6 Assessment of the fish processing activity - localised depletion

6.1 Introduction

The panel defined localised depletion as a spatial and temporal reduction in the abundance of a targeted fish species that results from fishing. This definition is consistent with that adopted in the first declaration report (Expert Panel on a Declared Commercial Fishing Activity 2014). Under that strict interpretation, the panel concluded that it is inevitable that any fishing by the declared commercial fishing activities (DCFAs) in either the first or second declaration, or that has occurred in past or present fisheries (Jack Mackerel Fishery (JMF) or Small Pelagic Fishery (SPF)), will cause, or has caused, localised depletion. It was clearly noted that localised depletion should not be confused with range contraction or overall stock depletion. As in the panel's assessment of the DCFA in the first declaration (DCFA1), the central issue for the panel's assessment of the fish processing activity (FPA) was whether the fishing activity could be concentrated enough, both spatially and temporally, to cause a localised depletion of the target species sufficient to cause adverse environmental impacts to the Commonwealth marine environment.

The panel's assessment of DCFA1 considered factors that would influence the extent and impact of localised depletion such as the scale and persistence of the depletion and the vulnerability of the SPF species to localised depletion (see Section 6.4 in the first declaration report). Pertinent to the assessment of the FPA is the conclusion that "Whether the localised depletion occurs as a result of one or many boats is irrelevant according to international and Australian fisheries managers and scientific experts interviewed by the panel. Vessels of a smaller capacity tend to concentrate effort around their home ports because their limited fish handling and storage facilities, and fuel and provisioning capacity, restrict their range. A fleet of many smaller vessels has the potential to create localised depletion if the fishing intensity is spatially and temporally dense" (Expert Panel on a Declared Commercial Fishing Activity 2014).

The panel's assessment of DCFA1 focused on the assessment of the impacts of localised depletion by a single large-scale, mid-water trawl freezer vessel. In contrast, the catching fleet under the FPA fishing scenario comprises three vessels using purse seine and two vessels using mid-water trawl. All of these vessels are wet boats (i.e. cannot freeze catch).

The panel considered that there were potentially five elements of the FPA that might modify the impacts of localised depletion compared to those under the first declaration, i.e. DCFA1. These were:

- that the processing vessel did not fish
- the reduced storage capacity of the processing vessel
- an additional and possibly enhanced fish finding ability provided by the processing vessel to the catching fleet
- that the catching fleet comprised five wet boats, three of which used purse seine and two that used mid-water trawl, rather than a single freezer trawler using mid-water trawl
- the ability to tranship catch via a pump from the catching fleet to the processing vessel.

These differences are considered below in relation to the potential impacts on target species and on predators, particularly central place forager (CPF) species of localised depletion arising from the FPA. In addition, the panel has made a relative, qualitative assessment of potential impacts between the DCFAs, i.e. DCFA1, the mid-water trawl activity (MTA) and the FPA, and the past and present SPF fleet. The panel acknowledges that many assumptions were made in the development of the scenarios of the FPA, none of which might truly reflect the nature of the activity had it proceeded.

6.2 Assessment of the impact of localised depletion arising from the FPA on target species

6.2.1 Summary of potential impact of localised depletion arising from DCFA1 on target SPF species

The nature of the potential adverse environmental impacts that might arise from localised depletion on target species in the SPF under DCFA1 was discussed in detail in Chapter 6 of the first declaration report (Expert Panel on a Declared Commercial Fishing Activity 2014) and will not be repeated here. However, many of the findings and outcomes are relevant to this assessment of the FPA and are summarised below.

With regard to DCFA1's capacity to catch fish, the panel concluded that the ability of a mid-water trawl vessel to stay on a school of fish and therefore take a greater proportion of that school so as to increase the extent of localised depletion was dictated more by the behaviour of the school than by the particular characteristics of the mid-water trawl vessel and was not significantly affected by the freezing and processing capacity of the vessel specified in DCFA1.

With regard to small pelagic species' vulnerability to fishing, the panel found that SPF target species had characteristics that made them both vulnerable to fishing (detection and size of schooling behaviour and association with environmental features) and resilient to fishing (swimming proficiency, reproductive capacity and unpredictability of schooling behaviour). These latter qualities are able to reduce the temporal and spatial extent of any depletion that occurs from fishing or natural causes and therefore on the extent of adverse environmental impacts either on the target species themselves or on dependent predator species.

With regard to current and past harvest rates of small pelagic species in southern Australia, the panel was unable to find evidence of discernible adverse impacts on the target species. The available genetic evidence for jack mackerel *Trachurus declivis* did not suggest that past, apparently high, levels of fishing had significantly affected reproductive capacity. There have been no significant changes in the age or size composition of redbait *Emmelichthys nitidus* in recent years that might indicate a potential impact on reproductive capacity. There were too few data available for the Australian sardine *Sardinops sagax* in the Eastern Zone, or blue mackerel *Scomber australasicus* to determine significant changes on age, size structure or reproductive capacity to date but the low levels of effort and catch suggest that there is little likelihood that this has occurred. There is no evidence to suggest that localised depletion has caused any impacts on genetic diversity. Furthermore, the panel considered that any localised depletion of SPF target species that might arise from the DCFA1 was unlikely to affect the overall status of stocks of those species in the SPF, assuming that the total allowable catches (TACs) are set in accordance with the current Harvest Strategy Policy (HSP) (Department of Agriculture, Fisheries and Forestry (DAFF) 2007) and with the best possible stock estimates.

6.2.2 Potential impacts of localised depletion arising from the FPA on target SPF species

Target species

As noted above, SPF target species possess characteristics that make them resilient to fishing and to the risk of adverse environmental impacts arising from localised depletion. This resilience will apply whether the fishing operation takes the form of the DCFA1, the MTA, the FPA or the typical SPF fleet operation.

The nature of the potential adverse impacts on target species in the SPF under the FPA was considered to be essentially the same as for DCFA1 discussed in detail in the first declaration report (Section 6.5 of Expert Panel on a Declared Commercial Fishing Activity 2014) and summarised above.

The direct effect of removal of the target species was a reduction in stock size such that changes occur in size and age structure at lower levels of exploitation, through to reduction in reproductive capacity and loss of genetic diversity at higher levels of exploitation. As discussed above, such impacts have not been detected in the SPF target stocks even at the relatively high exploitation rates in the JMF when jack mackerel catches in the 1980s were up to four-times greater than the current Eastern Zone TAC (Section 6.8.3 of first declaration report) and from 10-times higher than the catches in the post-2000 SPF fishery (see Figure 3.4 in Ward *et al.* 2014). The panel concluded in the first declaration report that "The impact of localised deletion of a target species on its stock status will depend in part on whether the stock as a whole is being managed sustainably. A stock that is in an overfished state, or for which catch/effort limits are not set sustainably, is clearly more susceptible to the impact of localised depletion events than well-managed stocks" (Expert Panel on a Declared Commercial Fishing Activity 2014).

Given the conservative exploitation rates in the SPF and that concerns about the basis for spawning stock biomass estimates are being addressed, the panel considered that any localised depletion of SPF target species that might arise from the FPA was unlikely to affect the overall status of stocks of those species in the SPF. The panel also acknowledged that recent TACs have not been caught in the SPF thus adverse environmental effects were unlikely to be occurring now.

