductions in bycatch mortality of common dolphins, but pingers appear unlikely to deter common bottlenose dolphins from interacting with trawl nets or effectively mitigate bycatch for this species.

- Codes of practice to reduce the risk of interactions include suspension of fishing and relocation to another area following bycatch events, but the success of the 'move on' tactic for cetaceans is uncertain.
- Spatial and temporal fishing closures can reduce interactions and bycatch mortality of cetaceans where the risks of interactions and bycatch are relatively high and consistent and where closures encompass sufficient parts of the range. However, effective planning of closures requires detailed knowledge of spatial and temporal use of habitats, which is lacking for most cetacean species in the SPF area.
- Data on population size and trends, genetic structure, and mortality from fisheries' bycatch and other anthropogenic threats are lacking for most cetacean species in the SPF area. This precludes the development of population demographic models needed to determine sustainable biological removal limits for these species and bycatch trigger limits for cetaceans in the SPF mid-water trawl fishery.
- Independent observer programs are very important for assessing fisheries management options because they provide more reliable data on cetacean interactions and bycatch mortality, enabling adaptive management to reduce the risks of interactions.

Management of cetacean interactions in purse seine fisheries

International

Since its inception in 2009, the ISSF, a global partnership of scientists, the tuna industry and the World Wide Fund for Nature, has made efforts to better understand what the main issues of concern are in the tuna purse seine fisheries of the world (Eastern Pacific, Western Pacific, Atlantic and Indian Oceans), by using scientific information primarily from scientific observer programs to quantify relative impacts, as well as:

- conducting at-sea research to investigate potential mitigation measures
- conducting workshops with purse seine skippers to share with them mitigation techniques and to seek their input about other potential mitigation measures
- advocating for regional fisheries management organisations (RFMOs) to adopt mandatory data collection and mitigation measures (Restrepo *et al.* 2014).

Mitigation and monitoring measures have been adopted by the relevant RFMOs in relation to marine mammals specifically (ISSF 2014, Justel-Rubio and Restrepo 2015):

- IATTC
  - The AIDCP establishes total per-stock and annual limits on incidental dolphin mortality (DMLs), with a structured protocol for allocating and keeping track of DMLs (using observers). A vessel must stop setting on dolphin associations for the rest of the year once its DML has been reached.
  - 100 per cent observer coverage on all large purse seiners (more than 363 t in carrying capacity) and lower coverage on smaller vessels is required.
- IOTC
  - Resolution 13/04 prohibits deliberate purse seine sets around cetaceans and requires reporting of interactions.
  - Resolution 10/04 established a regional observer program that requires at least 5 per cent coverage for vessels more than 24 m in length, and for smaller vessels operating in the high seas.
- WCPFC
  - Conservation and Management Measure 2011-03 prohibits deliberate purse seine sets around cetaceans and requires reporting of interactions.
  - 100 per cent coverage on purse seine vessels that fish on the high seas or between two or more EEZs is required.

In 2011, the ISSF initiated a research program to develop and test technical options to reduce bycatch resulting from industrial tuna fisheries.

Mitigation measures to reduce the bycatch of marine mammals in tuna purse seine fisheries

Gabriel *et al.* (2005) described various methods to reduce the bycatch that was initially a serious consequence of setting on dolphins. Dolphins are capable of leaping over the purse lines but they tended not to, and instead they tried to escape through the net wall, which led to drowning of hundreds of thousands of animals. Enlarging mesh size to allow dolphins to escape was not a solution because the tuna and dolphins were often a similar size (Gabriel *et al.* 2005). Playing back the alarm call of the dolphins, or using other acoustic signals (e.g. killer whale sounds) have not been successful (Gabriel *et al.* 2005). The first method that was successful was the 'back-down process' developed by industry and several modifications were made subsequently.

- The 'back-down' process used for dolphin sets (developed by Captain Anton Maizetich in 1959–1960)
  - When two-thirds of the purse seine net is hauled, the vessel is put into reverse in a wide arc, elongating the net into a long channel instead of a circle. The dolphins tend to congregate at the end away from the vessel whereas the tuna generally range back and forth in the channel between the dolphins and the vessel. When the tuna are near the vessel, the vessel is reversed rapidly causing the cork line farthest from the vessel to submerge for several metres and allowing dolphins to escape. This may have to be done several times until all dolphins have escaped (Gabriel *et al.* 2005). Dolphins exit the net while the vessel pulls the net under the dolphin group (Hall and Roman 2013).
- Use of Medina panels (developed by Captain Harold Medina 1971)
  - To prevent dolphins becoming entangled in the mesh by their jaws or pectoral fins, panels of the netting in the 'back-down' area are replaced with small-meshed netting, a Medina panel (Francis 1992, Gabriel *et al.* 2005). Additional strips of finer mesh sections of net about 33 feet deep are placed adjacent to the back-down area and below the corkline (Francis *et al.* 1992). This apron forms a ramp that makes it easier for the dolphins to swim over the cork line without becoming entangled (Gabriel *et al.* 2005). This modification resulted in significant reductions in mortality (Coe *et al.* 1984).
- Other methods to aid release of dolphins from the net were reported on by Francis *et al.* (1992) as follows.
  - *Use of the skiff to prevent collapse of the seine.* To keep the net from collapsing while dolphins remain inside, the net skiff is used to pull the seiner to starboard, away from the seine.
  - *Use of speedboats to prevent net collapse.* The speedboats, whose principal purpose was to prevent the dolphins from getting away from the seiner, are equipped with towing bridles and can be used to tow on the corkline if the net threatens to collapse.
  - *Use of rafts and swimmers to effect release.* A crewman in an inflatable raft is deployed within the net to herd the dolphins toward the release area near the apex of the back-down channel to prevent them from swimming back toward the seiner and to help in the manual rescue of trapped or entangled animals.
  - *Optimised set orientation and back-down manoeuvring.* Guidelines to aid in determining the best orientation of the set with respect to wind conditions and proper rudder, bow thruster, and skiff controls were developed to minimise the chance of the net billowing, a situation called 'canopying'.
  - *Use of pear-shaped snap rings which helps to reduce the time before back-down begins.* Instead of a simple steel ring, the design is pear-shaped and has a spring-loaded gate portion that can be opened for inserting or removing the purse line. In conventional purse seining, once the rings are up, the rings must be transferred from being supported by the purse line to being supported by the cantilevered ring stripper. With the snap rings this process is unnecessary and sacking up (the process of reducing the water in the net and raising the fish to the surface) can begin immediately after the rings are up. This innovation can save up to 15 minutes, reducing the time that the dolphins are exposed to canopies or net collapse (Francis *et al.* 1992).

Australia

There are two Australian examples where dolphin interactions in purse seine fisheries have become a management issue. As noted in Section 5.3.2, in Queensland the management response was to prohibit the use of the purse seine fishing method. In the SASF, the issue has been addressed through an industry code of practice (SASF CoP) (SASIA 2009). The key mitigation elements of the SASF CoP, as they apply to dolphins are:

- skippers are encouraged to communicate the presence of dolphins in 'real time' to allow other skippers to avoid aggregations of dolphins
- to minimise shots by offering other skippers the opportunity to take excess fish
- to assess the presence of dolphins prior to setting the net and suspend the set until the area is free of dolphins

- to assess the presence of dolphins in the net as soon as the net is pursed
- if dolphins are present in the pursed net, enact the release of the dolphin/s as the priority
  - let the front of the net go to create a safe escape route for dolphins
  - 'drop rings', haul additional net and/or utilise thrusters/skiffs to ensure that dolphins are released successfully
  - if the encircled dolphin is in range of the fishing vessel or skiff, use the TEPS cradle to guide the dolphin through an opening in the net or over the corkline
- Ward *et al.* (2013) noted in their assessment of the effectiveness of the SASF CoP that:
  - In 2012–13, observers monitored 9.8 per cent of net-sets in the SASF and reported that 26 short-beaked common dolphins were encircled (32.1 dolphins per hundred net-sets) in 10 encirclement events and one mortality occurred (1.2 dolphins per hundred net-sets).
  - In the same period, logbook data recorded 226 encircled dolphins in 99 encirclement events and four mortalities from four of those events.
  - The rates of encirclement and mortality recorded by observers were 1.2 and 3.1 times higher, respectively, than those recorded in logbooks when an observer was not on board.
  - The discrepancy between interaction rates recorded in logbooks in the absence of an observer and those reported by observers has reduced since the industry-initiated program to monitor dolphin interactions in real-time in 2011.
  - The SASF CoP has reduced rates of encirclement and mortality.

