

Marine Environment & Ecology

Mitigating Seal Interactions in the SRLF and the Gillnet Sector SESSF in South Australia

Final Report to the Fisheries Research and Development Corporation



SD Goldsworthy, B Page, PD Shaughnessy, A Linnane

FRDC PROJECT NUMBER: 2007/041

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1 NON TECHNICAL SUMMARY

2007/041 Mitigating Seal Interactions in the SRLF and the Gillnet Sector SESSF in South Australia

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OBJECTIVES

- Develop and assess methods for mitigating sea lion interactions with southern rock lobster pots.
- 2. Assess the significance of Australian sea lion bycatch in the gillnet sector of the GHAT (SESSF) fishery.
- Develop options for spatial closures in the gillnet GHAT (SESSF) fishery to mitigate Australian sea lion bycatch.
- 4. Develop performance indicators to evaluate the effectiveness of the different mitigation options developed for each fishery.

OUTCOMES ACHIEVED TO DATE

Bycatch of Australian sea lions (ASL) in rock lobster and shark gillnet fisheries has been identified as a key threat to the species, which is listed as *threatened* under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). This report outlines and assesses methods for mitigating ASL bycatch in these fisheries in South Australia (SA). Mitigation approaches were investigated in each fishery; gear modification in the SA rock lobster fishery (SARLF), and spatial closures in the shark gillnet sector of the Gillnet Hook and Trap (GHAT) fishery. This report also provides an assessment of the extent and impact of bycatch mortality of ASL in the shark gillnet GHAT fishery. Based on these findings, the report indicates the likely outcomes of a range of spatial closure options in the fishery and an assessment of their effectiveness in reducing ASL bycatch. Implementations of the outcomes will assist the fisheries meet Wildlife Trade Operation (WTO) conditions that are required to maintain export exemptions under the EPBC Act. Mitigation of ASL bycatch will benefit both the SARLF and GHAT fisheries by improving their ecological sustainability and will also assist implementation of the draft Recovery Plan for the *threatened* ASL.

Bycatch in rock lobster and shark gillnet fisheries has been identified as a key threat to the *threatened* ASL. This project aimed to: i) develop pot protection devices to mitigate entrapment of ASL in the SARLF; ii) assess the significance of ASL bycatch in the gillnet sector of the GHAT fishery; iii) develop options and make recommendations for spatial closures in the shark gillnet fishery to mitigate ASL bycatch and iv) develop performance indicators to evaluate the success of the mitigation options for each fishery.

Sea lion- rock lobster pot interaction trials were undertaken to test the effectiveness of spikes of different heights in reducing ASL bycatch by decreasing pot entry success. Pups and small juveniles can become entrapped in unprotected pots, but entry success decreased significantly as spike height (relative to the bottom of the pot collar) increased. Industry trials demonstrated that a spike extending to 20 mm below or flush with the base of the pot collar had no significant effect on the catch rate or size of rock lobsters caught. Pots fitted with a spike extending high up into the collar (+70 mm from base) had significantly lower catch rates compared to other treatment and control pots. A correctly fitted spike extending up to the base of the pot collar will significantly reduce the likelihood of sea lion entrapment (bycatch mortality) while not affecting the catch rate and size selectivity of the fishery.

To assess the risks to ASL subpopulations from bycatch mortality in the shark gillnet sector of the GHAT fishery off SA, data from four main sources were integrated and modelled: i) survey data on ASL subpopulation size; ii) satellite tracking data to estimate distribution of foraging effort; iii) data from a dedicated ASL bycatch observer program and iv) detailed spatial data on the distribution of fishing effort. Bycatch mortality rates based on observer data were highly correlated with ASL foraging density, enabling levels of bycatch mortality to be estimated with confidence limits. Population viability analyses (PVA) were used to provide a quantitative assessment of the risks to ASL subpopulations from bycatch in the fishery.

Based on the current distribution of fishing effort, an estimated 374 (272-506, ±95%CL) ASL bycatch mortalities occur off South Australia each breeding cycle (17.5 months), 197 (142-266, ±95%CL) of which are females. This equates to about 3.9% of the overall female population being removed as bycatch mortality each breeding cycle, representing an increase over natural mortality levels of around 35%. The level of bycatch mortality is likely to vary considerably among subpopulations depending on their foraging distributions and their proximity to fishing effort. Population viability analyses (PVA) and bycatch models suggest that the majority of ASL subpopulations in SA are exposed to unsustainable levels of bycatch mortality and, if modifications are not made to current levels and distribution of fishing effort or to the methods of fishing (e.g., gear type), further population declines, subpopulation extinctions and reductions in range are likely. The current distribution of abundance of the species is characterised by many depleted subpopulations which may reflect vulnerability to bycatch mortality and the distribution of fishing effort since the gillnet fishery began 36 years ago.

Based on this assessment of the impacts of bycatch mortality from the gillnet sector of the GHAT fishery off SA, the likelihood of further declines and potential extinctions of ASL subpopulations would be minimised, and the capacity for the species to recover would be enhanced, if that bycatch could be reduced. The greatest benefit would be obtained if female bycatch mortality was reduced to zero. If this is not achieved, some subpopulations are likely to decline further. Significant reductions in ASL bycatch mortality will require substantial contraction in the area of the gillnet sector of the GHAT fishery off SA, particularly in shallow, inshore waters in proximity to ASL subpopulations.

Closure scenarios based on minimum core foraging areas of ASL females provide the greatest reduction in bycatch while minimising the area closed to the fishery. Closures based around minimum depth ranges may prove easier to implement, but would increase the area closed to the fishery for similar levels of protection to ASL females. The benefit of fishing closures in terms of reduction in bycatch mortalities was greatest when fishing effort was removed completely, and was significantly reduced when fishing effort was unchanged and displaced to remaining areas of the fishery.

Monitoring the trends in abundance of key (selected) ASL subpopulations and the demographic response of the Seal Bay subpopulation would provide the most direct performance indicators for the success of bycatch mitigation measures in both the shark gillnet and lobster fisheries. The number of ASL bycatch in the shark gillnet fishery, and their subpopulation origin, should also be considered as key performance indicators. To achieve them would require additional investment and improvement to independent observer programs, and to ASL foraging distribution and population modelling. An observer program that adequately assessed bycatch reduction in the SA lobster fishery would need to be very large and therefore expensive. An alternative could be for fishery managers to ensure high compliance to new management measures and further educate and support fishers to report all TEP species interactions.

Keywords: Australian sea lion, *Neophoca cinerea*, shark gillnet fishery, bycatch, bycatch mitigation, spatial management, threatened species

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3 BACKGROUND

Australian sea lion

The Australian sea lion, Neophoca cinerea (ASL), is one of seven sea lion species. Sea lions comprise around 40% of the species in the Otariidae that includes all of the fur seals and sea lions. Globally, sea lions are facing conservation and management challenges. Most sea lion species are either low in abundance or facing declines throughout parts or all of their range. Over recent decades there has been growing concern over the status of all sea lion species. In the North Pacific Ocean, the Steller sea lion, Eumetopias jubatus has been declared endangered in parts of its range and is considered threatened with extinction in other parts (IUCN 2009). This is in contrast to the rapid increase in California sea lions, Zalophus californianus, in Mexico and California (IUCN 2009). However, there have been reductions in numbers of the Galapagos sea lion, Z. wollebaeki, and the Japanese sea lion, Z. *japonicus*, is considered to be extinct; the last credible sighting occurred in the late 1950s (Wolf et al. 2007). Numbers of South American sea lions, Otaria flavescens, have reduced in recent years (especially in the Falkland Islands), and numbers of New Zealand sea lions, Phocarctos hookeri, and Australian sea lions have not recovered from historic sealing (Campbell et al. 2006), and are the lowest of all sea lion species.