The recent review of the harvest strategy settings for the SPF (Smith *et al*. 2015), completed since the first declaration report, found that target reference points of B_{50} and B_{20}[14] were consistent with current HSP default settings (see DAFF 2007). Combined with evidence from other studies, the authors considered that these suggested levels were "safe from an ecosystem perspective and provide reasonable levels of yield relative to MSY [maximum sustainable yield]" (Smith *et al*. 2015). Perhaps more importantly, Smith *et al*. (2015), taking into account the broad range of life histories and ecology of the SPF species (see Chapter 4 and Section 6.4.2 in the first declaration report), also suggested that exploitation rates should be species-specific or possibly even stock-specific. They concluded that currently some of the Tier 1 harvest rates in the SPF Harvest Strategy (AFMA 2008) appear too high for some species. The panel notes that none of the SPF stocks are currently managed at Tier 1. Smith *et al*. (2015) also made further suggestions regarding more appropriate harvest rates for the other Tier levels.

The suggestion by Smith *et al*. (2015) that species harvest rates might need to be stock-specific is dependent on knowledge of stock boundaries, however, their interpretation of stock was based on the east-west split of the SPF. In the first declaration report the panel noted that movement and structure of the SPF stocks are rather poorly known and genetic evidence suggesting sub-structuring within the jack mackerel and Australian sardine stocks (Ovenden 2015[15]) could be investigated further to establish risks of localised depletion at sub-population level. Finer sub-structuring of stocks, for example into genetically distinct spawner groups as in sardines, may have further implications for determining appropriate harvest rates. However, the evidence for jack mackerel, in particular, is inconclusive and while sub-structuring may occur it may have little impact on determination of the TAC or harvest rate, depending on how the separation is produced and maintained.

As discussed in Section 4.4.2, the panel considered that compared to the typical, particularly 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, according to the panel's definition of localised depletion, increased catch would necessarily result in increased localised depletion. Whether the localised depletion arising from the ability to tranship under the FPA is large enough and maintained for long enough to cause adverse effects to the target species is the central issue for the assessment.

The processing vessel

Since the processing vessel in the FPA does not fish, it has no direct impact on localised depletion. The direct impact will be incurred through the catching fleet. The storage capacity (and fuel capacity) of the processing vessel will influence how long it can remain at sea before returning to port to unload and/or refuel. However, the panel considered that this would have less bearing on the potential impact of localised depletion arising from the FPA than the constraints around the fuel-carrying capacity of the catching fleet, which will influence how often the catching fleet needs to return to port to refuel.

The catching fleet

The panel considered that the FPA catching fleet had the potential to cause localised depletion, as defined by the panel. The FPA scenario involves one less purse seine vessel and one more mid-water trawl vessel than has been the case 'on average' in the SPF. Since it is recognised that purse seine fishing has more capacity to take a whole school of fish by encircling the school compared with mid-water trawl which trawls through the school, the reduced purse seine capacity of the FPA, compared to the typical SPF fleet, might reduce the potential for localised depletion. This is reinforced by the examples of localised depletion of small pelagic species identified in the first declaration report (see Box 6.1) all of which involved purse seine fishing. For the same reason, compared to DCFA1, which relied entirely on mid-water trawl gear, the inclusion of purse seine gear in the FPA may increase the potential for localised depletion.

14 B_{50} and B_{20} represent 50 per cent and 20 per cent of unfished biomass respectively.
15 Cited in Expert Panel on a Declared Commercial Fishing Activity (2014) as Ovenden unpublished.

Box 6.1 Examples of localised depletion effects in fisheries for small pelagic species

Several examples of serial depletion, or possible depletion, in other fisheries for small pelagic species outside Australia were reviewed by the panel in the first declaration report. These were a purse seine fishery targeting four species of mackerels in the Java Sea (Cardinale *et al*. 2011); a purse seine fishery on anchovy *Engraulis ringens* in the Humboldt Current off Peru (Bertrand *et al*. 2012); and a purse seine fishery for Atlantic menhaden *Brevoortia tyrannus* in Chesapeake Bay (Haddon 2009). While these fisheries were not transhipping, they illustrate the effect that a fleet of small vessels that are constrained to relatively small ranges from a home port can have on local target stocks. Of these three, the first had obvious depletion effects on the stocks, and the anchovy fishery was shown to have had adverse impacts on Peruvian boobies *Sula variegate,* but no clear evidence for adverse impacts on either target or dependent species was proven for the menhaden fishery case. In all three cases the fleet size was large (500 reducing to 200 in the Java Sea, and the TAC was large (100,000 tonnes (t) for menhaden).

The panel considered that the assistance in finding fish provided to the catching fleet by the processing vessel would increase the fishing efficiency of the catching fleet. However, as noted in Chapter 4, the panel did not consider that this assistance was likely to be a significant determinant of the extent of localised depletion under the FPA.

Transhipment

A panel commissioned literature review (Hamer 2015) found no evidence of localised depletion attributable to transhipment. The review examined experience in two Australian fisheries where transhipment is allowed: the South Australian Sardine Fishery (SASF) and the Northern Prawn Fishery (NPF).

Management arrangements in the SASF do not provide for transhipping specifically, however "pumping from the net of another vessel is informally encouraged and is likely to occur when one vessel catches more than it can carry" (Hamer 2015). This was seen as a 'prudent' measure to prevent removal of fish, whether landed or dumped, exceeding the total allowable commercial catch (TACC). There is some evidence suggesting that localised depletion may have occurred in the SASF in the mid-2000s and may have had some adverse effects: shifts in the age structure of the sardine stock in the Spencer Gulf; a decline in catch-per-unit-effort; and low egg counts from daily egg production surveys (Rogers and Ward 2005 and Ward *et al*. 2006 cited in Hamer 2015, Shanks 2006). Various explanations were proposed to explain these events (Shanks 2006, and see Expert Panel on a Declared Commercial Fishing Activity 2014), however the practice of transhipment was not implicated directly. TACCs were reduced substantially from 2006 and subsequent assessments have found that the stock appears to be relatively stable (Ward *et al*. 2012). A recent risk assessment attributed only a medium risk of fishery impacts on the spawning biomass of the sardine stock (Primary Industries and Regions, South Australia (PIRSA) 2013). In 2012, Senator the Hon. Joseph Ludwig, then Commonwealth Minister for Fisheries, stated that "Scientific studies have also determined that at catch levels of around 30,000 t per annum the South Australian sardine fishery is not impacting on the healthy functioning of the local ecosystem. This strongly suggests that at the much lower catch levels in the SPF over a much larger area, the risk of ecosystem impacts from localised depletion are low." (Ludwig, 2012)

The NPF targets sedentary crustaceans with demersal nets and is therefore not strictly comparable to the SPF; however this fishery does employ transhipment. The NPF uses motherships that transport frozen product back to port and provision the fishing vessels, allowing them to stay within the area for up to 80–90 per cent of available fishing time, longer than would be possible without the support of the motherships. In the late 1990s up to 130 vessels were actively fishing and by the end of the fishing season catch-per-unit-effort declined due to over-fishing (Timcke *et al*. 1999). Analyses of vessel monitoring data and catch records by Deng *et al*. (2005) supported the hypothesis that the rate of depletion of the two species of tiger prawn (*Penaeus semisulcatus* and *P. esculentus*) was more rapid in highly aggregated fishing areas than in randomly fished areas and that the effect of this type of behaviour could be "quite marked and should be investigated". How much transhipment contributed to the over-fishing of the 1990s is unknown, however, many other factors such as natural variability of stocks, improved fish-finding technology, and the size of the fleet probably had greater measurable impact than the transhipment capability. The effort in the fishery has since fallen to less than half (currently 52 vessels, AFMA 2014g) thus relieving pressure and allowing stocks to rebuild, and transhipment is still permitted.