SPF – mid-water trawl

Part 13 accreditation of the SPF under the EPBC Act requires that:

- Prior to fishing, mid-water trawl vessels must have in place effective mitigation approaches and devices to the satisfaction of AFMA to minimise interactions with dolphins, seals and seabirds.
- AFMA requires that at least one observer be deployed on each new mid-water trawl vessel for the first 10 fishing trips with additional observer coverage or other monitoring implemented as appropriate, following scientific assessment of the SPF.

AFMA enforces this by requiring the development and implementation of an approved VMP that sets out operational and management approaches to minimise and mitigate interactions with marine mammals and seabirds. Each VMP is developed by AFMA in consultation with industry and the Department of the Environment, and all SPF mid-water trawl operators are required to comply with and enforce them onboard. With respect to onboard observer coverage, AFMA has an observer coverage target of 20 per cent of shots and, in accordance with the Part 13 accreditation above, observer coverage of the first 10 trips is required for new boats entering the fishery or existing boats moving into significantly new areas.

The panel noted that under an FPA there might be overlap in fishing and associated interactions with dolphins, including bycatch mortality between the SPF and the gillnet sector of the GHAT fishery, and considered that management arrangements would need to take account of this issue. The panel noted that the gillnet sector of the GHAT fishery currently has a Dolphin Strategy (AFMA 2014f) that includes individual vessel based bycatch limits and 100 per cent observer coverage through electronic monitoring in the 'Dolphin Observation Zone' and an exclusion from fishing in the area for six months if the individual bycatch limit of that vessel is met or exceeded.

SPF - purse seine

AFMA's observer coverage target for purse seine in the SPF is 10 per cent of shots or the first five trips for new boats entering the fishery or existing boats moving into significantly new areas (AFMA 2014b). In contrast to mid-water trawl, use of the purse seine fishing method in the SPF does not require a VMP nor are cetacean excluder devices mandated. Instead, the SPF CoP (Anon. 2008a) includes voluntary operating practices to minimise impacts on the environment, particularly to TEPS. With respect to cetaceans Clauses 3.3 and 3.4 are most relevant:

"3.3 Fishers will make every reasonable endeavour to return any captured individual of a Threatened, Endangered, or Protected Species (TEPS) alive:

- having priority of consideration for the safety of the vessel crew members engaged in the release of the animal; and
- in a manner that, where appropriate, utilises techniques outlined in the "Protected Species Handling Manual" produced by Ocean Watch Australia Ltd.

3.4 Recognising the wide range of vessel sizes, gear configurations, style, and operational practices of the purse seine fleet, each such vessel shall employ one or more of the following TEPS Mitigation Practices

3.4.1 Where a TEPS is captured by the fishing operation, when any such TEPS cannot be released by the application of 3.3 and the TEPS exhibits unreasonable distress, the vessel Master shall terminate the shot and release one end of the net to enable release of the contents of the net by towing the net open whilst maintaining tension on the net wall to minimise entanglement opportunities until such time that TEPS have exited the net.

3.4.2 Where a TEPS is observed within the deployed purse seine net the TEPS Mitigation action relevant to the circumstances is undertaken consistent with the premise that early detection and action is the key to successful mitigation of TEPS interactions."

The panel found that the Protected Species Handling Manual (Anon. 2008b) referred to in the SPF CoP outlined procedures for handling dolphins and whales, in relation to disentangling them from fishing gear and releasing the animal. However, the advice on whales relates largely to release of these species from entanglements with head-gear on traps rather than purse seine gear.

5.3.4 Nature and extent of direct interactions of the FPA with cetaceans

The panel's consideration of the impact of the presence of the processing vessel, fishing methods, fishing effort and transhipment under the FPA fishing scenario on the likely nature and extent of cetacean interactions is provided below.

The processing vessel

As noted in Chapter 4, the presence of the processing vessel may increase the risk of vessel strike compared to typical SPF fleet operations. Vessel strike is a threat to some cetacean species and particularly for threatened large whale species with depleted populations (e.g. Laist *et al*. 2001, Kemper *et al*. 2008, Silber *et al*. 2009). Vessel strikes are thought to be relatively common in Australian waters including the SPF area but these are not well documented. The incidence of vessel strikes is likely to increase in future as some whale populations continue to increase following severe depletion from whaling. The risk of vessel strike from large fishing vessels in the SPF area is uncertain, but international data indicate that most severe or lethal vessel strikes are caused by vessels that are 80 m or longer and which travel at speeds greater than 14–15 km per hour (Laist *et al*. 2001, Vanderlaan and Taggart 2007). The panel considered that the processing vessel would likely meet these criteria.

The risk of vessel strike with cetaceans under the FPA is likely to be highest when the processing vessel is travelling to and from port to unload. The panel considered (see Chapter 4) that there was unlikely to be any significant difference between the number of transit trips made by the processing vessel under the FPA and that of the vessel in DCFA1. The risk associated with vessel strike is therefore not considered to be any higher under the FPA than under DCFA1. However, those risks are likely to be higher than under typical SPF fleet operations since vessel strikes by the processing vessel are, due to its size and speed, more of a risk to cetaceans than the smaller, slower wet boats of the typical SPF fleet.

Fishing method

As detailed above and in Section 5.3.2, most cetacean interactions (particularly bycatch mortality) in the SPF have occurred in the mid-water trawl sector of the fishery. Given that the FPA fleet configuration includes more mid-water trawl and less purse seine vessels than the typical SPF fleet, this would likely result in an increase in the number of interactions and greater levels of cetacean bycatch mortality under the FPA compared to those of the SPF to date.

Fishing effort

As discussed in Section 4.4.2 the panel considered that compared to the typical and, particularly the recent SPF fleet, the ability to tranship fish under the FPA would result in increased effort and catch in both the purse seine and mid-water trawl sectors. The panel could not, however, quantify this increase nor could it determine whether fishing effort and catch would be more or less concentrated (see Section 4.4.3). However, factors that could influence the number and/or the rate of interactions with cetaceans under the FPA include the configuration of the fleet in terms of fishing method (see above), any change in the spatial and temporal pattern of fishing, and the process of transhipment (see below).

Spatial and temporal pattern of fishing

Whether the rate of interaction changes will largely be determined by whether the FPA fleet fishes in areas or at times of the year that have not been fished previously. SPF fleet operations to date have not operated extensively in areas of the highest cetacean species richness (see Figure 5.6). The FPA will allow the catching fleet to fish the SPF more broadly, although the extent of any expansion will be constrained by the need to return to port regularly to refuel. As discussed in

Chapter 4, the panel could not predict with any confidence the spatial and temporal distribution of fishing effort under the FPA. However, if the FPA catching fleet ventured into areas of higher cetacean species richness, the nature and extent of interactions, including bycatch mortality, of cetaceans could vary from that of the SPF fleet to date. While there remains some uncertainty about the potential rate of direct interactions with cetaceans under the FPA, the panel considered that the rate of interactions was likely to remain low if previous experience in the SPF was a reliable guide to the likely rate of interactions and given the fuel carrying capacity of the wet boat fleet.

Transhipment

Catches of purse seine vessels fishing under the FPA are at the surface, and therefore more readily available to cetaceans, while the catch is transhipped/pumped to the processing vessel. The panel assumed that discarding from purse seine vessels would be allowed under the FPA. This has been the case in the SPF to date and in the earlier JMF where transhipment occurred. Since interactions with cetaceans in the purse seine sector of the SPF and the JMF have been low, the panel considered that any accidental loss of fish during transfer from purse seine vessels to the processing vessel under the FPA would pose no additional risk to cetaceans.

The panel concluded that the transhipment of fish to the processing vessel via pumping was unlikely to pose a discernibly greater risk to cetaceans than fishing operations under the DCFA1, in the typical SPF fleet or in the earlier JMF where fish were routinely 'transhipped' from fishing vessels.