The Australian sea lion is Australia's only endemic seal species and its least numerous. It is unique among pinnipeds in having a non-annual breeding cycle of 17 to 18 months (Gales et al. 1994). Furthermore, breeding is temporally asynchronous across its range (Gales et al. 1994, Gales & Costa 1997). It has the longest gestation period of any pinniped, and a protracted breeding and lactation period (Higgins & Gass 1993, Gales & Costa 1997). The evolutionary determinates of this atypical lifehistory remain enigmatic. Recent population genetic studies have indicated little or no interchange of females between breeding colonies, even those separated by short distances (Campbell 2003, Campbell et al. 2008c). The important management implication of extreme levels of female natal site-fidelity (philopatry) is that each colony may represent a closed population. There are 76 known locations where Australian sea lion pups have been recorded, 48 of them in South Australia (SA) (Figure 3.1), where the species is most numerous (86% of pups counted), with the remainder (28 sites) in Western Australia (WA) (Goldsworthy et al. 2009a). The species was subject to sealing in the late 18th, the 19th and early 20th centuries, resulting in a reduction in overall population size and extirpation of populations in Bass Strait and at localities within its current range (Warneke 1982b, Robinson & Dennis 1988, Shaughnessy et al. 2005). Despite the large number of breeding sites, only eight sites produce over 100 pups per season: North and South Page Islands, Seal Bay Conservation Park on Kangaroo Island (referred to in this report as Seal Bay), Dangerous Reef, Lewis Island, West Waldegrave Island, Olive Island and Purdie Island, all of which are in SA (Goldsworthy et al. 2009a). Total pup production for the species during each breeding cycle is estimated to be 3,610, with an estimated overall population size of around 14,730 sea lions (Goldsworthy et al. 2009a).

Although the pre-harvested population size of the Australian sea lion is unknown, the overall population is believed to be highly depleted relative to pre-European colonisation of Australia. Population sizes of Australian and New Zealand fur seals (*Arctocephalus pusillus doriferus* and *A. forsteri*) have increased significantly in Australia over the last 15-20 years (Shaughnessy et al. 1995, 2000, 2002, Shaughnessy & McKeown 2002, Goldsworthy et al. 2003, Kirkwood et al. 2005, Shaughnessy et al. 2005), but the population size of the Australian sea lion remains low and there is evidence for declines over parts of their range (Shaughnessy 1999, Shaughnessy et al. 2006, Goldsworthy et al. 2008a, 2009a).

The Australian sea lion was listed under the *Environment Protection and Biodiversity Conservation Act 1999* (Cth) (EPBC Act) as *Threatened* ('vulnerable' category) in February 2005, and as *vulnerable* under the *National Parks and Wildlife Act 1972* (SA) in February 2008. In October 2008, the International Union for the Conservation of Nature (IUCN) listed ASL as *Endangered*. The ASL is also protected under the *Fisheries Management Act 2007* (SA).

A species Recovery Plan that has been recently drafted by the Department of the Environment, Water, Heritage and the Arts (DEWHA) identified anthropogenic and top-down (mortality driven) factors as the most likely cause for declines in Australian sea lion populations. The leading anthropogenic threats to Australian sea lion populations are fishery bycatch and entanglement in marine debris (Robinson & Dennis 1988, Shaughnessy & Dennis 1999, Gibbs 2002, Shaughnessy & Dennis 2003, Page et al. 2004, Goldsworthy et al. 2007a, Goldsworthy & Page 2007, Campbell 2008). In southern Australian waters, all three resident pinniped species: the Australian sea lion (ASL), Australian fur seal and New Zealand fur seal interact with and form bycatch in a range of Australian wild fisheries, including trawl (Knuckey et al. 2002, Shaughnessy et al. 2003, Page et al. 2004, Hamer & Goldsworthy 2006, Tilzey et al. 2006); line (Warneke 1975, Constable & Shaughnessy 1999, Hume 2000), trap (Warneke 1982a, Temby 1988, Kirkwood et al. 1992, Gales et al. 1994, Shaughnessy et al. 2003, Campbell et al. 2008b) and gillnet fisheries (Ling & Walker 1977, Robinson & Dennis 1988, Gales et al. 1994, Ellner et al. 2002, Shaughnessy et al. 2004, Walker et al. 2005, Goldsworthy & Page 2007).

The fisheries identified as a major concern to the Australian sea lions are the trapfishery for southern (*Jasus edwardsii*) and western (*Panulirus cygnus*) rock lobster, and the demersal gillnet hook and trap (GHAT) fishery of the Commonwealth managed Southern and Eastern Scalefish and Shark Fishery (SESSF) that targets gummy shark (*Mustelus antarcticus*) (Goldsworthy et al. 2009a).

ASL interactions with the rock lobster fishery

Background to the rock lobster fishery

The southern rock lobster (*Jasus edwardsii*) fishery extends from south western WA, through to SA, Victoria, NSW, Tasmania and New Zealand. In SA, the rock lobster fishery (SARLF) is a single species fishery that commenced in 1968, and is currently managed in two zones (Northern and Southern) and 19 marine fishing areas (MFAs) (Linnane et al. 2009a, b). The Northern Zone fishery extends from the WA/SA border to just east of the Murray River mouth and operates from November to May, while the Southern Zone fishery extends from the Murray River mouth to the SA/Victorian border and operates from October to May. A quota system was introduced in the Southern Zone in 1993 and in the Northern Zone in 2003. In the 2007/08 season, 2,309 tonnes of rock lobster valued at around \$91.67 million were harvested from SA waters, making it South Australia's most valuable commercial fishery (Knight & Tsolos 2009). Most (80%) of the catch is from the Southern Zone and more than 95% of the catch is exported, mainly to China.

Southern rock lobsters are caught using traps, known as 'beehive' pots in the industry (see Figure 6.1). Pots are set on the benthos overnight and are baited (typically with Australian salmon, *Arripis truttaceus* or blue mackerel, *Scomber australasicus*). Rock lobster preferentially inhabit complex reef structures, which are mainly comprised of limestone or granite (Edgar 2000).

The Northern Zone fishery is currently considered to be overfished, with catches in the 2008/09 season (403.7 tonnes) being the lowest in the history of the fishery, and the sixth consecutive season in which the quota (470 tonnes in 2008/09) was not caught (Linnane et al. 2009a). Effort in the Northern Zone in 2008/09 was 600,347 pot-lifts (Linnane et al. 2009a). Catch and effort data for the Southern Zone of the fishery suggests it is also in decline (Linnane et al. 2009b). Catch for the 2008/09 season (1,407.3 tonnes) was about 80% of the quota (1,770 tonnes). Effort in the Southern Zone in 2008/09 was 1,916,436 pot-lifts, representing an increase in effort of 84% since the introduction of the TACC in 2003, when it was 1,042,233 pot-lifts (Linnane et al. 2009b).