Summary: Assessment of the potential impact of localised depletion arising from the FPA on target SPF species

- *Localised depletion, as defined by the panel, will occur under the FPA but is unlikely to have adverse environmental impacts on the SPF target species.*
- *Given that no impacts on target species were discernible during periods of the fishery when catches were relatively high, i.e. higher than current TACs, the panel concluded that the FPA is unlikely to cause localised depletion to such an extent as to cause adverse environmental impacts on the target species.*
- *The relative impacts of localised depletion on the target stocks caused by the FPA, DCFA1 and the typical SPF fleet will be influenced by the fishing method used, the concentration and intensity of fishing effort and the quantum of catch.*
- *The storage capacity of the processing vessel is not relevant to the assessment of the potential for the FPA to cause localised depletion resulting in adverse environmental impacts.*
- *The ability to tranship at sea would potentially allow for the catching fleet to increase its effort and hence the extent of localised depletion compared to operations in the past but this would be constrained by the need for the catching fleet to regularly return to port to refuel.*
- *The panel concluded that compared to the typical SPF fleet, the FPA is likely to:*
  - *increase the quantum of catch because of the improved efficiency of fishing offered by the presence of the processing vessel*
  - *increase the distribution of effort by allowing wet boats greater range and therefore reduce the intensity of fishing in a given area*
  - *reduce the proportion of catch taken by purse seine with potentially less impacts on individual schools of fish.*
- *The panel concluded that compared to DCFA1 (and the MTA) that the FPA is likely to:*
  - *result in similar levels of catch*
  - *reduce the distribution of effort since wet boats are more constrained by the need to return to port to refuel, and therefore increase the intensity of fishing in a given area*
  - *increase the proportion of catch taken by purse seine with potentially more impacts on individual schools of fish.*
- *The panel could not predict how these factors would balance out. However, as in its assessment of DCFA1 and the MTA, the panel considered that any localised depletion of SPF target species that might arise from the FPA was unlikely to affect the overall status of stocks of those species in the SPF, assuming that the TACs are set in accordance with the current SPF Harvest Strategy (AFMA 2008) and with the best possible stock estimates. The panel notes that current and ongoing research is designed to ensure that this is the case. The panel remains of the view that further research into stock structure would be needed to improve certainty about the appropriate spatial scale at which to manage effort and catch of SPF stocks.*
- *The panel noted that the catching fleet of the FPA may be configured quite differently to the one assessed here. For example, the proposed configuration of the fishing fleet by the proponent of the proposal to bring a processing vessel into the SPF was one purse seine and one mid-water trawler (Mr G. Geen, Director, Seafish Tasmania in litt. cited in Hamer 2015). This configuration would likely present a significantly smaller risk than the FPA scenario assessed here.*

6.3 Assessment of the impact of localised depletion arising from the FPA on protected predator species

6.3.1 Summary of potential impact of localised depletion arising from the DCFA1 on protected predator species

The issue of ecological allocation of resources to dependent predators and the 'trade-offs' that might be necessary to support growing demand for food supplies was examined in the first declaration report (see Section 6.6 in Expert Panel on a Declared Commercial Fishing Activity 2014). The critical issue was to determine the level of removal of the prey species that, when added to the requirements of the overall ecosystem and taking into account natural variability, would not cause unacceptable adverse impacts to the ecosystem or components. Ecological modelling of the southern Australia region was discussed in Chapter 4 of the first declaration report: an important finding was that current exploitation rates under the SPF Harvest Strategy (AFMA 2008) appear to provide an adequate 'ecological allocation' to CPFs and other dependent predators, and that no adverse impacts were likely at the current level of allowable harvest. As noted in Section 6.2.2, the recent review of the Harvest Strategy (Smith *et al*. 2015) supported the current HSP default setting of B_{50} and B_{20} (DAFF 2007) as the target and limit reference points as safe from an ecosystem perspective while allowing reasonable yields. The panel did not address the issue of TAC setting directly as several research projects were in place to improve both stock estimates and harvest strategy policy.

However, as noted in the first declaration report, the available ecological models gave results at a spatial scale that is less finely resolved than is required to identify adverse impacts on particular species of CPFs such as fur seals, sea lions and birds. To avoid those impacts the ecological allocation needs to be within reach of the CPFs, both spatially and temporally. The ability of predators to switch prey in times of reduced prey availability can mitigate the effects of depletion. This ability is inherent in predators of small pelagic species so they can cope with the fluctuations of abundance of their prey that are caused by environmental variability, and which may be indistinguishable from the fluctuations caused by fishing. However, some predators, while being able to switch prey when necessary may be switching to sub-optimal diets that in the long term reduce breeding success or longevity.

The nature of the potential adverse environmental impacts on predators and CPFs that might arise from localised depletion in the SPF under DCFA1 was discussed in detail in Chapter 6 of the first declaration report (Expert Panel on a Declared Commercial Fishing Activity 2014) and will not be repeated here. However many of the findings and outcomes are relevant to this assessment of the FPA and are summarised below.

From dietary data for predators of small pelagic fish collated from studies and sources, including a commissioned technical review by Patterson *et al*. (2015)[16], the panel found that southern bluefin tuna *Thunnus maccoyii* (SBT) had a high reliance on SPF species in Australian waters especially as juveniles. The panel concluded that SBT being migratory, highly mobile and opportunistic, had greater ability to forage on other prey even as juveniles than many species such as the CPFs. The panel considered that the risk of adverse impacts from localised depletion on SBT arising from concentrated fishing effort by DCFA1, under sustainable catch limits, was unlikely.

The panel concluded that the nature and extent of impact would depend on the spatial and temporal scale of the depletion. Concentrated fishing activity at locations and times when CPFs are most susceptible to the impacts of prey depletion may reduce foraging efficiency resulting in longer foraging trips and/or reduced rates of provisioning to offspring. Persistent depletion can result in reduced offspring growth rates, fledging/weaning mass and reduced survival, and reduced adult breeding success. Longer-term impacts can affect major demographic factors such as survival, recruitment and reproductive rates that drive population age structure, growth rates and, ultimately, population size.

The panel also noted that the distinction between fishing-induced prey depletion at the broader stock level or at the local level is irrelevant to a CPF. However, localised depletion, and any associated adverse environmental impacts, may be shorter in duration (days to months) and less persistent than those caused by broader stock depletions.