Panel assessment: likely nature and extent of direct interactions by the FPA with cetaceans

- *The extent of interactions of the FPA with cetaceans will depend on the number of transit trips made by the processing vessel, the actual fleet configuration, the fishing practices adopted, the level of fishing effort, the spatial and temporal pattern of fishing and the cetacean mitigation measures used.*
- *While there remains some uncertainty about the possible loss of fish during transhipment from purse seine vessels and the potential for such loss to increase cetacean interactions, there is no evidence to suggest that the practice of transhipment would pose a specific risk to cetaceans.*
- *The extent of cetacean interactions with the FPA would likely be higher than the DCFA1 and typical SPF fleet.*
- *Most mid-water trawl interactions with dolphins in the SPF have occurred in the south-east area of the SPF.*
- *All reported interactions between cetaceans and mid-water trawl and purse seine in the area of the SPF have involved dolphins.*
- *If the presence of the processing vessel allows fishing to extend into areas not previously fished and of higher cetacean species richness, this could result in differences in the rate of interactions and the species involved.*
- *Compared to the typical SPF fleet:*
  - *there would be more effort under the FPA and this would likely result in a greater number of interactions*
  - *the FPA scenario would likely result in an increase in cetacean bycatch mortality given that the FPA fleet configuration includes more mid-water trawl and less purse seine vessels*
  - *if the presence of the processing vessel allows fishing to extend into areas not previously fished or more intensive fishing of some areas, it is reasonable to expect a change in both the rate of interactions and the cetacean species involved.*
- *Compared to DCFA1:*
  - *The number of interactions with cetaceans under the FPA may be less, similar or more depending on the comparative levels of effort and catch under each scenario. For example, if the mid-water trawl wet boat catching fleet of the FPA needs to expend more fishing effort to take the same amount of catch as the DCFA1 fishing vessel then the number of interactions could be higher. The panel could not predict with any certainty the relative levels of effort in the catching fleets under DCFA1 and the FPA.*
  - *The FPA fleet would be more constrained in terms of the additional area of the fishery that can be fished (wet boats will remain constrained by the need to refuel and return to port regularly). As a result, there may be less potential for a change in the species composition of cetacean interactions than under the DCFA1. The FPA would be more likely to focus its fishing in areas nearer the coast where short-beaked dolphins happen to be more abundant and interactions with this species may therefore be higher than under DCFA1.*
  - *Both the DCFA1 and FPA fleets will concentrate their fishing in the waters of the shelf and upper slope, where the target species are distributed. As a result, it is unlikely that either fleet would fish extensively in areas of the highest cetacean species richness (see Figure 5.6).*

5.3.5 Assessment of the effectiveness of the proposed measures to mitigate impacts

Mid-water trawl

No specific measures had been proposed for the FPA but it is assumed that the routine management arrangements for the SPF (AFMA 2014e) would be applied to all purse seine and mid-water trawl vessels in the FPA catching fleet. VMPs would be required for mid-water trawl vessels, however, the SPF Bycatch and Discarding Workplan for the SPF does not specify what these VMPs would require for cetacean mitigation purposes (AFMA 2014b).

Under the DCFA1 scenario there was a requirement for 100 per cent observer coverage on the mid-water trawl fishing vessel. Under the FPA scenario the observer coverage targets for mid-water trawl would be 20 per cent of shots or the first 10 trips for new boats entering the fishery, or existing boats moving into significantly new areas. The panel notes that the reduced level of observer coverage would significantly reduce the capacity to independently verify cetacean interactions. Further, the panel notes that 'new boats' and 'new areas' are not defined by AFMA and considers that this would need to be addressed to provide confidence that fishing activities of FPA mid-water trawl vessels in new fishing areas were monitored adequately to detect any change in the rate of interactions with cetaceans.

Purse seine

AFMA does not require VMPs for purse seine vessels nor does the SPF CoP address the issue of discards of biological material. The panel assumed that purse seine vessels operating under the FPA would be permitted to discard fish. As noted above, the panel found that the protected species handling manual referred to in the SPF CoP provides advice on releasing dolphins but little relevant advice on whales.

The target observer coverage for purse seine in the SPF is 10 per cent of shots or the first five trips for new boats entering the fishery or existing boats moving into significantly new areas (AFMA 2014b). As noted above the panel believes that 'new boats' and 'new areas' should be defined by AFMA to provide confidence that FPA purse seine vessels fishing in new fishing areas were monitored adequately to detect interactions and any change in the rate of interactions with cetaceans.

Panel assessment: effectiveness of proposed measures

- *The requirement to have a VMP for marine mammals, including cetaceans, on mid-water trawl vessels, is the only specific management measure to avoid, reduce or mitigate the impact of FPA mid-water trawl vessels on cetaceans.*
- *The current management arrangements do not specify any requirements of such VMPs in relation to cetaceans. The panel could not therefore assess the effectiveness of VMPs for cetaceans.*
- *There are no specific management measures in place to avoid, reduce or mitigate the impact of the FPA purse seine vessels on cetaceans.*
- *The application of observer requirements for mid-water trawl and purse seine vessels are loosely defined and, as a result, provide little confidence that they would adequately monitor fishing in new areas under the FPA.*

5.3.6 Actions to avoid, reduce and mitigate adverse environmental impacts

Panel assessment and advice: effectiveness of proposed measures and actions to avoid, reduce and mitigate impacts of direct interactions by the FPA with cetaceans

Mid-water trawl

The following advice draws heavily on the panel's assessment of the impact of mid-water trawl on cetaceans in its first declaration report.

- *Use an excluder device for cetaceans only after its operation has been optimised for the vessel, fishery and different dolphin species, including both bottlenose and short-beaked common dolphins, under a scientific permit with the required level of performance developed in consultation with experts, noting that excluder designs tested to date have not been consistently effective in reducing cetacean bycatch in trawls, and at present there is no solution to filter or deter cetaceans from entering the net opening.*
- *Use underwater video to monitor dolphin behaviour within the net and around the excluder device to determine the efficacy of the excluder device and levels of cryptic mortality.*
- *Ensure 100 per cent observer coverage of mid-water trawl fishing operations and, if trigger limits are used in conjunction with move-on rules or requirements to review mitigation measures, provide sufficient observer capacity to ensure that underwater video footage is monitored at the end of each shot to maximise response times to mortalities.*

- *Management actions applied to dolphin interactions in the SPF should be consistent with the current spatial management zones and actions to mitigate dolphin bycatch in the gillnet sector of the GHAT fishery off SA.*

Purse seine

- *Incorporate the elements of the SASF CoP that relate to mitigation of interactions with dolphins (see Section 5.3.3) into the SPF CoP.*
- *Validate the logbook reporting of interactions with dolphins in purse seine operations in the SPF through independent observer coverage.*

All fishing operations

- *Introduce a bycatch rate trigger limit for dolphin species for the fishery or fishing areas, or a total mortality trigger for a fishing season and/or fishing areas on a precautionary rather than an evidentiary basis.*
- *In response to a single dolphin mortality, require the vessel to move to an area where interactions with cetaceans are less likely, based on available data on estimated at-sea density distributions.*
- *Assess the efficacy of acoustic deterrent pingers (during rigorous controlled trials under scientific permit with the required level of performance developed in consultation with experts), and temporal and spatial closures, that have been shown elsewhere to have potential to reduce the risk of interactions for some cetacean species, including dolphins.*
- *Prohibit the discard of any biological waste (excluding the release of any protected fauna) from all fishing and processing vessels.*
- *In addition to the above actions to mitigate impacts on dolphins, ensure that monitoring and agreed management responses are in place to allow a timely management response if other cetacean species interact with the FPA.*
- *The risk of vessel strike by the processing vessel could be reduced by:*
  - *reducing the co-occurrence of whales and vessels where possible, in particular by identification and avoidance of key feeding grounds or aggregation areas*
  - *use of reduced vessel speed zones to reduce the likelihood of fatal vessel strikes in identified high-risk areas*
  - *using marine mammal observers to alert vessel crew to the presence of cetaceans in the vicinity or path of vessels.*

5.3.7 Research and monitoring to reduce uncertainties

The previous sections have highlighted the considerable uncertainties associated with assessing the likely nature and extent of direct interactions of cetaceans with the FPA and the efficacy of the proposed management measures to mitigate interactions with cetaceans and the FPA. The panel's first declaration report examined in detail some potential areas of research that could reduce the uncertainties associated with the impacts of DCFA1 on cetaceans (see Expert Panel on a Declared Commercial Fishing Activity 2014, Section 5.3.6). The panel considered that these remain relevant to the FPA.