Goldsworthy et al. (2007a) summarised historic levels of fishing effort in the SARLF over a 35 year period (1970-2004) in 19 MFAs (Figure 3.2). Over this period there were a total of 78.9 million pot-lifts, averaging about 2.3 million pot-lifts/year. Annual effort in the fishery increased from around 2.2 to 2.5 million pot-lifts per year between the 1970s and 1980s, to a maximum of 2.7 million pot-lifts in 1991. Fishing effort in 2008/09 was 1.9 million (Linnane et al. 2009a, b). The mean distribution of fishing effort in the SARLF between 1970 and 2004 highlights that effort has been concentrated in the south-east of the state in MFAs 55, 56 and 58 (Figure 3.3). Elsewhere, effort is focused close to the shore along the south coast of Kangaroo Island, and the southern and western coasts of the Eyre Peninsula (Figure 3.3).

ASL lobster-pot interactions

Seals are known to interact with lobster fisheries and may be attracted to bait and rock lobsters in pots (Shaughnessy et al. 2003). As a consequence, small individuals (pups and juveniles) may enter pots and drown. In addition, seals scavenge old baits as they are discarded, which may attract them to rock lobster vessels. Furthermore, discarded bait-box straps form the largest component (30%) of entanglement

Background

material recorded/recovered from New Zealand fur seals on the south coast of Kangaroo Island (Page et al. 2004). Warneke (1975) suggested that 43 of 182 juvenile Australian fur seals tagged in Victoria were drowned in rock lobster pots. Gales et al. (1994) suggested that a large proportion of sea lion pups drown in lobster pots in Western Australia and, based on industry dependent surveys, Campbell et al. (2008a) reported 34 bycatch mortalities over a 20 year period in this fishery. The extraordinary capabilities of Australian sea lions to remove western rock lobster from pots have been documented in underwater video footage (Campbell 2004, Campbell et al. 2008a).

Quantitative data on the level of mortality of Australian sea lions through entrapment in rock lobster pots is limited. Published reports suggest that the drowning of Australian sea lion pups in rock lobster pots is infrequent and only occurs where pots are set adjacent to breeding colonies (Department of Fisheries WA 2002, Campbell et al. 2008b). Spatial analysis by Campbell (2004) and Campbell et al. (2008b) of incidental mortality of Australian sea lions in the western rock lobster fishery (WRLF) indicated that captures were localised around breeding colonies and haul-out sites, and occurred in shallow water (<20m), with the majority occurring in depths less than 10m. Gales et al. (1994) reported that 'a significant proportion of pups from one colony had drowned in crayfish pots'. Campbell et al. (2008b) estimated that a minimum of 4-5 mortalities of Australian sea lions occurred every fishing season in the WRLF based fishery-dependent bycatch data. This incidental mortality of Australian sea lions in the WRLF on the west coast of WA is a key threatening processes for the local subpopulations of about 700 ASLs (Campbell et al. 2008b). Although the minimum level of mortality of Australian sea lions due to interactions with the fishery is low, Potential Biological Removal (PBR) and Population Viability Analysis (PVA) models suggest that the low rates observed may be enough to adversely impact the growth of populations in WA and cause further declines in abundance (Campbell 2004, Campbell et al. 2008a).

ASL bycatch was mitigated in the WRLF by modifying the lobster pots with a sea lion exclusion device (SLED) (Campbell et al. 2008b). The SLEDs were designed to minimise the size of the passage through the neck of the pot to prevent entry by ASL but still enable unimpeded entry of the target species. In consultation with fishers, two SLED designs were tested: a) a steel upright (spike) attached to the base of the pot rising up to near the neck of the pot, which is a variation on an idea used by some rock lobster fishers in SA to deter sea lions from robbing baits in pots (Anon

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1996), and b) a batten or stiff rod placed across the neck of the pot (Campbell et al. 2008b). Various height settings of the steel upright SLED were trialled on the most commonly used pots in the fishery (redneck batten pots).

Experiments using pots seeded with rock lobster were undertaken to examine the efficiency of different SLED designs by observing and recording in-water interactions between ASL and lobster pots, both with and without SLEDs. Successful entry by sea lions occurred if an animal managed to get its head completely below the bottom of the pot neck structure and into the main body of the pot (Campbell et al. 2008b). Different height configurations of the steel upright SLED were tested to examine their effectiveness in excluding ASL. SLED heights flush with the pot neck and 20mm below the neck appeared effective in almost eliminating pot entry by sea lions (Campbell et al. 2008b). The batten SLED also eliminated pot entry by ASL. Both SLED designs conformed to a minimum SLED-neck gap of 132mm.

The effect of various SLED designs on the catch rate of lobster in the WA commercial fishery was investigated using fishery-dependent trials in the area of reported incidental capture locations. The lower SLED height (20mm below pot-neck) was preferred to the flush configuration as its impact on lobster catch rate was less (Campbell et al. 2008b). Fishery dependent trials of SLEDs indicated no significant difference in the catch-rate or size of lobsters caught in SLED and control pots in shallow fishing areas <20m depth. Batten SLED pots showed a 14% reduction in catch-rate of rock lobsters compared to control pots (although this difference was not significant), with no significant difference in size frequency of lobsters between experimental and control pots (Campbell et al. 2008b).

Campbell et al. (2008b) satellite-tracked a number of pup and juvenile Australian sea lions, and also equipped them with dive recorders to determine the depth range of foraging. These data, in conjunction with the bycatch distribution reported by the fishery, were used to determine a 0-20 m deep mandatory SLED zone that was introduced in the 2006/07 fishing season for commercial and recreational fishers. In the first season following its introduction, there was a high compliance rate (95%) for use of the SLED (Campbell et al. 2008b).

Unlike in WA, there has not been any quantitative assessment of the nature and extent of interactions between ASL and southern rock lobster pots, nor of the extent of predation on pot contents by seals. In SA, some fishers use 'spikes' (vertical, central spikes) to impede seals entering pots (Anon 1996). These are thought to be used primarily in the Northern Zone fishery, although the extent of their use and details on the spike height are not known. In a recent assessment of logbooks used in the SARLF, no reports of any marine mammal interactions were recorded (Goldsworthy et al. 2007a). Thus, no quantitative data on ASL bycatch rates exist for this fishery.

A risk assessment of the interactions between ASL and the SRLF in SA waters was undertaken by Goldsworthy et al. (2007a) and by Goldsworthy and Page (2007). Although the level of effort in the SARLF is high, about two-thirds occurs in the Southern Zone of the fishery outside the expected range of breeding populations of ASL (Goldsworthy et al. 2007a). Thus most interactions between the SARLF and ASL were predicted to occur in the Northern Zone (south cost of Kangaroo Island, lower Eyre Peninsula and along the west coast of the Eyre Peninsula), where sea lion breeding colonies are located (Figure 3.1). Goldsworthy et al. (2007a) determined that, as with the gillnet sector SESSF, an unknown level of bycatch of ASL is likely to occur in the SARLF. Because bycatch involves entrapment and drowning of sea lions in pots, the measurable impact of the fishery is likely to be limited to small sea lions that can physically fit in pot openings, as is the case in the western rock lobster fishery (Campbell et al. 2008b).