CPF species have been shown to be highly responsive to changes in prey availability within their key foraging areas but the panel found very few studies that linked reduced foraging and reproductive performance to the impacts of fishing, and even fewer to localised depletion. Five international case studies demonstrate active management, at some level, of the potential impacts of localised depletion caused by fishing on CPF species. These case studies focus on:

- Peruvian anchovy *Engraulis ringens* and Peruvian boobies *Sula variegata*
- North Sea sandeels *Ammodytes marinus* and seabirds
- Benguela anchovy *Engraulis encrasicolus*/sardine *Sardinops sagax* and African penguins *Spheniscus demersus*
- Atka mackerel *Pleurogrammus monopterygius* and Steller sea lions *Eumetopias jubatus* (Alaska)
- Antarctic krill *Euphausia superba* (Commission for the Conservation of Antarctic Marine Living Resources fisheries).

In only one case study (Peruvian boobies) was there compelling evidence for localised depletion. In three case studies (North Sea, Benguela, Alaska) impacts on CPFs were identified (declines in population size and reproductive success). Despite uncertainty of the cause of those impacts, spatial closures have been introduced as a precautionary measure to mitigate potential adverse impacts of localised depletion. In one case study (the Antarctic krill fishery), spatial closures to protect CPFs from indirect fishing impacts are only in development.

16 Cited in Expert Panel on a Declared Commercial Fishing Activity (2014) as Patterson *et al. unpublished.*

Within Australia there are even fewer studies linking reduced foraging and reproductive performance of CPFs to the impacts of fishing on their prey species. The studies on little penguin *Eudyptula minor*, Australasian gannet *Morus serrator* and crested tern *Thalasseus bergii* following the 1995 and 1998 sardine mortality events in southern Australia provided some insight on the potential impacts on CPFs when a major prey species suddenly becomes unavailable. An estimated 70 per cent of the sardine biomass in that area died over short periods in each year. Impacts on the birds included dietary shifts, reduced provisioning rates and reduced chick, juvenile and adult survival (Dann *et al.* 2000, Bunce *et al.* 2005, McLeay *et al.* 2009). In South Australia (SA), Goldsworthy *et al.* (2011) attempted to identify a suite of reproductive and foraging performance indicators in four CPFs to act as ecological performance indicators (EPIs) for the SASF. However, the short time series (of three to four years) for most species precluded a meaningful conclusion.

The panel concluded that there was a potential for localised depletion of target species by DCFA1 to adversely impact their predators in the SPF. The most susceptible to impact were the CPF species, especially those with restricted foraging ranges while raising offspring and where species targeted by the SPF constitute a significant portion of their diet. The CPFs that forage within the SPF and for which SPF target species contribute more than 10 per cent of their diet include Australian fur seal *Arctocephalus pusillus doriferus*, New Zealand fur seal *A. forsteri*, Australasian gannet, short-tailed shearwater *Ardenna tenuirostris*, little penguin, crested tern and shy albatross *Thalassarche cauta cauta*. The key areas of importance to these species are in south-eastern Australia, especially Bass Strait, Tasmania and SA. There remains some uncertainty about other CPF species that might be susceptible to localised depletion since diet information is poor or unavailable. The panel also noted that there is very limited monitoring of CPF populations and the chance of detecting any indirect fishery-related impacts within the SPF area is extremely low.

6.3.2 Potential for adverse environmental impacts from localised depletion arising from the FPA on protected predators and CPF species

As discussed in Section 6.2.2, the impact of the characteristics of the processing and storage capacity of the processing vessel itself of the FPA has no direct relevance to CPFs. However, an increase in effort under the FPA, compared to the SPF fleet to date, will increase the level of localised depletion which might increase the risk of adverse environmental impacts, particularly if the effort is concentrated spatially and temporally. Whether the depletion is large and persistent enough to cause adverse effects to the predators is the central issue.

Smith *et al.* (2015) found that the HSP settings for target and limit reference points are appropriate for small pelagic species and were "safe from an ecosystem perspective". This implies that TACs set in accordance with the HSP are adequate to account for the dietary requirements of predators of small pelagic species. Modelling exploitation of small pelagic species, either singly or in combination, and even at very high levels of exploitation that far exceeded the HSP rules, resulted in minimal impact of the broader ecosystem except for a minor decrease in shark biomass (Smith *et al.* 2015). This ability of predators to switch prey in the absence of any particular prey mitigated negative impacts of the loss of that prey.

Smith *et al.* (2015) also found that exploitation rates should be species-specific or even stock specific, taking into account the broad range of life histories and ecology of the SPF species. While these findings are applicable to the broader stock, the question remains as to what level of localised depletion i.e. concentration of removal, could produce adverse environmental effects on dependent predators.

SBT

The panel collated dietary data for predators of small pelagic fish from studies and sources including a commissioned technical review by Patterson *et al.* (2015). Most of the species that ate a high proportion of small pelagic species were CPFs, dolphins, SBT and sharks. The importance of the prey varied according to region, length and timing of study and life history stage (see Tables 4.1 and 4.2 in Expert Panel on a Declared Commercial Fishing Activity 2014). The panel also warned that the data in some instances were up to several decades old and becoming less reliable. Of the non-CPFs, SBT was the most dependent on small pelagic species. Young *et al.* (1997) collected SBT specimens from the east and south coasts of Tasmania between 1992 and 1994 from inshore around the Hyppolyte Rocks and offshore in oceanic waters. Inshore fish (40–130 centimetres (cm)) ate around 45 per cent jack mackerel and 30 per cent redbait while offshore fish (74–192 cm) ate around 24 per cent and 1 per cent respectively (Young *et al.* 1997). Juvenile squid *Notodarus gouldi*, krill *Nyctiphanes australis* and Australian sardines were also important in inshore diets. Adult fish fed further offshore, sometimes in the fronts and eddies of the East Australian Current and on a greater diversity of prey including macrozooplankton particularly the copepod *Phronima sedentaria* and larger pelagic fishes such as Rays bream *Brama brama*.

Young *et al.* (1997) concluded that the inshore waters were important for immature SBT on their annual migration through Tasmanian waters coinciding with autumn blooms of phytoplankton. These blooms provide food for krill which in turn provide food for jack mackerel and redbait. As krill abundance declines towards winter, jack mackerel and redbait move on in search of prey and become more difficult to find. SBT then move offshore in search of prey and the inshore tuna fishery declines (Young *et al.* 1997). The complexity and variability of this east Tasmanian ecosystem were discussed in detail in the first declaration report with particular reference to the 'ups and downs' of the fishery for jack mackerel over the past decades. Natural variability of oceanographic conditions that are fundamental in 'driving' the ecosystem will cause variability in phytoplankton and higher trophic levels in the food web. Large changes in the fishery for jack mackerel caused by changed availability and catchability of the fish have been observed since the 1950s. Obviously, SBT at the next trophic level would also experience changes in availability of this prey.

Another factor to consider in relation to SBT prey is that the SBT (largely immature) were taking jack mackerel less than 125 millimetres (mm) (length measured along the longest axis) (Young *et al.* 1997), about half the size taken by the JMF (250–370 mm fork length). Similar size selectivity was found for Australasian gannets off southern Tasmania and little penguins (see first declaration report). However the panel noted that there has to be sufficient mature stock to maintain recruitment of juveniles for the dependent predators and for the stock itself (Expert Panel on a Declared Commercial Fishing Activity 2014). With regard to the FPA, the panel concluded that SBT was migratory, highly mobile and opportunistic and had greater ability, even as juveniles, than species such as the CPFs, to forage on other prey. The panel considered that the risk of adverse impacts on SBT from localised depletion of SPF target stocks was low and unlikely to be detectable, particularly given the large environmental variability experienced in this region.