Panel advice: research and monitoring to reduce uncertainties

Research that addresses the following questions could help to reduce uncertainties about the potential for adverse environmental impacts of the FPA on protected cetacean species.

- *What regions in the SPF area are important habitats used by cetaceans that have increased risk of interactions with the FPA?*
- *What levels of mortality arising from interactions with the FPA could be sustained by cetacean populations in the SPF area?*
- *What modifications to the proposed fishing gear and operations of the FPA are needed to improve management and reduce the potential for interactions including bycatch of cetaceans?*
- *At a minimum, maintain the current management arrangements which specify targets of observer coverage for existing vessels of 10 per cent of purse seine coverage and full coverage for either five or 10 trips respectively for new vessels entering the fishery or moving into new areas (AFMA 2014d) and clearly define the terms 'new areas' and 'new vessels'.*
- *Develop a dedicated observer program for purse seine vessels to validate logbook reporting of interactions with protected cetacean species.*

5.4 Seabirds

5.4.1 Species assessed

There are 89 protected species of birds that occur within the SPF area (see Appendix 3). The ecological risk assessments (ERA) for the SPF purse seine and mid-water trawl sectors (Daley *et al.* 2007a, Daley *et al.* 2007b respectively) identified 78 bird species as possibly interacting with the fisheries. Of the 78 species, 53 were albatrosses and petrels which are species usually most impacted by direct interactions with fisheries, particularly by longline fisheries (Baker *et al.* 2002, Department of Sustainability, Environment, Water, Population and Communities (DSEWPaC) 2011a). Two species of albatross are now considered synonymous thereby reducing the current ERA lists to 76 valid species. The remainder of the dataset comprised penguins, cormorants, gannets, boobies, tropicbirds, skuas, gulls and terns, all of which are considered at low risk of mortality from trawling.

Of the valid 76 bird species, the ERA for the SPF mid-water trawl sector (Daley *et al.* 2007b) assessed only three as high risk: shy albatross *Thalassarche cauta*, Chatham albatross *T. eremita* and black-browed albatross *T. melanophris*. Subsequent residual risk assessments reduced their risks to medium (AFMA 2010b) based on expert information with regard to the high level of observer coverage (54 per cent) during the assessment period (2003–2009) during which no interactions were recorded. Therefore, all bird species assessed were at medium (43) or low (33) risk from mid-water trawl operations in the SPF.

The ERA for the SPF purse seine sector (Daley *et al* 2007a) assessed all 76 species at high risk initially. All risks were reduced to medium (70) or low (6) risk in the subsequent residual risk assessment by AFMA using an over-ride based on expert advice that reduced the selectivity of the gear i.e. purse seine nets being open at the surface allow birds to escape (AFMA 2010a).

Overall, no seabirds assessed in the SPF ERA processes were identified as high risk. However, there are a further 13 species that were not identified by the ERA process but these species were mostly terrestrially-based or probably extra-limital and therefore highly unlikely to be encountered. The only oversight in the ERA process was the Australian fairy tern *Sternula nereis nereis* which is listed as Vulnerable under the EPBC Act. This bird lives and breeds in coastal locations throughout the SPF (Blakers *et al.* 1984) and feeds on anchovies, sardines and blue sprat *Spratelloides robustus* (Taylor and Roe 2004) and probably overlaps with the Commonwealth fishery on its inshore boundary.

A panel-commissioned review of literature on global purse seine fisheries (Finley *et al.* 2015a) found that seabird bycatch was not considered to be a problem. The only purse seine fishery reporting significant seabird bycatch was the Western Australian SCPSMF for Australian sardine which caught flesh-footed shearwaters *Ardenna carneipes* (see Section 5.4.2).

5.4.2 Nature and extent of interactions in the SPF and other Australian purse seine fisheries

SPF

The purse seine and mid-water trawl fisheries operate in areas of medium-high seabird richness (Figure 5.7) particularly off the Tasmanian east coast in the Eastern Zone, and in areas where many CPF seabird species occur (Figure 5.8). The species richness of all seabirds and CPF birds in the Great Australian Bight (GAB) tends to be less than elsewhere. Despite the very high abundances of some of the CPF species such as short-tailed shearwaters *Ardenna tenuirostris* estimated in the millions, the level of interaction with the fisheries has been low historically (see first declaration report).

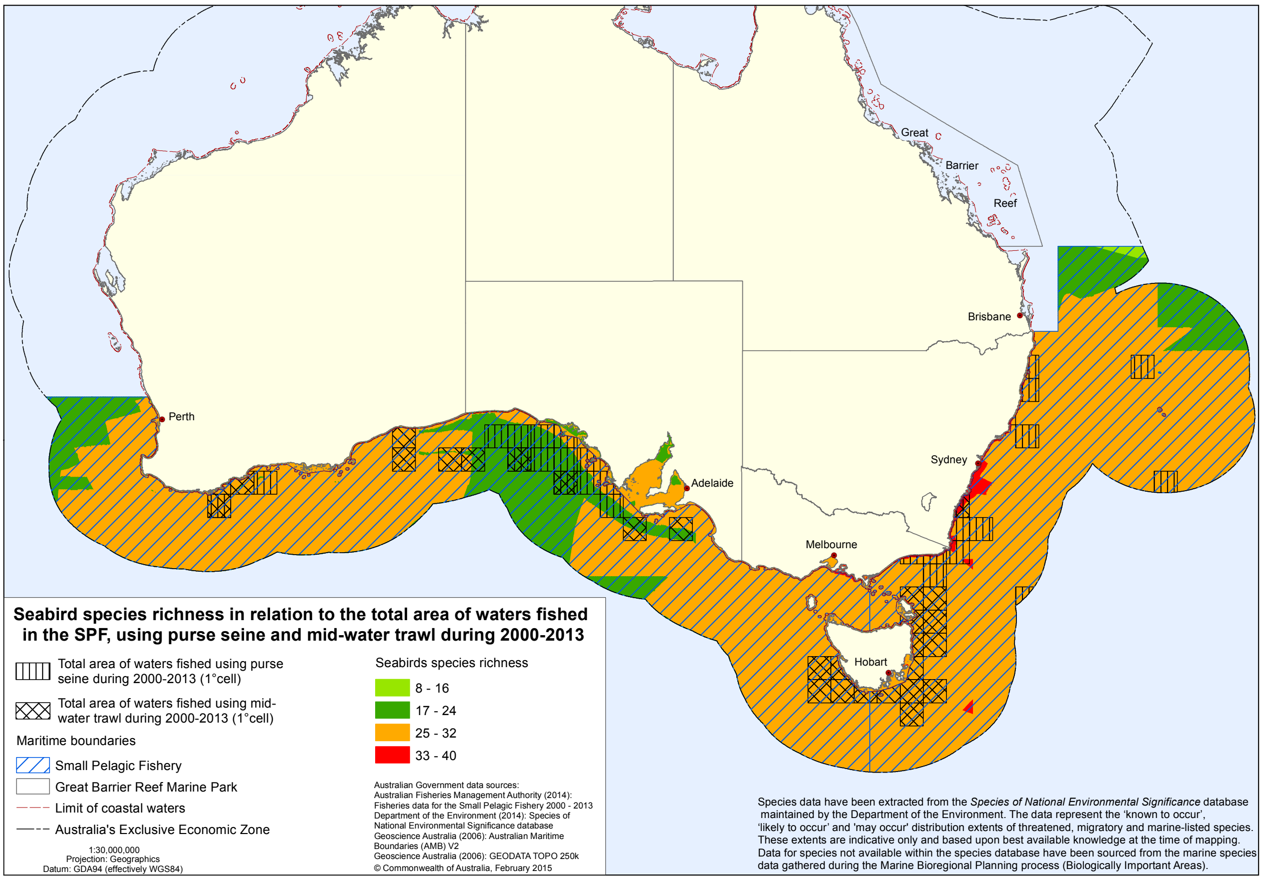

Figure 5.7 Seabird species richness (number of species) in relation to the total area of waters fished in the SPF using purse seine and mid-water trawl during 2000–2013. **Source:** Map produced by ERIN using unpublished AFMA data.