ASL interactions with the shark gillnet fishery

Background to the shark gillnet fishery

The fishery for shark in southern Australia extends back to early European settlement in bays and inlets of Victoria. Shark fishers based in SA and Tasmania began operating during the Second World War (Kailola et al. 1993). The fishery initially targeted school shark (*Galeorhinus galeus*) with long-lines. In 1964 monofilament gillnet was introduced, and by the early 1970s gillnetting was the main fishing method used (Kailola et al. 1993, Larcombe & McLoughlin 2007). Catch and effort records exist for this fishery in SA and adjacent Commonwealth waters since at least 1973. Catch of school shark peaked in 1987 and this species is currently regarded as overfished (Larcombe & McLoughlin 2007). The fishery now targets gummy shark (*Mustelus antarcticus*) and in recent years there have been efforts to reduce the catch of school shark to allow their stocks to rebuild. Arrangements between the Commonwealth government and State governments of Tasmania, Victoria and SA under the Offshore Constitutional Settlement (OCS) transferred State management of school and gummy shark in coastal waters (extending out to 3 nautical miles offshore, excluding internal waters in bays and inlets) to the AFMA in 2001 (Larcombe & McLoughlin 2007). The gillnet sector and the shark hook sector of this fishery are managed collectively by AFMA through the Southern and Eastern Scalefish and Shark Fishery (SESSF) as part of the Gillnet Hook and Trap (GHAT) fishery. The gillnet sector of the GHAT fishery is restricted to depths shallower than 183m, whereas autolongline operators with scalefish hook boat statutory fishing rights (SFRs) are restricted to waters greater than 183m depth in Commonwealth waters. In SA waters, the State managed gillnet fishery (large mesh set-net >15cm) is confined to State and internal waters. With the introduction of bycatch limits on school shark and gummy shark in the SA Marine Scale Fishery (SA Government Gazette, 22 March 2001, pp.1060-1061; and 2 May 2001, pp. 1703), this shark fishery became quite small, averaging around 79 boat-days and 5.6 tonnes per year between 2001-2007 (Goldsworthy et al. 2009a).

Goldsworthy et al. (2007a) summarised historic levels of fishing effort in the gillnet sector of the SESSF off SA, spanning 32 years between 1973 and 2004. Over this period, there was a total of 634,496 km of net-lifts, averaging about 20,000 km per year (Figure 3.4). Annual effort in this fishery increased from around 3,000 km to 12,000 km net-set per year between 1973-1983, with a considerable increase in fishing effort between 1984 and 1987, peaking at nearly 43,000 km net-sets in 1987. Fishing effort then decreased annually to about 23,000 km net-sets in 1993 and increased to just over 32,000 km net-sets in 1998. Fishing effort reduced to around 17,000 km net-sets in 2000, and remained at about this level until 2004 (Figure 3.4). Mean annual fishing effort (km net-lifts/year) for the 29 Marine Fishing Areas (MFAs) in SA are presented in Figure 3.5. Major regions of fishing effort occur south and south-east of Kangaroo Island, and off the west coast of the Eyre Peninsula. Between 2000 and 2004, about 42% of total fishing effort occurred south and south-east of Kangaroo Island. The estimated value of the SA GHAT catch for 2008/09 was \$6.56 million (AFMA pers. comm.).

Commercial exploitation of sharks commenced in WA, in 1941, the principal target species being the whiskery shark (*Furgaleus macki*), dusky (whaler) shark (*Carcharhinus obscurus*) and gummy shark (Kailola et al. 1993). As with the SA fishery, bottom set long-lines were the main gear used until the early 1960s, when

fishers switched to monofilament gillnets (Kailola et al. 1993). There are two fisheries that include demersal gillnetting over the range of the Australian sea lion in WA. These are the Southern Demersal Gillnet and Demersal Longline Joint Authority Fishery (JASDGDLF), managed jointly by WA and the Commonwealth that extends southeast from Cape Bouvard, just north of Bunbury on the southern part of the west coast, to the WA-SA border (Larcombe & McLoughlin 2007), and the West Coast Demersal Gillnet and Demersal Longline Fishery (WCDG DLF), managed by the WA Government that extends north from Cape Bouvard to Shark Bay.

ASL interactions with the demersal gillnets

Globally, marine mammal bycatch is a significant management issue for the ecological sustainability of many commercial fisheries, and recent estimates suggest that the annual global bycatch of marine mammals is in the hundreds of thousands (Read et al. 2006). Interactions are expected to increase as a consequence of human population growth and expansion, and greater industrialisation of fisheries (DeMaster et al. 2001, Read et al. 2006).

The potential that significant levels of ASL bycatch occur in demersal gillnet fisheries has been suspected for some time. Anecdotal reports from shark fishers have suggested that sea lions are attracted to fish caught in nets and become entangled (Shaughnessy et al. 2003). Animals that become entangled can drown, tear out a section of net or be cut free by fishers (Robinson & Dennis 1988, Gales et al. 1994, Shaughnessy & Dennis 2002, Shaughnessy et al. 2003). Entanglement in sections of net may lead to the death of the individual by increasing energetic demands, inhibiting effective foraging behaviour, cutting into the flesh and causing wounds or drowning (Shaughnessy et al. 2003, Page et al. 2004).

Shore-based surveys of entangled ASL indicate that the monofilament gill netting found entangling Australian sea lions is the same as that used in the Commonwealth managed SESSF (Shaughnessy et al. 2003, Page et al. 2004, Dennis 2005). During a 15-year study at Seal Bay, 55% of entangling material observed on ASL was monofilament netting (Page et al. 2004, Shaughnessy & Goldsworthy 2007). Pups were the most frequent age-class observed to be entangled (54%). The entanglement rate of pups at Seal Bay increased significantly per year from 1.0 ± 0.7 SD. between 1988 and 2000, to 4.5 ± 2.1 SD. in 2001 and 2002 (Page et al. 2004),

potentially reducing future recruitment rates. During surveys at The Pages Islands and Dangerous Reef, 0.19% and 0.28% of non-pups counted showed signs of entanglement (entangling material, wound or scar observed). Where the entanglement material could be identified, 75% was monofilament gill net (Shaughnessy & Dennis 2001).

ASL become entangled more frequently in gill nets compared to New Zealand fur seals (1% of entanglements) (Page et al. 2004). Although the foraging range of both species probably overlap, most New Zealand fur seals forage further offshore than ASL and feed throughout the water column (Page et al. 2006). ASL are thought to encounter bottom-set monofilament nets or debris more frequently than New Zealand fur seals, because ASL are benthic foragers and are more likely to forage in areas where nets are set or where nets may have been lost on the benthos (Page et al. 2004).

Anecdotal reports from shark fishers indicate that some interactions occur inshore (i.e., in State waters). In 2001 a juvenile ASL was reported entangled and released alive from a shark net set close to Jones Island, SA (Shaughnessy & Dennis 2002). In 1996, one shark fisher in SA reported catching up to 20 Australian sea lions per year, mostly near Kangaroo Island and the Neptune Islands (Shaughnessy et al. 2003). ASL have been recorded entangled in sections of commercial shark net at a number of sites in SA, including Seal Bay (Page et al. 2004), The Pages Islands (Shaughnessy & Dennis 2001), Dangerous Reef (Shaughnessy 1998, Shaughnessy & Dennis 2001), English Island (Shaughnessy 1998) and Jones Island (Shaughnessy & Dennis 2002).