CPF species

There is very limited information currently available that enables the panel to assess the potential for adverse impacts on CPF species from localised depletion in the SPF. The CPF species most susceptible to localised depletion of SPF target species were identified in the first declaration report by taking into account both their dietary reliance on SPF target species (more than 10 per cent) and their reliance on near-colony prey resources while raising offspring (Expert Panel on a Declared Commercial Fishing Activity 2014). They are the Australian fur seal, New Zealand fur seal, Australasian gannet, short-tailed shearwater, little penguin, crested tern and shy albatross. The key areas of importance to these species include south-eastern Australia, especially Bass Strait, Tasmania and South Australia, although information is variable. There are few studies that have examined the potential impact of localised depletion on these species. Further, the dietary data available for CPFs in the SPF are by no means comprehensive and therefore this list of susceptible CPF species is unlikely to be comprehensive.

As discussed in the previous section, the panel considers that the studies reviewed in the DCFA1 assessment that identified links between prey abundance and population performance of CPFs are relevant to assessment of the FPA. These studies provided some insight about the likely nature of adverse impacts from localised depletion. The responses of little penguins, Australasian gannets and crested terns to the Australian sardine mortality events of 1995 and 1998 serve to illustrate the severity of a depletion needed to not only affect populations but to be detectable, if only for a few years. They also show that a level of persistence of the depletion event is needed in order to have ongoing adverse effects beyond what might be expected through natural variability, which was not the case in these events.

Similarly, the study linking reproductive and foraging success parameters for CPF seals and seabirds to annual changes in Australian sardine catch and biomass (Goldsworthy *et al.* 2011) provided further insights into potential impacts in the event of declines in sardine abundances in the GAB. Negative correlations were found between sardine annual catch and the morphology and growth of New Zealand fur seal pups, the breeding success of little penguins, the morphology of crested terns and the growth of shearwaters. However, because of the very short time series and unclear trophic and spatial overlap between the fishery and some of the predators, the authors expressed the need for caution when interpreting the results and noted that longer time series were needed to enable more robust analyses.

Spatial and temporal pattern of fishing

As discussed above, it is not possible to accurately predict where and to what extent localised depletion will occur or how long that depletion might persist under a FPA. As the panel concluded in Section 4.2.2, the introduction of a processing vessel enables catching vessels to stay at sea for longer periods. This could enable the catching fleet to fish areas of the fishery that have not been previously accessible due to their distance from ports, and provides an economic incentive to increase fishing effort. However, while the fleet would be less constrained spatially, the panel cannot predict whether the fleet would increase their range or concentrate effort in areas traditionally fished compared to the SPF to date, or both.

The panel believes that an expansion of range might increase the exposure of more CPF colonies to fishing activity by the FPA but to a far lesser extent than the DCFA1 or MTA. Conversely, the FPA has an increased ability to avoid those areas or move out of them if a problem occurs then does the typical SPF fleet, but to a far lesser extent than the DCFA1 or MTA.

In the first declaration report the panel concluded that: "Because central-place foraging predators (seabirds and pinnipeds) raise offspring on land, the availability of key prey resources near their breeding colonies at key times (e.g. incubation and chick rearing in seabirds, lactation in pinnipeds) is critical to their reproductive success and the longer-term sustainability and maintenance of breeding populations. This dependency on near-colony prey resources at certain locations and times increases the vulnerability of these species to localised depletion of prey in their key foraging areas" (Expert Panel on a Declared Commercial Fishing Activity 2014). Therefore, if the FPA fleet concentrated more effort in fishing grounds closer to home ports, as has been the case in the SPF to date, the risk of adverse impacts arising from increased levels of localised depletion would only occur if these grounds are in CPF foraging areas and the effort occurs at critical times.

The first declaration report identified the distribution of known breeding colonies of six of the key CPF species excluding crested tern (Figure 6.1). These were predominantly located in the south east region of the SPF and most are adjacent to areas that have been historically fished by the SPF. A panel-commissioned review by Patterson *et al.* (2015) for the first declaration report identified timing of breeding and offspring growth for the most susceptible CPFs (Figure 6.2). However, the extent of the CPF-specific foraging areas adjacent to their colonies is an important factor in determining overlap with the fishery. Goldsworthy *et al.* (2011) estimated the spatial distribution of foraging and consumption effort off South Australia for five key CPF species in the area of the SASF. These models highlighted areas of importance to these species in the SASF (Figure 6.3), however they were not designed for management of localised depletion and do not take into account the critical times. They also do not address the CPFs that are dependent on SPF species other than Australian sardine.

The panel concluded that it is not possible to predict the spatial and temporal pattern of fishing of the FPA but that there is the potential for increased localised depletion and an increased risk of adverse environmental impacts on CPFs compared to the SPF operations to date.