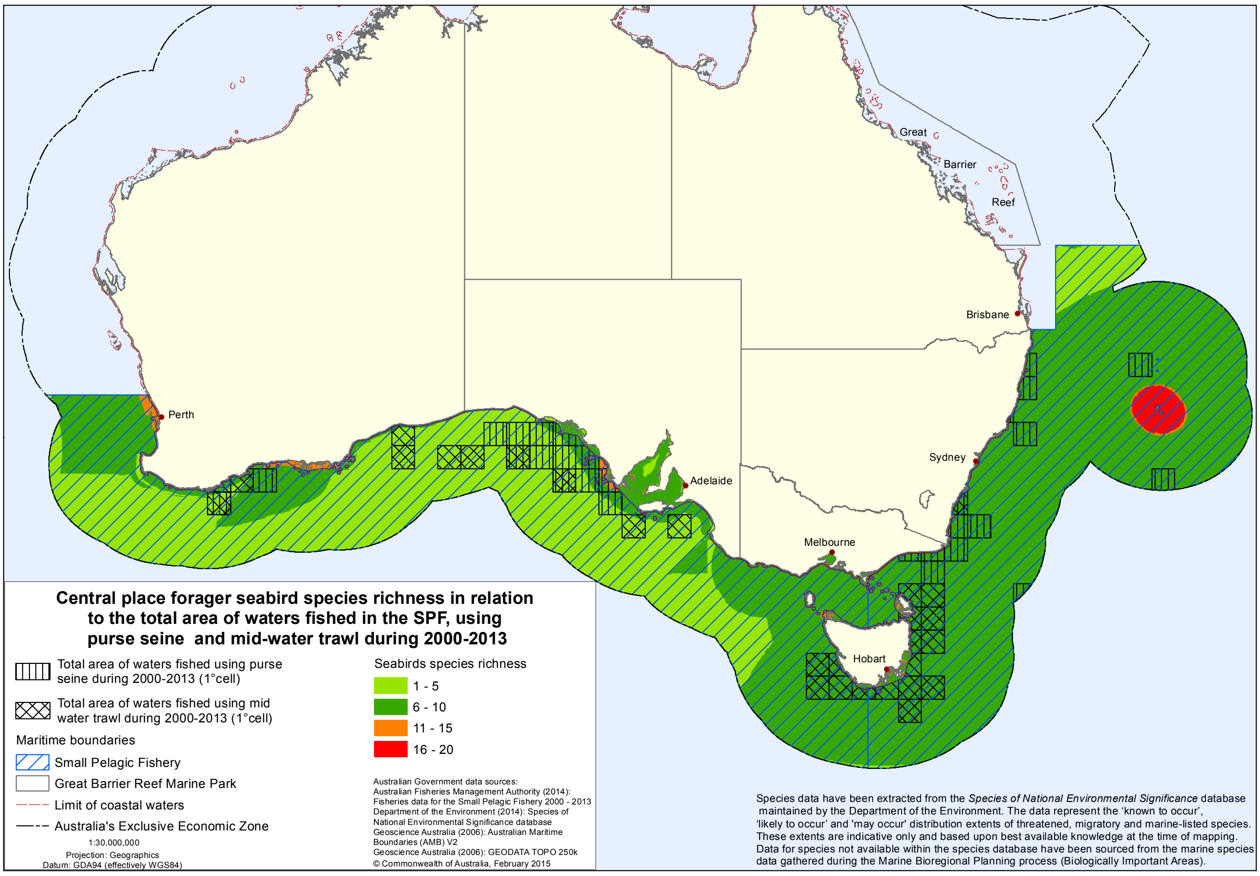

Figure 5.8 CPF seabird species richness (number of species) in relation to the total area of waters fished in the SPF using purse seine and mid-water trawl during 2000–2013. Source: Map produced by ERIN using unpublished AFMA data.

The most comprehensive compilation of data on interactions with protected species in the mid-water trawl and purse seine sectors of the SPF is contained in Tuck *et al.* (2013). They reported that, between 2001 and 2011, there were 38 recorded seabird interactions: 37 in the mid-water trawl sector and one in the purse seine sector. No interactions with seabirds were reported in logbooks in the mid-water trawl and purse seine sectors of the SPF in the period 2012–2014 (to the end of the third quarter) (AFMA 2014e).

The mid-water trawl sector interactions were discussed in the panel's first declaration report (p.159). In summary, there was one fairy prion *Pachyptila turtur* released unharmed and 36 shearwater interactions (24 flesh-footed shearwaters, eight short-tailed shearwaters and four unidentified shearwater species) of which 22 were fatal. The panel concluded that the rate of seabird interactions with mid-water trawl operations under the FPA was likely to be similar to the past rate of interactions of SPF mid-water trawl operations. The panel concluded that the rate of interactions in the SPF to date was likely to have been low due partly to a low level of discharge of biological material in the form of discards in the fishery, and this is assumed to remain the case in the FPA scenario.

Prior to 2000, there is no evidence indicating that seabirds interacted significantly or at all with the purse seine JMF off Tasmania at its peak in the 1980s (Harris and Ward 1999). From then, effort declined in the JMF, and particularly in the subsequent SPF. In the purse seine sector since 2001, only two interactions with seabirds were recorded and neither caused mortality: an unidentified species of storm petrel (AFMA 2009a) and a yellow-nosed albatross *Thalassarche chlororhynchos* were both released unharmed in 2005–06 (AFMA 2009a, Tuck *et al.* 2013). AFMA (2014b) states that the risk of bycatch of TEPS when using purse seine gear is low and that there have been no reported purse seine gear interactions with TEPS since the first SPF Bycatch and Discarding Workplan commenced in 2009, and very low levels of reported interactions before this.

An investigation into cumulative catch of non-target species in Commonwealth fisheries, using black-browed *Thalassarche melanophris* and shy albatross *T. cauta cauta* as two of several case studies, found that due to low levels of observer coverage, extrapolation of observed catch rates to overall rates was highly uncertain (Phillips *et al.* 2010). They stated that a "more informative cumulative assessment, which could better direct how bycatch policy and legislation should be applied more strategically in the interests of governments, fishers and the general community, may not be possible until observer coverage across fisheries is increased or logbook reporting of wildlife bycatch becomes more reliable" (Phillips *et al*. 2010). Under-reporting was also clearly an issue in the SCPSMF (see section below on state managed fisheries). The panel concluded that under-reporting is an issue of concern however the real level of seabird interaction in the SPF is still likely to be relatively low.

Impacts on seabirds resulting from acoustic disturbance or behavioural changes brought about by habituation to fishing operations are not considered as interactions according to AFMA observers and were not reviewed by Tuck *et al*. (2013). The panel found no evidence suggesting that acoustic disturbance from fishing vessels either mid-water trawl or purse seine was likely to be a source of direct interactions with seabirds. While 'habituation' to fishing operations for jack mackerel was suggested in some AFMA observer reports (McKinley unpublished (a) and (b)) whether this alters long-term seabird behaviour is unknown. The observers noted that the proximity of other fishing operations, e.g. longlining and other non-SPF trawling operations, were more likely to contribute to habituation. The SPF CoP (Anon. 2008a) acknowledges habituation of seals but does not mention seabirds specifically.

Southern Bluefin Tuna Fishery

A panel-commissioned review of the international literature on purse seine fisheries (Finley *et al*. 2015a) did not find that birds were at high risk of direct capture from purse seine fisheries. Of the Commonwealth purse seine fisheries, the SBTF is the main fishery operating within the broad area of the SPF. While the targets of these fisheries, bluefin tuna and skipjack, are much larger and distinct from the SPF target species, the fisheries operate off southern Australia within the SPF jurisdiction and potentially interact with the same range of TEPS as the SPF purse seine fishery. Prior to the establishment of an observer program in the purse seine component of the SBTF in 2002–03, there was little information on TEPS interactions (AFMA 2005). This concern was addressed with the development of strategies and actions under a Bycatch Action Plan, which included development of a Code of Practice and AFMA logbook and data management actions. Between 2003 and 2011, six interactions with seabirds were recorded by observers which resulted in four fatalities: two short-tailed shearwaters, one unidentified species of storm petrel and one 'unidentified shearwater' (AFMA 2013, DSEWPaC 2013). According to the AFMA quarterly logbook reports (AFMA 2014e), there have been no interactions reported in the period 2006 to 2014. In 2007, the ERA for the SBTF identified 73 seabirds, none of which were assessed at high risk (Hobday *et al*. 2007). Both residual risk assessment and ecological risk management reports were completed in 2009 finding no TEPS were at high risk in the SBTF (AFMA 2009b, AFMA 2009c).