Goldsworthy et al. (2007a) reviewed AFMA logbook records in the gillnet sector of the SESSF for evidence of seal bycatch. They determined that there were few logbook records of interactions with any pinnipeds in either State or Commonwealth waters adjacent to the SA coast. No records were available for the years between 1973 and 1999. From the 68,070 net-sets recorded between October 1999 and October 2004, nine entanglement events involving 10 animals (two in one net) were reported by five vessels. Seven animals died and three survived. In addition, animals were observed and recorded swimming near the vessels on two other occasions. Based on logbook records, all interactions involving pinnipeds were recorded as 'seal' by vessel operators (Goldsworthy et al. 2007a). The species most likely to encounter commercial gillnet vessels were either the ASL or the New Zealand fur seal, based on the distribution of seal species in southern Australia. McAuley and Simpfendorfer (2003) observed a single mortality of an ASL during the observation of approximately 2-5% of fishing effort across the two shark fisheries in WA during the period 1994-1999.

A recent risk assessment identified that even low levels of bycatch of ASL in the demersal gillnet fishery could explain the lack of recovery of the species, and the broad scale depletion of subpopulations across the species range (Goldsworthy & Page 2007, Goldsworthy et al. 2009a). Similar conclusions were also reached in a risk assessment of ASL bycatch in WA shark fisheries (Campbell 2008). Goldsworthy and Page (2007) identified that interaction between ASL and the demersal gillnet fishery could be significant because there is almost complete spatial overlap between fishing effort with ASL foraging effort. Fishing effort is and has been high in SA and adjacent waters (~ 20,000 km of net-set per year); and fishing effort occurs year-round and in close proximity to most ASL subpopulations. Furthermore, bycatch can potentially impact all age-sex classes (Goldsworthy & Page 2007).

The observed recovery of the Dangerous Reef ASL subpopulation following a substantial reduction in gillnet fishing effort provides circumstantial evidence that bycatch mortality of ASL was impacting the recovery of subpopulations (Goldsworthy et al. 2007b). Finally, high levels of ASL bycatch mortality were indentified from a recent independent observer program in the gillnet sector of the GHAT fishery off SA (see Chapter 7).

In summary, awareness of the significance of bycatch mortality in gillnet fisheries as a key source of ASL mortality on subpopulations is supported by multiple lines of independent evidence, including:

- anecdotal reports from fishers of bycatch (Shaughnessy et al. 2003),
- high incidence of ASL entanglement in gillnetting material at Seal Bay (Page et al. 2004),
- overlap between historic and current fishing effort with modelled ASL foraging distributions (Goldsworthy et al. 2007a, Goldsworthy & Page 2007),
- the very limited ability of ASL subpopulations to withstand additional mortality rates (Goldsworthy et al. 2007a, Goldsworthy & Page 2007),

- a detailed assessment of the potential risk posed to ASL populations from bycatch in gillnet fisheries (Goldsworthy et al. 2007a, Goldsworthy & Page 2007, Campbell 2008), and
- increasing pup production and population recovery at Dangerous Reef that coincides with the closure of the Commonwealth gillnet fishery in southern Spencer Gulf in 2001 (Goldsworthy et al. 2007b).

Bycatch mortality of ASL in the shark gillnet fisheries has been identified as the most pressing management issue for the species because the fishery overlaps substantially with the foraging distribution of sea lions, effort in the fishery has been and is currently high, fishing occurs year round in close proximity to ASL colonies and potentially impacts all age and sex classes (Goldsworthy & Page 2007). It is recognised as a significant management issue for the GHAT fishery and protected species managers to resolve, and it is likely that the fishery has been a major impediment to recovery of the species since the fishery began (Goldsworthy et al. 2009a).

Current spatial management of the shark gillnet fishery

There are several spatial closures that restrict the distribution of gillnet fishing effort in the gillnet sector GHAT fishery (Figure 3.6). These are documented in AFMA (2009) and include:

Great Australian Bight Marine Park (GABMP) and Head of the Bight fishery closures, comprising a South Australian State water component which includes a Sanctuary Zone (that functions under the SA *Fisheries Management Act 2007*) and a Conservation Zone (under the SA *National Parks and Wildlife Act 1972*), and a Commonwealth component that includes a Marine Mammal Protection Zone (MMPZ) and a Benthic Protection Zone (BPZ), The MMPZ primarily provides protection for southern right whales, but also for ASL, and it supplements the State Marine Park. As with the State Conservation Zone, there is a seasonal closure of gillnet fishing in the MMPZ between 1 May and 31 October. The BPZ was established to preserve a representative sample of the unique seafloor plants, animals and sediments of the area and does not restrict gillnet fisheries.

- Head of Bight fishery closure was introduced by AFMA in 2007 (Schedule 8 SESSF Fishery Closures Directions 2008). The region from Eyre Bluff to the WA border, out to 3nm near the SA-WA border, then to 2nm adjacent to the coast to Eyre Bluff is closed to all fishing.
- Murray Commonwealth Marine Reserve does not restrict gillnet fishing.
- Internal State waters closure to gillnet SESSF the Offshore Constitutional Settlement (OCS) that resulted in the transfer of management of school and gummy shark fishery in coastal waters from the State to the Commonwealth (AFMA) in 2001 resulted in a significant reduction in fishing effort in SA internal waters and bays that were excluded from this agreement.
- Murat Bay (Schedule 1 SESSF Fishery Closures Directions 2008).
- Seal Bay (Schedule 6 SESSF Fishery Closures Directions 2008). Seal Bay and Bales Beach are closed to all fishing. This closure was introduced to provide some protection to the ASL colony at Seal Bay, Kangaroo Island.
- The Pages (Schedule 7 SESSF Fishery Closures Directions 2008). An area extending 1nm around both North and South Page Islands is closed to all fishing. This area was identified by commercial fishers in the region as having high potential for interactions with great white sharks and ASL. There are large colonies of ASL on The Pages Islands (Goldsworthy et al. 2009a).
- Backstairs Passage (Schedule 10 SESSF Fishery Closures Directions 2008). Along with the Kangaroo Island and Victor Harbor closures (see below), this closure is aimed principally at providing protection for school shark breeding stock.
- Kangaroo Island (Schedule 11 SESSF Fishery Closures Directions 2008).
 Gillnet and shark hook methods are prohibited in the area south of Kangaroo Island, SA extending 1nm seawards from the low water mark from Cape Willoughby to Cape du Couedic.
- Victor Harbor to Victorian border (Schedule 12 SESSF Fishery Closures Directions 2008). Gillnet and hook methods are prohibited in the area extending 3nm seawards from the low water mark from Granite Island, near Victor Harbor eastwards to the Victorian border (141°E).
- 183 m Gillnet depth closure (Schedule 13 SESSF Fishery Closures Directions 2008). All waters deeper than 183m are closed to the gillnet sector GHAT fishery.

In addition to these closures, there are 16 South Australian Aquatic Reserves: Point Labatt; Cowleds Landing (Whyalla); Blanche Harbour; Yatala Harbour; Goose Island; Coobowie; Troubridge Hill; St Kilda-Chapman Creek; Barker Inlet-St Kilda; Port Noarlunga Reef and Onkaparinga Estuary; Aldinga Reef; West Island; American River Inlet; Seal Bay; Bales Beach (as above) and the GABMP (as above).

Comparison of potential impacts of bycatch of ASL in shark gillnet and rock lobster fisheries

The recently completed pilot study funded by the FRDC titled 'Assessment of the implications of interactions between fur seals and sea lions and the southern rock lobster and gillnet sector of the Southern and Eastern Scalefish and Shark Fishery (SESSF) in South Australia' 2005/077 (Goldsworthy et al. 2007a, Goldsworthy & Page 2007), examined the likely significance of interactions between seals and these fisheries.