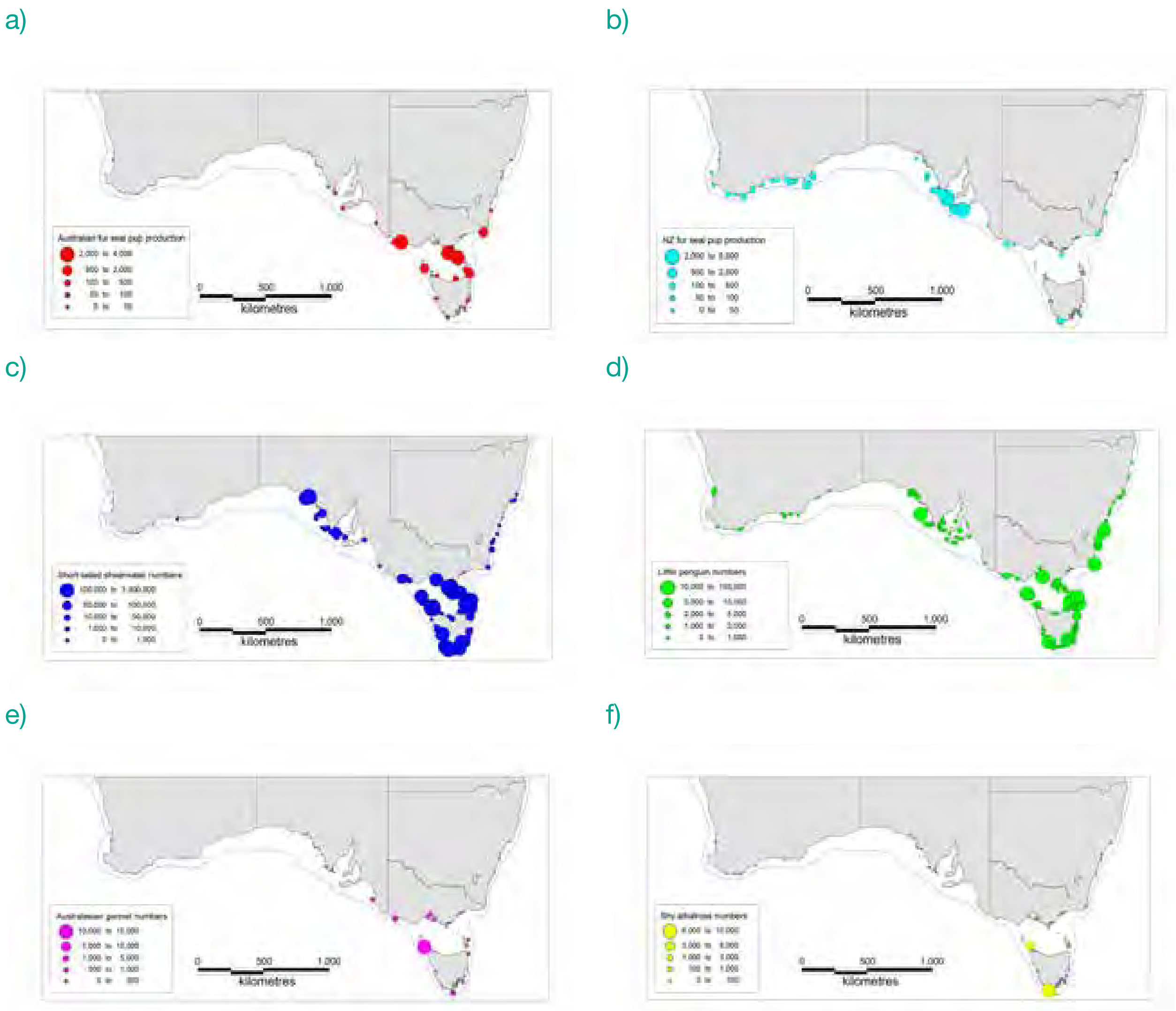

Figure 6.1 Distribution of breeding colonies of six key CPF species that occur in the SPF: a) Australian fur seals, b) New Zealand fur seals, c) short-tailed shearwater, d) little penguin, e) Australasian gannet, and f) shy albatross. Symbols are scaled to the size of the populations. The 200 metre bathymetry isobath is indicated. **Source:** S. Goldsworthy, South Australian Research and Development Institute (SARDI) unpublished.

SPECIES	FORAGING MODE	J	A	S	O	N	D	J	F	M	A	M	J
Australian fur seal	benthic												
New Zealand fur seal	pelagic												
Short-tailed shearwater	plunge dive												
Little penguin Vic./Tas./NSW	pelagic												
Little penguin SA/WA	pelagic												
Australian gannet	plunge dive												
Crested tern	plunge dive												
Shy albatross	surface feeder												

Figure 6.2 Approximate timing, by month, of breeding and offspring growth for key CPF species in the SPF area (light green). The periods of greatest vulnerability to CPFs (incubation, chick feeding, early lactation) when offspring are young are indicated in dark green. General foraging mode is also indicated. **Source:** adapted from Patterson *et al.* (2015) and S. Goldsworthy, SARDI, unpublished data.

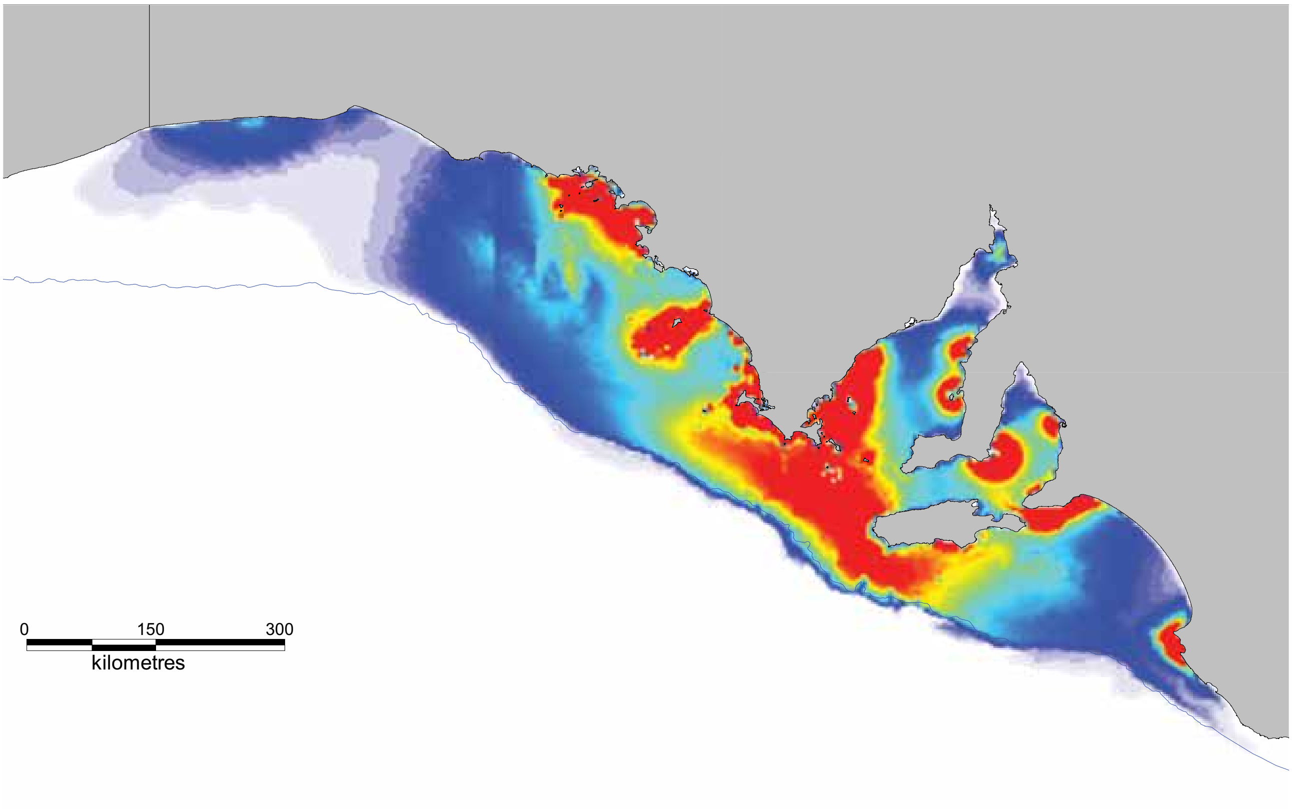

Figure 6.3 Combined model of the spatial distribution of foraging effort for five CPFs over shelf waters off South Australia, drawn as heat plots (New Zealand fur seal, Australian sea lion, short-tailed shearwater, little penguin and crested tern). **Source:** S. Goldsworthy, SARDI unpublished; redrawn from data from Goldsworthy *et al.* (2011).