State managed fisheries

In the state-managed purse seine fisheries for sardine, interactions with seabirds vary. State purse seine fisheries operating in the area of the SPF include the NSW Ocean Haul sector, the SASF and the Western Australian SCPSMF.

Three assessments of the NSW Ocean Haul Fishery by the Department of the Environment (in 2003, 2008 and 2013) did not identify any concerns about the interactions of the fishery with any protected species. The 2013 submission to the Department of the Environment (NSW Department of Primary Industries, 2013) noted that there were no observer data available and that there had been one report of an interaction with a large seabird in September 2012. It is unclear whether this interaction involved purse seine gear.

In the SASF for the period 2007–08 to 2012–13, there has been one interaction (entanglement) involving two shearwaters (unidentified species) resulting in death (Tsolos and Boyle 2014). However in the SCPSMF, which operates within 3 nautical miles (nm) offshore, there was a high rate of interaction with flesh-footed shearwaters in one particular zone (Zone 1: King Sound, Albany). It was estimated that prior to 2006–07 when the bycatch mitigation project began, annual shearwater mortality was likely to have been around 900–1000 birds (Dunlop 2007 cited in Western Australian Department of Fisheries 2008, Appendix 6). The hot-spot of interactions around the Albany zone during February and March coincides with breeding activities and a critical time when birds provision their chicks and are limited in their foraging range. They are reported to feed on small fish, cephalopods and crustaceans and offal from fishing boats (Milledge 1977 in Blakers *et al*. 1984), and sardines would be an appropriate prey. The shearwaters were attracted to the 'bait ball' (of sardines) when visible, and during hauling, to enmeshed 'stickers' (Western Australian Department of Fisheries 2008, Appendix 5). Interactions with this species were also found to increase during daylight hours.

In 2006, a Western Australian Department of Fisheries working group examined the issue of seabird interactions in the fishery and developed strategies for the mitigation of seabird bycatch which are reviewed and adjusted annually. In the 2006–07 and 2007–08 seasons, the fishery monitored shearwater bycatch during the peak interaction period between 1 March to 15 April and 1 March to 30 April respectively. The agreed management measures included the submission of bycatch report forms and implementation of an observer program during which two observers recorded the outcomes of fishing operations during the monitoring/mitigation period (Western Australian Department of Fisheries 2008). All fishers in Zone 1 agreed to reduce bycatch to 0.84 birds per trip aiming to reduce this value annually and continue to support a code of practice (WA CoP) developed in 2008.

Between the 2006–07 and 2007–08 seasons, entanglement and mortality rates decreased (Table 5.3) despite a 31 per cent increase in fishing effort in 2007-08. Total bird mortality was estimated at 200, down from around 1000 (Western Australian Department of Fisheries 2008).

Table 5.3 Flesh-footed shearwater interactions for 2006–07 and 2007–08, SCPSMF

SEASON	NO. OF OBSERVED TRIPS	NUMBER ENTANGLED	ENTANGLEMENT RATE (% BIRDS/TRIP)	NUMBER OF MORTALITIES	MORTALITY RATE (% BIRDS/TRIP)	% MORTALITIES PER ENTANGLEMENT
2006–07	48	512	10.66	54	1.12	10.5
2007–08	64	395	6.17	54	0.84	13.6

Source: Western Australian Department of Fisheries (2008).

The 2007–08 observer data (Table 5.3) were compared with fisher records for the same period to estimate entanglement and mortality rates and the difference between the two data sets. Rates of shearwater entanglement were 1.54 per trip for fisher data and 6.17 per trip for observer data; mortality rates were 0.29 per trip for fishers and 0.84 per trip for observers resulting in an under-reporting factor of 2.9 (Western Australian Department of Fisheries 2008, Appendix 6). The observer program ended in 2009 (Finley *et al.* 2015a) however monitoring of shearwaters is ongoing (see below).

A bycatch reduction program has been in place for the past seven years. The following mitigation measures (Mr S. Walters, Western Australian Department of Fisheries *in litt.* 25 February 2015; Ms Felicity Horn, Western Australian Fishing Industry Council (WAFIC) *in litt* 5 March 2015) recently agreed upon by industry, Oceanwatch (South Coast Natural Resource Management (NRM) Officer), WAFIC, the Western Australian Department of Fisheries and the Western Australian Department of Parks and Wildlife will be implemented in the fishery for the special mitigation period (15 March to 30 April):

- A dawn closure from 5am to 9am between 15 March and 31 March and from 5:30 am to 9:00 am from 1 April to 30 April.
- Fishers to consult each other prior to fishing on high risk days where the level of risk of shearwater interaction may be higher, noting it is likely 3-4 vessels will operate during this time. Industry to inform the Western Australian Department of Fisheries of days they don't go fishing so these can be reported.
- Fishers act in accordance with the WA CoP and Manual for Setting Protocol, Wildlife Interaction and Species Identification.
- Three crew members are to be on board during daylight hours to implement the tow-off procedure or two members if the vessel is fitted with bow thrusters with suitable power for the task.

In addition to the above measures, a trial of a weighted line through the net to remove the fold in the net will recommence in 2015.

The "Manual for Setting Protocol, Wildlife Interactions and Species Identification" (Anon. 2008b) mentioned in the mitigations measures and in the WA CoP was developed specifically for purse seine fisheries by Ocean Watch and SeaNet in collaboration with the operators of the SCPSMF and the Western Australian Fishing Industry Council. This manual provides a guide to identification of seabirds and protocols for the handling and release of net-entangled birds and the reporting of banded birds.

Ongoing monitoring of shearwater interactions in the SCPSMF for 2015 (Mr S. Walters, Western Australian Department of Fisheries *in litt.* 25 February 2015) includes:

- Bycatch record sheets containing records of protected species interactions be completed for all fishing trips.
- Dead shearwaters are collected along Middleton and Goode Beach at a monetary cost to fishers and processors. The shearwaters are then tagged and kept in cold storage for collection from the Department of Parks and Wildlife for an autopsy.
- The South Coast NRM officer (OceanWatch) is to provide a report at the completion of the special mitigation period regarding the outcomes of the mitigation measures implemented and trialed during the special mitigation period.

Following the 2015 special mitigation period, WAFIC will be preparing a report and generally reviewing the success of the program over the past seven years (Ms Felicity Horn, WAFIC pers. comm. 10 March 2015).

Recently, the Western Australian Department of Fisheries implemented an Ecosystem Based Fisheries Management framework under which an assessment of risks to regional ecological assets , i.e. captured fish species, protected species, benthic habitats and external impacts, was made (Fletcher and Santoro 2014). As a protected species, the shearwater bycatch was assessed as moderate (= acceptable) due to implementation of the WA CoP. This fishery underwent Marine Stewardship Council pre-assessment in 2014 (Molony *et al.* 2014).

There still remains a need to demonstrate that a mortality rate of around 200 would not impact on the local meta-population in King George Sound (Western Australian Department of Fisheries 2008, Appendix 6). Recent population estimates indicate that the global population could be as much as 40 per cent smaller than previously thought; the total WA population was estimated at between 18,300–35,900 pairs while the Breaksea Island (King George Sound) population was estimated at 1862 ±1226 pairs (Lavers 2015). A sustainable bycatch limit is yet to be determined.

Other fisheries

While the SCPSMF has had a significant problem with flesh-footed shearwater interactions, it should be noted that more are killed in tuna longlining operations. Baiting of hooks is an important feature that distinguishes this method from mid-water trawl and purse seine methods which do not involve baiting and which are therefore generally less attractive to birds. A study of the Eastern Tuna and Billfish Fishery (ETBF) around Lord Howe Island, a breeding colony for flesh-footed shearwaters, estimated between 1794–4486 birds per year were killed during the period 1998–2002, a rate of mortality considered unsustainable (Baker and Wise 2005). This heightened interaction with the longline fishery was attributed to the birds' habit of diving for scraps and following baited hooks (Marchant and Higgins 1990). The fishery has since successfully mitigated the bycatch of shearwaters (Mr Barry Baker, Latitude 42, pers. comm. 24 February 2015). However, recent studies of the ETBF fishery and the interactions with flesh-footed shearwaters found that the most likely reason for falling bycatch rates in that fishery was more to do with movement of the fishery away from the birds rather than changes in technique (Reid *et al*. 2012). This suggests that area closures are potentially the only method of mitigation for species for which standard mitigation practices fail.