A major constraint in the assessment of the risk of bycatch to seal subpopulations is the limited fishery dependent data on bycatch rates. A review of the PIRSA and AFMA fishery logbooks for by the SARLF and GHAT fisheries provided limited evidence of ASL interactions. Anecdotal evidence and seal entanglement data would suggest there has been significant under-reporting of seal interactions in these fisheries (Goldsworthy et al. 2007a, Goldsworthy & Page 2007).

Seal-fishery interaction risks were assessed based on overlap in the spatial distribution of fishing effort and the estimated spatial distribution of seal foraging effort. The probability of interactions was assumed to increase as a function of the extent to which fishing effort and seal foraging effort overlapped in space and time. Of the two pinniped species investigated, ASL showed the higher risk of significant depletion and quasi-extinction (<10 females in a subpopulation) as a result of fishery bycatch. In contrast, the risk that SA subpopulations of the New Zealand fur seal would be significantly depleted was estimated to be very low (Goldsworthy et al. 2007a, Goldsworthy & Page 2007).

Population viability analysis (PVA) of ASL subpopulations reinforced the recent Australian Government listing of the ASL as a threatened species, by identifying that many subpopulations of the species are likely to be significantly depleted already (60% of them produce <30 pups per breeding season), and therefore vulnerable to extinction. PVA simulations suggested that in the absence of any anthropogenic mortality, some ASL subpopulations are likely to become extinct in the near future and in the face of sustained but small additional mortalities (1-2 additional female deaths/year, e.g., from fishery bycatch), up to 40% of subpopulations could become extinct, and negative growth will become a feature of even the largest subpopulations of the species; details are provided by (Goldsworthy et al. 2007a, Goldsworthy & Page 2007).

The pilot study indicated that many ASL subpopulations may be small because of depletion caused by bycatch in gillnet and trap-fisheries and that this hypothesis required urgent attention (Goldsworthy et al. 2007a, Goldsworthy & Page 2007).

The pilot study also identified the gillnet SESSF to be a more significant risk to ASL subpopulations than the SARLF (Goldsworthy et al. 2007a, Goldsworthy & Page 2007) because :

- i) there was almost complete spatial overlap in fishing effort with the foraging effort of ASL in SA,
- ii) fishing effort has been substantial in SA and adjacent waters (about 20,000 km of net-set per year), occurs year-round and in close proximity to most ASL subpopulations,
- iii) bycatch could potentially impact all age-sex classes.

The impact from SARLF was likely to be less because:

- there was less overlap in fishing effort with seal foraging effort, because about two-thirds of the fishing effort occurred in areas with little ASL foraging,
- ii) fishing was restricted to eight months of the year,
- iii) bycatch was likely to be restricted to pups and juvenile seals.

The potential impacts posed by the addition and interaction of the combined bycatch in the gillnet SESSF and SARLF fisheries have not been investigated, but they could be significant, especially to ASL (Goldsworthy et al. 2007a, Goldsworthy & Page 2007). The pilot study concluded that the two fisheries lend themselves to different mitigation approaches to address seal bycatch issues.

In the gillnet SESSF, gear modification options are limited, with the possible exception of acoustic deterrent devices ('pingers'), but evidence for their effectiveness in deterring seals interacting with gill-nets is equivocal, with some studies suggesting they have the reverse effect and act as a 'dinner-bell' (Bordino et al. 2002, Barlow & Cameron 2003, Northridge et al. 2004). Spatial management of fishing effort was identified as the most practical solution, and provides a range of risk-reduction options to management in the gillnet SESSF. The pilot study made considerable progress towards developing spatial tools to assess the potential risk-reduction (e.g., risk of extinction) benefits that could arise from a range of spatial management options (Goldsworthy et al. 2007a, Goldsworthy & Page 2007).

In contrast, the pilot study identified considerable scope for gear modification in the SARLF, with pot-protection devices already used to reduce the incidence of seal bycatch in some parts of the fishery. Quantitative testing of these pot protection devices and alternate protection measures as is taking place in the WA WRLF (Campbell 2004, Campbell et al. 2008a), and industry-wide adoption of best-mitigation practices to eliminate seal bycatch, were identified as appropriate approaches, with the benefit of not requiring a large and costly independent observer program, or spatial closures (Goldsworthy et al. 2007a, Goldsworthy & Page 2007).

A number of recommendations arose from the pilot study:

1. The spatial risk assessment approach developed in the pilot study should be improved using higher resolution fishing effort data (lat/long location of effort in the gillnet SESSF) coupled with higher resolution ASL spatial foraging data (utilising satellite telemetry). This would produce a spatial risk-management tool that managers could use to assess the changes in risk from different spatial management scenarios.

2. An independent observer program in the gillnet sector of the SESSF should be implemented to assess the significance of ASL bycatch in the high-risk regions identified and to provide support for spatial management options developed above. 3. Quantitative trials to assess the efficacy of different pot-protection devices at eliminating seal bycatch in the southern rock lobster fishery should be undertaken. These trials should include testing the impact of different protection measures on catch and size selectivity. Once developed, seal excluding/pot-protection devices should be adopted throughout the southern rock lobster fishery, to address broader seal interactions issues in other States (e.g., Victoria and Tasmania).

4. Methods and guidelines for measuring and evaluating the performance of systems for monitoring, assessing and mitigating interactions between the fisheries and seals need to be developed. These would include improving industry reporting of seal interactions, and developing performance indicators to assess the level and effectiveness of risk reduction following implementation of mitigation options.

The above recommendations formed the basis of the objectives of this FRDC project.



Figure 3.1 The location of Australian sea lion breeding sites (subpopulations) in SA and their relative pup production per breeding cycle. Data are sourced from (Goldsworthy et al. 2009a). Bathymetry lines are indicated from light to dark blue (100, 200, 500, 1000, 2000m).



Figure 3.2. Temporal variation in total fishing effort in the SA Rock Lobster Fishery between 1970-2008.



Figure 3.3. Mean annual distribution of fishing effort in the SA Rock Lobster Fishery between 1970 and 2004. Numbers in the blocks refer to Marine Fishing Area (MFA) for which catch and effort data have been recorded. From Goldsworthy et al. (2007a).







Figure 3.5. Mean annual distribution of fishing effort in the gillnet sector of the GHAT fishery (SA and adjacent Commonwealth waters) between 1973 and 2004 from Goldsworthy et al. (2007a). Numbers in the blocks refer to Marine Fishing Area (MFA) for which catch and effort data have been recorded since 1973 are also indicated.



Figure 3.6. Area of the gillnet sector GHAT(SESSF) Fishery off SA, indicating the main area closures from State internal waters, State Aquatic Reserves and Marine Parks, Commonwealth Marine Parks, and AFMA net-closures. From Goldsworthy et al. (2009a).

4 NEED

SA Rock Lobster Fishery (SARLF)

This project addresses recommendations specified in the ecologically sustainable development (ESD) assessments of the SARLF in 2003 (Department of the Environment and Heritage 2003b, Sloan 2003). Overall, 3 of the 13 DEH recommendations specifically focussed on the interactions of the rock lobster fishery and endangered, threatened or protected species. Furthermore, the recent ecological assessment of the fishery in July 2008, also identified interactions with Australian sea lions as an important management issue, and this project as a means to address them (Primary Industries and Resources South Australia 2008). The recommendations from DEWHA were that "PIRSA and industry continue to monitor the extent of interactions between rock lobster fishery and fur seals and sea lions, and develop appropriate mitigation measures, including establishment within 2 years of preliminary trigger and reference points, to minimise these interactions" (Primary Industries and Resources South Australia 2008).