Summary: Potential for adverse environmental impacts from localised depletion arising from the FPA on predators and CPF species

- *CPFs that forage within the SPF and for which SPF target species comprise more than 10 per cent of the diet include Australian fur seal, New Zealand fur seal, Australasian gannet, short-tailed shearwater, little penguin, crested tern and shy albatross.*
- *There remains some uncertainty about other CPF species that might be susceptible to localised depletion since diet information is poor or unavailable.*
- *Key areas of importance to these species include south-eastern Australia, especially Bass Strait, Tasmania and South Australia.*
- *The relative impacts of localised depletion caused by the FPA, DCFA1 and the typical SPF fleet on CPFs will be influenced by the quantum of catch and the intensity and the distribution of effort.*
- *The panel concluded that compared to the typical SPF, the FPA is likely to:*
  - *increase the quantum of catch because of the improved efficiency of fishing offered by the presence of the processing vessel*
  - *allow wet boats to remain at sea for longer and therefore may*
    - *broaden the distribution of effort and reduce the intensity of fishing in a given area*
    - *increase the fishing effort in a given area*
    - *if fishing is concentrated in critical foraging areas of the CPFs, slightly increase the potential for localised depletion and the risk of adverse impacts on CPFs*
    - *if fishing is more broadly distributed, slightly decrease the potential for localised depletion and the risk of adverse impacts on CPFs.*
- *The panel concluded that compared to the DCFA1 and MTA, the FPA is likely to:*
  - *result in similar or higher levels of catch*
  - *reduce the distribution of effort since wet boats are much more constrained by the need to return to port to refuel, and therefore increase the intensity of fishing in a given area*
  - *if fishing is concentrated in critical foraging areas, increase the potential for localised depletion and potentially the risk of adverse impacts on CPFs.*
- *The panel could not predict how these factors would balance out. However, overall, the panel concluded that there was slightly more potential for the FPA fishing fleet to have adverse impacts on protected CPF species than the typical SPF fleet but slightly less potential than under DCFA1 or the MTA.*

6.3.3 Management of the impacts of localised depletion on CPFs

There are three mechanisms that contribute to SPF management of localised depletion. These are:

- management settings including precautionary reference points
- zoning of stocks, TACs and individual transferable quotas
- prescribed responses to localised depletion.

The reference settings prescribed by the SPF Harvest Strategy claim to be precautionary, a view supported by Smith *et al.* (2015). According to their model results the recommended harvest levels were found to have minimal impact throughout the ecosystem and therefore allow adequate provision for dependent predators.

Zoning (Eastern and Western Zones) of stocks and TACs is an attempt to allocate catch and effort across the fishery. However, there is evidence to suggest that further sub-structuring of stocks of jack mackerel and Australian sardine might exist. There is no further information regarding this sub-structuring or if this is important to the issue of ecological allocation to dependent CPFs.

The SPF Harvest Strategy (AFMA 2008) does specifically acknowledge the risk of adverse impacts from localised depletion on CPFs (Box 6.2).

Box 6.2 Accounting for ecological impacts

"On the basis of all available information including independent observations of the fishery, the potential ecological effects of the SPF will also be considered by SPFRAG [Small Pelagic Fishery Resource Assessment Group] when setting RBCs [recommended biological catches] using the following decision rules.

1. If evidence of significant interactions with threatened, endangered or protected species exists, SPFRAG must recommend one or more of the following:

- that a program be established to mitigate interactions; and/or
- an appropriate reduction in the RBC; and/or
- that the stock/s be reduced to a lower level Tier (ie with a smaller catch).

2. If, as a result of fishing, there is evidence of localised depletion or a concerning trend/change in age/size structure, SPFRAG must recommend one or more of the following:

- an appropriate reduction in the RBC; and/or
- appropriate spatial or other management measures.

3. If, as a result of fishing in the SPF, there is evidence of changes in ecosystem function (eg. reduced breeding success of seabirds), SPFRAG must recommend one or more of the following:

- an appropriate reduction in the RBC; and/or
- appropriate spatial or other management measures; and/or
- that a program be established to:
  - assess the potential impacts of the fishery on the ecosystem;
  - investigate potential ecological performance indicators for the fishery; and
  - report management performance against those indicators."

(AFMA 2008)

There were no additional measures proposed to be applied to the FPA in order to monitor or to address any increased risk of localised depletion on CPF species.

Panel assessment: proposed measures to manage the risks to CPF species arising from localised depletion caused by the FPA

- *The overall level of exploitation permitted in the SPF is consistent with the best available advice on management of small pelagic species.*
- *The overall level of exploitation proposed in the SPF Harvest Strategy has been found to be adequate from an ecosystem perspective; however, species-specific and possibly stock-specific exploitation rates may need to be adjusted.*
- *The precautionary SPF Harvest Strategy settings are unlikely to make a significant contribution to avoiding adverse environmental impacts of localised depletion on CPF species. While separate TACs are allocated to Eastern and Western Zones, there is no finer spatial allocation of catch or effort.*
- *The provisions of the SPF Harvest Strategy outline responses to localised depletion once it has been detected.*
- *There are no measures in place in the SPF that would detect the spatial and temporal extent of localised depletion or adverse environmental effects that arise from it.*
- *There are no spatial and temporal closures in place, or proposed, that address potential trophic impacts to CPF species in the SPF.*

6.3.4 Actions that could be taken to manage localised depletion in the SPF

The mitigation measures for reducing the risk of adverse environmental impacts of localised depletion caused by the FPA on CPFs are the same as those proposed by the panel for the DCFA1. These are:

- spatial allocation of TAC
- move-on rules
- spatial closures.

Spatial allocation of TAC

The use of spatially allocated TACs would require the SPF fishery to be managed in smaller spatial management units within which the consumption needs of predators of SPF species (including CPFs) would be assessed and taken into account. Area-specific TACs would be set for each management unit. However, unless the management units are relatively small in scale, spatial allocation may not prevent most of the allocated catch within a management unit being taken in a small geographic space over a short time period, as a result this may be a less effective management tool to mitigate the potential impacts of localised depletion on CPFs.

Move-on rules

Move-on rules could be applied to critical foraging zones of CPFs and/or at critical times (for example, during breeding season, chick or pup-rearing periods) to manage the potential adverse impacts from localised depletion by the FPA on CPFs. These rules are a form of spatial closure that is enforced after a certain level of catch has been taken within a sensitive CPF area and at sensitive times.

The panel notes that the Small Pelagic Fishery Resource Assessment Group (SPFRAG) is focusing effort on the use of move-on rules (SPFRAG 2014) and is discussing two options: moving a set distance or moving on to another grid, both of which would require close monitoring of catches. It is the panel's view that there is less information available to inform the setting of a meaningful level of catch over space and time as required by a move-on rule than is the case for broader, spatial/temporal closures.

Spatial closures

Spatial closures are used to prevent any fishery catch taking place in critical foraging areas, typically adjacent to CPF species' breeding colonies. Closures may be temporary to protect CPFs at critical time periods, such as during the breeding season, or permanent where animals may reside at colonies or haul-outs year round, and where offspring may be provisioned over longer time periods (e.g. seals with long lactation periods). Typically, the extent of the spatial closure(s) would be determined by an understanding of where the key foraging areas are, or on limitations in the foraging ranges or spatial at sea distribution, and would potentially vary among species and populations in their scale, timing and duration.

The panel notes that SPFRAG (2014) continues to view the use of spatial/temporal closures as part of the toolbox for managing localised depletion.