Of concern is the recent evidence showing that unreported cryptic mortality associated with warp-strike could seriously cause underestimation of bycatch mortality in trawl fisheries (Parker *et al*. 2013). As in the longline fishery, the high incidence of seabird interaction with these fisheries was caused by discharge of waste whilst fishing. Previously, the panel found widespread agreement of a strong link between discharge of biological material from trawl vessels and seabird interactions (Expert Panel on a Declared Commercial Fishing Activity 2014). Prohibition of discarding of offal or any material during fishing operations is considered the single-most effective mitigation strategy (Mr Barry Baker, Latitude 42, pers. comm. 24 February 2015) and minimisation of offal discharge is a condition of VMPs for mid-water trawlers in the SPF (see Section 5.4.3).

Species

Based on the information available, the species most commonly involved in interactions with mid-water trawl and purse seine gear in the area of the SPF is the flesh-footed shearwater. Flesh-footed shearwaters are listed under the Japan and Australia Migratory Bird Agreement[12] which provides for "the protection and conservation of migratory birds and their important habitats, protection from take or trade except under limited circumstances, the exchange of information, and building cooperative relationships" (Department of the Environment 2015). The Action Plan for Australian Birds 2010 (Garnett *et al*. 2011) recommended raising the flesh-footed shearwater listing from Least Concern to Near Threatened on the basis that populations may be approaching a 30 per cent decline in three generations, loss of breeding habitat, pollution and bycatch in longline fisheries. This species is found throughout the SPF and, as noted above, interactions have been recorded in the mid-water trawl sector and in the purse seine sector of the SCPSMF.

Summary: nature and extent of direct interactions with seabirds

- *The reported rate of interactions with seabirds in the SPF has been low, particularly in the purse seine sector, despite most operations having been in areas of high seabird species richness. The panel concluded that the low rate of interactions in the purse seine sector reflected the fact that birds can generally interact with fish in the purse seine net without capture. The low rate of interactions in the mid-water trawl sector was due to a low level of discharge of biological material in the fishery. However, the panel did not dismiss the issue of under-reporting of seabird interactions.*
- *Based on the information available, the species most commonly involved in interactions with mid-water trawl and purse seine gear in the SPF area are shearwaters, most commonly the flesh-footed shearwater.*
- *Proximity to seabird breeding sites is probably a major factor in the rate of interactions. For example, the flesh-footed shearwater interaction and mortality rate in the SCPSMF was orders of magnitude higher than either fishing method in the SPF and this appears to be explained by the fact that the SCPSMF operates within close proximity to shore and breeding sites. The panel noted that this fishery targets Australian sardine which is a targeted prey of the flesh-footed shearwater in the SCPSMF and is assumed by the panel not to be targeted by the FPA.*

12 Details of the Agreement can be found at http://www.environment.gov.au/biodiversity/migratory-species/migratory-birds.

5.4.3 Management of seabird interactions in the SPF

There are no specific seabird-mitigation measures in place for mid-water trawl vessels in the SPF. However, Part 13 accreditation of the SPF under the EPBC Act requires that mid-water trawl boats must have in place effective mitigation approaches and devices to minimise interactions with seabirds. AFMA enforces this by requiring the development and implementation of an approved seabird VMP. These plans are developed by AFMA in consultation with the Department of the Environment and industry, and all SPF mid-water trawl operators are required to comply with and enforce them onboard. The SPF Bycatch and Discarding Workplan states that VMPs "must contain measures to minimise and avoid where possible, the discharge of biological material whilst fishing gear is in the water and to use physical mitigation devices in a particular manner to avoid interactions with seabirds." (AFMA 2014b).

The SPF CoP (Anon 2008a) covers issues such as minimising impact on TEPS. While some of the SPF CoP reflects legislative requirements, it also includes voluntary operating practices routinely undertaken. With respect to seabirds, Clause 3.3 is most relevant:

"Fishers will make every reasonable endeavour to return any captured individual of a Threatened, Endangered, or Protected Species (TEPS) alive:

- having priority of consideration for the safety of the vessel crew members engaged in the release of the animal; and
- in a manner that, where appropriate, utilises techniques outlined in the "Protected Species Handling Manual" produced by Ocean Watch Australia Ltd."

The panel found that the "Protected Species Handling Manual" referred to in the SPF CoP outlined procedures for handling seabirds and reducing interactions in longlining operations which are irrelevant to purse seine or mid-water fishing operations in the SPF. The panel concluded that this manual is largely irrelevant and therefore inadequate in dealing with seabirds interacting with either fishing gear in the SPF.

The panel considered that the WA CoP "Manual for Setting Protocol, Wildlife Interactions and Species Identification" (Anon 2008b) specifically for a purse seine fishery was more appropriate to the SPF purse seine sector than the manual referred to in the SPF CoP. The SCPSMF manual also provides a guide to identification of seabirds, noting that AFMA does provide a protected-species guide (AFMA 2006), and protocols for the handling and release of net-entangled birds and the reporting of banded birds.

5.4.4 Nature and extent of direct interactions of the FPA with seabirds

Fishing effort

As discussed in Section 4.4.2 the panel considered that compared to the typical and, particularly the recent SPF fleet, the ability to tranship fish under the FPA would result in increased effort and catch in both the purse seine and mid-water trawl sectors. The panel could not, however, quantify this increase nor could it determine whether fishing effort and catch would be more or less concentrated (see Section 4.4.3). However, factors that could influence the number and/or the rate of interactions with protected species under the FPA include the configuration of the fleet in terms of fishing method, any change in the spatial and temporal pattern of fishing and the process of transhipment.

Fishing method

As noted in Section 5.4.2, most seabird interactions in the SPF have occurred in the mid-water trawl sector of the fishery. The FPA fleet configuration includes more mid-water trawl and less purse seine vessels than the typical SPF fleet. This may mean that the number of interactions with seabirds may rise under the FPA compared to those of the SPF to date. However the rate of interactions (interactions per shot) with mid-water trawl gear would not necessarily change and the VMPs should act to maintain low interaction rates.

Spatial and temporal pattern of fishing

Whether the rate of interaction changes will largely be determined by whether the FPA fleet fishes in areas or at times of the year that have not been fished previously. As discussed in Chapter 4, the panel could not predict with any confidence the spatial and temporal distribution of fishing effort under the FPA.

The introduction of a processing vessel would extend the range of the catching fleet and thus there is scope for a change in the spatial and temporal pattern of fishing. If this occurred, there may be a change in the number of interactions, the species encountered and the risk profiles of these species from that of the past. The panel believes that the FPA will enable the catching fleet to fish more broadly in the SPF than in the past, however it is not possible to predict with any certainty the spatial and temporal pattern of fishing under the FPA. As a result there is some uncertainty about the potential rate of direct interactions with seabirds under the FPA. The panel agreed, however, that the rate of interactions was likely to remain low.

Transhipment

Catches of purse seine vessels fishing under the FPA are at the surface, and therefore more readily available to seabirds, while the catch is transhipped/pumped to the processing vessel. However, the panel noted that such pumping had occurred previously in the JMF and SPF without any significant seabird interactions and that any seabirds attracted to feed on fish in the purse seine net would be able to escape given that the net is open at the surface.

The panel assumed that discarding from purse seine vessels would be allowed under the FPA. This has been the case in the SPF to date and in the earlier JMF where transhipment occurred. Since interactions with seabirds in the purse seine sector of the SPF and the JMF have been low, the panel considered that any accidental loss of fish during transfer from purse seine vessels to the processing vessel under the FPA would pose no additional risk to the seabirds.

Observers on mid-water trawl operations in the SPF stated that birds can be abundant and numbers increase when hauling. Smaller seabirds were observed feeding on fish falling from the front of the net when hauling or during pumping operations but were not interacting physically (Kranz unpublished, AFMA unpublished data). Observer reports from the 2002–03 pair trawl trials in the SPF stated that up to 100 kg of fish could be lost during these operations (McKinley unpublished (a) and (b)). Observer reports from small pelagic operations in the GAB indicated much greater seabird attraction particularly to flesh-footed shearwaters when offal was discharged just prior to hauling or during hauling (Gerner unpublished (a) and (b)). Larger seabirds such as albatrosses tended to sit further astern still feeding on discharged offal. This raises the possibility that any accidental loss of fish during transhipment might attract seabirds to the fishing operations and increase the risk of interaction. However, as noted in Chapter 4, the panel assumed that the VMPs for mid-water trawl vessels would prohibit the discarding of any biological material while gear (including the pump) was in the water, thus avoiding any increased risk of interaction and fatality with seabirds.