To have southern rock lobster taken from South Australian waters and placed on the list of exempt native specimens for export under Part 13 and 13(A) of the EPBC Act, there is an imperative to address these ESD recommendations. Failure to do so may jeopardise current and future export exemptions.

Shark gillnet GHAT Fishery (SESSF)

The project also specifically addresses a key objective of the Commonwealth Government to take immediate action in all Commonwealth fisheries to manage the broader environmental impacts of fishing, including to threatened species or to species otherwise protected under the EPBC Act. The need to mitigate interactions with seals is a significant issue across the various sectors of the SESSF and will be a priority in the revised management arrangements currently being developed for the SESSF to meet the Minister's Direction. Given the high risks generated by the gillnet sector of the SESSF to the threatened ASL, the research presented here is directed at a significant need. Furthermore, its outcomes are transferable to other fisheries that present similar risks to seal populations and have similar requirements under the EPBC Act (e.g., the Western Australian shark fishery). Bycatch Action Plans for the SESSF and South East Non-trawl Fisheries (AFMA 2001) identified several research priorities, under Action 6: Performance Indicator 6.1 (Analysis of pilot Integrated Scientific Monitoring Program and logbook data identifying incidences of gear and sea lion interaction by December 2001); and Performance Indicator 6.2 (Research proposal initiated through AFMA to map sea lion colonies by March 2002).

The EPBC Act requires that all Commonwealth managed fisheries (including all SESSF fisheries) undergo a strategic environmental impact assessment (Part 10), that all fisheries operating in Commonwealth waters undergo assessment for their interaction with protected species (Part 13), and that all fisheries with an export component undergo assessment to determine the extent to which the fishery is managed in an ecologically sustainable way (Part 13A).

Two strategic assessments of the SESSF pursuant to the EPBC Act have been undertaken (DEH 2003, 2006). The most recent (DEH 2006) made two recommendations, relevant to ASL:

Recommendation 4. "AFMA to develop and implement further measures to verify the extent and type of interactions with protected species in the SESSF, with priority given to sea lions, fur seals, great white sharks, syngnathids and seabirds."

Recommendation 5. "AFMA to give priority to developing specific mitigation measures to reduce fishing impacts on fur seals, seabirds and sea lions across the sectors of the SESSF. Measures to mitigate interactions should be formally incorporated into AFMA's management prescriptions for the relevant sectors of the fishery."

In addition, AFMA's environmental risk assessment (ERA) and management (ERM) processes, which for the SESSF are nearing completion, have provisionally identified sea lions as a high risk species in the GHAT. AFMA have also recently adopted bycatch and discard work programs which have identified sea lion bycatch as a priority issue. The goal of AFMA's ERA/ERM processes is to identify species which may be at risk due to fishing, and to propose management responses to reduce the risks to an acceptable level.

All fisheries in the South Eastern Scalefish and Shark Fishery (SESSF), including the gillnet sector of the Gillnet Hook and Trap (GHAT) fishery, are further required to obtain a Wildlife Trade Operation (WTO) exemption pursuant to the EPBC Act to enable them to export their product. Subsection 303FN(3) of the EPBC Act states that the Minister must not declare an operation an approved WTO unless the Minister is satisfied that the operation is consistent with Objects of Part 13A (wildlife trade provision); and the operation will not be detrimental to the survival or conservation status of a taxon to which the operation relates. Pursuant to s303FN(4), in deciding whether to declare an operation a WTO, the Minister must have regard to the significance of the impact of an operation on an ecosystem; and the effectiveness of the management arrangements for the operation.

In March 2008, the Administrative Appeals Tribunal made orders concerning an appeal lodged by the Humane Society International (HSI) contesting the accreditation of the SESSF as an EPBC approved WTO on a range of sustainability issues including threatened and protected species interactions. This resulted in a variation to s303FT (7b) of the EPBC Act, to condition b of the Schedule dated 12 December 2007 (Declaration of a WTO for the SESSF), which now includes changes (December 2008) to the WTO as ordered by the Administrative Appeals Tribunal (February 2008). For the gillnet sector of the GHAT fishery, condition 8 of the SESSF WTO (December 2008) requires that: "*AFMA, after considering advice from relevant experts, to develop and implement management measures, including fishery closures, that take account of site-specific issues and which seek to minimise the risks of interactions between fisheries regulated by AFMA and sea lions by 21 December 2009.*" This condition was extended in a variation to the declaration of an approved WTO (Gazetted 19 February 2010). It now states under Conditions 6:

"In accord with the precautionary principle, as outlined in section 391(20 of the EPBC Act 1999:

- a) AFMA to continue to implement interim management measures, which will include voluntary closures, increased observer coverage in areas adjacent to Australian Sea Lion colonies and other actions, designed to mitigate the impact of fishing activity on Australian Sea Lions;
- b) by June 2010, taking into account current information and in consultation with marine mammal experts, AFMA to implement long-term management measures, including formal fishery closures and other actions, that will lead to a significant reduction of the impact of the fishery on Australian sea

lions. These measures will be clearly directed towards enabling recovery of the species, including all subpopulations; and

c) AFMA, in consultation with marine mammal experts, will continue to monitor and review the adequacy of management measures towards the objective of avoiding mortality of, or injuries to, Australian Sea Lions so as to enable the recovery of Australian Sea Lion populations, including all sub-populations."

Recently, DEWHA drafted an Australian sea lion Recovery Plan. Although the Plan was not finalised at the time of writing this report, its proposed objectives in relation to the recovery of the ASL are to:

- "address the known impediments to the recovery of the Australian sea lion and ensure the protection of all breeding colonies from local extinction;
- better understand and mitigate potential threats that are currently poorly understood; and
- ensure that scientifically robust and repeatable population surveys of Australian sea lion populations are undertaken, to determine population size and rates of population change."

It should be noted that the draft Australian sea lion Recovery Plan has not yet been agreed to by the Minister for the Environment, Heritage and the Arts, nor has the plan been circulated for public comment. The plan is expected to be available for public comment in early 2010.

At a workshop held on 28 September 2009, specific "working" criteria were provided by DEWHA with respect to the objectives of spatial management arrangements in the gillnet sector GHAT fishery to reduce threats to ASL subpopulations. These "working" criteria were intended to articulate further the proposed recovery plan objectives, but as with the draft Recovery Plan, are not yet endorsed. The "working' criteria are consistent with the proposed Australian Governments' proposed objectives for the recovery of the ASL, and advise that mitigation measures should reduce bycatch mortality to a level that:

- "is not likely to increase the risk of extinction of the species, including of individual subpopulations;
- does not impact on the rate of natural growth (recovery) at the species and subpopulation level;

- does not result in contraction in the range of the species, intended as the current occupation of breeding sites; and
- is not likely to reduce significantly the genetic diversity of the species."