Panel advice: actions that could be taken to manage the risks to CPF species arising from localised depletion caused by the FPA

- *There are three main precautionary management approaches that could be implemented to mitigate the potential adverse impacts of localised depletion caused by fishing on CPFs: spatial allocation of catch, move-on rules and spatial closures.*
- *Spatial closures are the most common form of precautionary management used to mitigate the potential adverse impacts of localised depletion on CPFs; however, the effectiveness of spatial closures for this purpose has not been clearly demonstrated. Their effectiveness depends heavily on the ability to determine the scale of spatial closures that would be appropriately precautionary for particular species at particular locations and at particular times.*
- *The panel considered that the risks to CPF protected species from localised depletion caused by the FPA should be managed by taking a proactive approach separating the fishing activity from the key foraging areas and times used by CPF species rather than through move-on rules. This does not discount the potential value of move-on rules in the context of direct interactions with protected species.*
- *While determining the appropriate scale of the required closures in particular times and areas will remain a challenge, there are reasonable datasets available in at least some areas of the SPF that could inform these decisions. It may be necessary to extrapolate from this information in order to define appropriate spatial closures elsewhere in the SPF.*
- *It is likely that these spatial closures will need to be modified adaptively to reflect additional information as it becomes available, either through fishing or targeted research.*

- *Global studies on CPFs demonstrate that they are responsive to changes in the availability of prey within their foraging range, but they do not distinguish between changes caused by localised and overall stock depletion. Careful consideration of how management of the entire stock, and especially the reduction in available biomass through fishing, impacts on CPFs at a local scale and at critical times, is required.*

6.3.5 Research and monitoring to reduce uncertainty associated with the risk of localised depletion

In the first declaration report the panel found no conclusive evidence of historical localised depletion that caused adverse environmental impacts in the SPF, and that remains the case under the FPA. The high level of dependence by some predators, particularly CPF species, highlights the need to manage for the risk of such impacts. It also points to the potential to use populations of these species to monitor the health of the SPF resources.

Many of the uncertainties that have been identified in relation to the panel's ability to assess the extent of localised depletion likely under an FPA cannot be addressed through monitoring and research. Some uncertainties reflect the dynamic nature of the marine environment and consequently, responses of small pelagic species. Some reflect the dynamics of fishing operations and economics. Thus many of the uncertainties will remain and management must, therefore, be precautionary and adaptive.

Target species

The panel considered that it is reasonable to expect that a significant increase in catch of SPF target species is likely to occur under a fleet configuration that is more economically efficient, can produce higher-priced product for human consumption and has a greater capacity to stay at sea and to fish the area of the SPF more broadly. The configuration of the FPA fleet assumed by the panel in its assessment, would allow more catch to be taken within the constraints of the TACs. In order to minimise the risk that fishing is concentrated on sub-populations of redbait, blue mackerel and jack mackerel, further investigation into the population structure of these species would be appropriate.

The projects identified by Ovenden (2015) in the first declaration report are still considered by the panel fundamental to understanding stock structure in the SPF species and to enabling better and more appropriate spatial management of all stocks. More robust spatial management of the stocks should reduce the likelihood and risks associated with localised depletion of those species. The projects identified ranged between a very cost-effective re-analysis of existing jack mackerel and sardine data, if available, using the latest statistical methods, to more targeted studies, at increasing costs, on all SPF species, including blue mackerel, yellowtail scad and redbait for which there is very poor information. Some of the latter studies could easily be added into the fishery–independent surveys currently being conducted or planned in the SPF. Ovenden (2015) also advocated that a combination of genetics and single–generation markers such as otolith chemistry, parasite abundance, tagging and tracking, is needed to define stocks and better understand "crinkles in connectivity between populations" but the panel noted that the SPF has limited resources to support such a range of research programs. The panel supports further well-designed and targeted research in this area to clarify the extent of sub-structuring within the Eastern and Western Zones specifically, and the SPF more broadly.

The panel considered that ongoing monitoring of the length frequency of catch taken by the FPA fleet and the SPF fleet more generally would be important for monitoring overall stock health and detecting any localised effects on target stocks. The catch of the FPA catching fleet would be frozen onboard the processing vessel therefore management measures would need to ensure that arrangements were made for observers to collect this information prior to freezing.

Panel advice: research and monitoring to reduce uncertainty associated with the risk of localised depletion

Research and monitoring in the following areas could reduce uncertainties associated with stock structure and hence with the adverse impacts of localised depletion arising from the FPA on target species and CPFs:

- *Well-designed and targeted research to clarify the extent of sub-structuring of SPF target species within the Eastern and Western Zones specifically, and the SPF more broadly.*
- *Dietary studies to determine which key CPFs or other commercially or ecologically important predators are most reliant on SPF species.*
- *Studies to better understand the critical foraging areas, habitats and times for key CPFs.*
- *Examination of the biological response of CPFs to changes in prey availability.*
- *Ongoing monitoring of the length frequency of catch taken by the whole fleet including the FPA catching vessels at a statistically appropriate sampling intensity.*
- *Development and implementation of potential ecological performance indicators for the fishery.*

CPF species

The panel determined in the first declaration report that there are widespread and large uncertainties in the population status and abundance of CPFs, the spatial distribution of foraging effort, and diet for most species and that remains the case under the FPA. To address these uncertainties and inform the understanding of the potential impacts from reductions in prey availability caused by any form of SPF depletion on the availability of prey to CPF within their key foraging areas, the panel reaffirms the following four research and monitoring needs:

1. Dietary studies to determine which key CPFs or other commercially or ecologically important predators are most reliant on SPF species.

In general, information on the importance of SPF species and other commercially targeted species in the diets of CPF predators is patchy, leading to large uncertainties due to the lack of representativeness in locations and years and for some species the basic information is absent. As a consequence there may be other species for which there are limited data that may well be susceptible to impacts associated with the SPF.

2. Studies to better understand the critical foraging areas, habitats and times for key CPF species.

There are major gaps in information on the distribution of key foraging areas for CPF species throughout the SPF area. Critical gaps include comprehensive and representative data on the foraging distributions and ranges at critical life-history stages for seabirds (during the incubation and chick rearing to fledging) and for seals (the key foraging areas of adult females throughout lactation). In managing for the potential adverse impacts of localised or stock depletion on dependent CPFs, such information is necessary to determine the scale of spatial closures that would be appropriately precautionary for particular species at particular locations and at particular times. This does not preclude the introduction of interim precautionary closures based on available information.

3. Biological response of key CPFs to changes in prey availability.

There are a number of global studies that provide an important foundation to our understanding of how CPF species respond to variation in prey availability over short and long time scales (see Boyd *et al.* 2006 and chapters therein). Unfortunately, there are few such studies in Australia that can be drawn upon to provide any insight into the likely nature and consequence of indirect fishing impacts on protected CPF species. Long-term monitoring of key CPF species' populations in the SPF area could provide important information on assessing the indirect effects of fishing. Such studies could monitor foraging efficiency, provisioning rates and offspring growth rates and fledging/weaning mass, survival and adult breeding success. Monitoring of annual production and/or population size would also provide very relevant time series and key performance indicators of CPF health, and would indirectly measure the degree to which potential indirect effects of fishing are being managed/mitigated.

4. Establishment of EPIs.

The panel noted the provision in the SPF Harvest Strategy for the establishment of a program to assess the potential impacts of the fishery on the ecosystem, investigate potential EPIs for the fishery and report management performance against those indicators if there is evidence of changes in ecosystem function (e.g. reduced breeding success of seabirds). The panel considered that there would be merit in establishing such a program in a proactive way, i.e. to detect such events, rather than only as a response mechanism.