The panel concluded that the transhipment of fish to the processing vessel via pumping was unlikely to pose a greater risk to seabirds than pumping operations to transfer fish from the net to the catching vessel in the DCFA1 or in the typical SPF fleet, or than the transhipment of fish in the earlier JMF.

Panel assessment: likely nature and extent of direct interactions of the FPA with seabirds

- *The extent of interactions of the FPA with seabirds will depend on the actual fleet configuration, the fishing practices adopted, the level of fishing effort, the spatial and temporal pattern of fishing and the seabird mitigation measures used.*
- *While there remains some uncertainty about the possible loss of fish during transhipment and the potential for such loss to increase seabird interactions, there is no evidence to suggest that the practice of transhipment poses a specific risk to seabirds.*
- *The rate of interactions between the SPF fleet and seabirds has been low, despite most operations having been in areas of high seabird species richness.*
- *While the number of seabird interactions may be higher in the purse seine component of the wet boat fleet than in the mid-water trawl component, seabird mortalities are more likely to arise from interactions with mid-water trawl operations.*
- *Overall, the panel expects that the rate of interactions with seabirds would remain low under the FPA. Since it is not possible to predict with any certainty where or when the FPA fleet might fish or the intensity of that fishing, it is not possible to provide any firm conclusions on the likely rate of interactions between the fleet and seabirds.*
- *Compared to the typical SPF fleet:*
  - *there would be more effort under the FPA and this would likely result in a greater number of interactions*
  - *an FPA scenario would likely result in an increase in seabird bycatch mortality given that the FPA fleet configuration includes more mid-water trawl vessels*
  - *if the presence of the processing vessel allows fishing to extend into areas not previously fished or more intensive fishing of some areas, it is reasonable to expect a change in both the rate of interactions and the seabird species involved*
- *Compared to DCFA1:*
  - *The number of interactions with seabirds under the FPA may be less, similar or more depending on the comparative levels of effort and catch under each scenario. For example, if the mid-water trawl wet boat catching fleet of the FPA needs to expend more fishing effort to take the same amount of catch as the DCFA1 fishing vessel then the number of interactions could be higher. The panel could not predict with any certainty the relative levels of effort in the catching fleets under DCFA1 and the FPA.*

- *The FPA fleet would be more constrained in terms of the additional area of the fishery that can be fished (wet boats will remain constrained by the need to refuel and return to port regularly). This may mean that they are more likely to fish closer inshore than DCFA1 and potentially have more interactions with protected CPF species of seabirds.*

5.4.5 Assessment of the effectiveness of the proposed measures to mitigate impacts

No specific measures had been proposed for the FPA but it is assumed that the routine management arrangements for the SPF (AFMA 2014e) would be applied to all purse seine and mid-water trawl vessels in the FPA catching fleet. VMPs would be required for mid-water trawl vessels and the panel assumed that, as with DCFA1, these would prohibit the discharge of offal and biological material (including whole fish) while gear is in the water.

AFMA does not require VMPs for purse seine vessels nor does the SPF CoP address the issue of discards of biological material. The panel assumed that purse seine vessels operating under the FPA would be permitted to discard fish. As noted above, the panel found that the protected species-handling manual referred to in the SPF CoP does not apply to purse seine interactions with seabirds.

5.4.6 Actions to avoid, reduce and mitigate adverse environmental impacts

While the risk of seabird interactions is considered to be very low in the SPF, the panel considered that certain actions could be taken in alignment with internationally recognised standards that would further ensure minimal risk of interactions. The following advice reiterates the advice for mid-water trawl vessels in the first declaration report and includes additional advice for purse seine. Based on experience in other fisheries, it is likely that seabird interactions in the SPF may be under-reported. This can only be addressed by validation of logbook data through increased observer coverage.

Panel advice: actions to avoid, reduce and mitigate adverse environmental impacts on seabirds

The panel considered that the following actions could be taken to manage the risk of adverse environmental impacts arising from direct interactions of the FPA's purse seine and mid-water trawl catching fleet with seabirds.

Mid-water trawl

- *Any requirements in the VMPs for mid-water trawl vessels regarding discharge of biological material, the removal of stickers and warp maintenance should be consistent with or equivalent to the advice of the Agreement on the Conservation of Albatrosses and Petrels (ACAP 2013 a, b and c).*
- *The ACAP advice regarding net binding, bird-scaring lines and the use of a snatch block should be adopted noting that the use of bird-scaring lines and net binding are part of the seabird VMP for Australia's winter blue grenadier fishery.*
- *If bird bafflers and warp deflectors are to be used, develop and optimise the design under scientific permit and in consultation with experts, noting that seabird captures in the Southern and Eastern Scalefish and Shark Fishery have been reduced by 75 per cent using 'pinkies'.*
- *Ensure that any seabird VMP meets the requirements of the National Recovery Plan for Threatened Albatrosses and Giant Petrels 2011–2016 (DSEWPaC 2011b).*
- *Direct deck lighting inboard and keep to the minimum level necessary for the safety of the crew.*

Purse seine

- *Update the SPF CoP by replacing the 'Protected Species Handling Manual' with, at a minimum, the bird handling protocol developed for the SCPSMF, and ideally, develop a protocol for handling protected species specifically for the SPF and all relevant gear types.*

All fishing operations

- *Develop advice on the correct interpretation of 'interactions' with seabirds in consultation with the Department of the Environment to ensure that it is consistent with the intent of the memorandum of understanding between the Department and AFMA and ensure that FPA operators and crew are familiar with this advice*
- *Validate logbook reports on interactions with seabirds through increased and spatially representative observer coverage.*
- *If unacceptable levels of interactions with protected seabird species occur, suspend fishing immediately and adopt one of the following options:*

- *time and area closures, noting that these will rely on knowledge of spatial and temporal uses of bird habitats that overlap with the fishery*
- *trigger limits and move-on rules*
- *review of transhipment procedures if the interactions occur during transhipment.*

5.4.7 Research and monitoring to reduce uncertainties

Given the uncertainties identified above in relation to the potential for changes in the spatial and temporal pattern of fishing under the FPA to alter the nature and extent of past interactions with seabirds in both sectors of the SPF, it is imperative that a high level of observer coverage apply to the FPA particularly if it includes mid-water trawlers.

The panel heard of the potential risk posed by uninitiated crews (Mr R. Wells, Resourcewise pers. comm. 28 April 2014) and the importance of education of the crew in ensuring that mitigation measures were properly implemented (e.g. Mr F. Drenkhahn and Mr S. Boag *in litt*. 28 October 2013 in Finley *et al*. 2015b[13]).

Panel advice: research and monitoring to reduce uncertainties

The following research and monitoring could reduce uncertainties about the potential for adverse environmental impacts arising from direct interactions between the FPA and protected seabird species:

- *Maintain the current management arrangements which specify targets of observer coverage for existing vessels of 10 per cent of purse seine coverage and 20 per cent of mid-water trawl coverage and full coverage for either five or 10 trips respectively for new vessels entering the fishery or moving into new areas (AFMA 2014d), and clearly define the terms 'new areas' and 'new vessels'.*
- *Identify ecologically sensitive seabird species, areas and times where spatial management strategies may be appropriate to mitigate direct interactions if required.*
- *Use electronic monitoring via video camera/s to assist in quantifying warp strikes.*
- *If warp strike is occurring, consider installing corpse catchers on warps to assist in understanding whether there is a level of cryptic mortality from warp strike that has been undetected.*
- *Develop a dedicated observer program for all SPF fishing operations to validate logbook reporting of interactions with protected seabird species. In the mid-water trawl sector this should focus on observing and validating warp interactions and trawl entanglements.*
- *Collect, analyse and publish observer data on all seabird interactions, including on the levels and causes of seabird bycatch. Ensure crews are properly trained in the use of the required seabird mitigation and on reporting requirements.*

13 Cited in Expert Panel on a Declared Commercial Fishing Activity (2014) as Elgin Associates unpublished (a).