The aim of this report is to provide a detailed and objective analysis with clear options to assist managers of fisheries and threatened species to mitigate bycatch of ASL and to manage for recovery of the species.
5 **OBJECTIVES**

The objectives of this project were to:

- 1. Develop and assess methods for mitigating sea lion interactions with southern rock lobster pots.
- Develop spatial management options for reducing bycatch to high-risk sea lion subpopulations in the gillnet SESSF, and make recommendations on spatial management options to Shark RAG.
- Assess the significance of ASL bycatch in the high-risk regions of the gillnet SESSF to provide support for spatial management options developed in objective 2.
- 4. Develop performance indicators to evaluate the effectiveness of the different mitigation options developed for each fishery.

Objectives 2 and 3 have been simplified and re-ordered to:

- Assess the significance of Australian sea lion bycatch in the gillnet sector of the GHAT (SESSF) fishery; and
- 3. Develop options for spatial closures in the gillnet GHAT (SESSF) fishery to mitigate Australian sea lion bycatch.

In addressing these objectives, the report is principally structured around four main chapters, one addressing each objective. Chapter 6 assesses the suitability of sea lion exclusion spikes to mitigate bycatch in the South Australian southern rock lobster fishery. Chapter 7 estimates the extent of ASL bycatch in the gillnet GHAT fishery based on current fishing effort, and assesses the impact of this level of bycatch on individual ASL subpopulations in South Australia. Chapter 8 provides an assessment of the effectiveness of different spatial closure options in mitigating Australian sea lion bycatch in the gillnet sector GHAT fishery off South Australia. Chapter 9 explores a range of potential performance measures that could be used to assess the effectiveness of the mitigation approaches developed for each fishery.

6 ASSESSMENT OF A SEA LION EXCLUSION DEVICE FOR MITIGATING BYCATCH IN THE SOUTHERN ROCK LOBSTER FISHERY

Introduction

As detailed in the background of this report, based on the levels of Australian sea lion (ASL) bycatch reported in the western rock lobster fishery and anecdotal evidence, it is likely that some ASL bycatch occurs in the South Australian rock lobster fishery (SARLF) which uses 'bee-hive' pots (Figure 6.1). In order to mitigate bycatch, seal exclusion devices (spikes) have been developed recently to prevent the entry of ASL into western rock lobster fishery (WRLF) pots. The use of these exclusion devices is now a requirement for licence holders fishing in parts of the west coast WRLF of WA (Campbell et al. 2008a).

Following the successful development and implementation of pot spikes in mitigating ASL bycatch in the west coast WRLF (Campbell et al. 2008a), and the requirement to mitigate bycatch of ASL in the southern rock lobster fishery in South Australia, this study aimed to develop and assess methods for mitigating sea lion interactions with southern rock lobster pots.

The approach used was to:

- 1. Determine the size range of sea lions most vulnerable to entrapment in rock lobster pots, and the minimum pot entry diameter required to prevent entry;
- Undertake field trials to determine the effectiveness of different spike height configurations in reducing the success of pot entry by sea lions; and
- 3. Conduct industry pot-trials to assess the impact of different spike heights on the catch rate and size distribution of southern rock lobster.

Methods

Pup morphometric measurements

The relative effectiveness of different spike heights in reducing the chance of successful pot entry will depend in part on the minimum size of sea lions likely to encounter rock lobster pots. Australian sea lion pups tend to limit their excursions to rock pools until about 4 months of age, when their diving and foraging behaviour develops in earnest and they begin exploring their marine environment to a greater extent (Fowler et al. 2006). At some breeding locations, pups start to make regular excursions to nearby haul-out sites and breeding colonies from about four months of age. Pups tagged at Dangerous Reef have frequently been resighted at two nearby breeding colonies, English Island and Lewis Island, both approximately 20 km away (Goldsworthy et al. 2007b, 2008b, 2009c).

To determine the size at which pups first became capable of interacting with the rock lobster fishery, pups that had been tagged at Dangerous Reef and had moved to an adjacent island were measured. After the tagging of 201 pups at Dangerous Reef during the 2008 breeding season (Goldsworthy et al. 2009b), six visits were made to English Island over a three week period to search for, capture and measure any tagged pups from Dangerous Reef (Figure 6.2). These represented the size range of pups capable of at least 20 km excursions, and therefore capable of interacting with rock lobster pots. Large vernier callipers were used to take two sets of lateral and two sets of dorso-ventral body diameter measurements to estimate the smallest diameter around the body and head of pups, respectively (Figure 6.3). The lateral measurements were taken from the scapulo-humero (shoulder) junction (with the flippers turned under the body), and across the widest point of the skull in line with the pinnae. Dorso-ventral measurements were taken perpendicular to the lateral measurements. In addition, axillary girth and standard length (nose to tail tip) measurements were taken.

Sea lion rock lobster pot-exclusion trials

Underwater experiments were undertaken to test the efficacy of different spike-height configurations in preventing the entry of sea lions into southern rock lobster pots. These were similar to experiments described by Campbell et al. (2008a) for the

western rock lobster fishery. Six spike-height configurations (treatments) relative to the bottom of the pot collar were tested: -50 mm, -30 mm, -10 mm below the bottom of the collar, 0 mm, and +70 mm and +140 mm above the bottom of the collar (Figure 6.4). Upright steel bolts fixed to the base of the pot that extended up towards the centre of the opening of the pots by 180 mm, 200 mm, 220 mm, 230 mm, 300 mm and 370 mm were used to achieve these six spike-height configurations.

Experiments were undertaken over 12 calm weather days in April 2008 in a bay at Hopkins Island, a haul-out site frequented by many juvenile sea lions (Figure 6.5). The shallow (4 - 7 m) sandy bottom just offshore and good water clarity facilitated observations. A pot fitted with one of the treatments was randomly selected each day and placed in the water adjacent to the colony, along with an identically configured control pot that did not contain a spike. Each treatment was replicated twice before being removed from the selection process. The treatment pot was seeded with ten lobsters, while the control pot typically contained between two and four (to reduce number of lobsters removed by sea lions). Each of the six treatment and control pairs were trialled for between 5 and 8 hours each day, resulting in between 10 and 16 hours of trial time for each treatment. Trials for each treatment continued until all lobsters were removed from either pot and/or when sea lions lost interest.

A closed circuit, real-time, wide-angle camera and video recording unit was used to monitor interactions between sea lions and rock lobster pots. The camera (in a waterproof housing) was fixed to a tripod and positioned approximately 4 m from the two pots enabling sea lion activity to be monitored. Sea lion activity was either scored instantaneously on the deck of the research vessel anchored nearby or was recorded and processed later.

Sea lion interactions with the seeded rock lobster pots were categorised as *successful* if the head of a sea lion attempting to enter a pot passed fully through the bottom of the collar and into the body of the pot. All other attempts were categorised as *unsuccessful*. This measure of success followed that developed by Campbell et al. (2008a), and provided an indication of the relative risk of drowning.

Observations of interactions between sea lions and lobster pots at Hopkins Islands were directed primarily at juvenile sea lions, none of which was observed to enter a pot fully and become trapped. This suggested they were too large to do so. To assess if smaller sea lions were more vulnerable to entrapment, a further experiment was directed at sea lion pups. This experiment was undertaken in a rock pool frequented by pups at the Olive Island breeding colony in April 2009 (Figure 3.1). Some trial and error was required before a suitable rock pool to perform the trial was located. The first rock pool selected was not frequented by pups; the second rock pool was too exposed to wave wash that obscured observations. The third rock pool selected was only large enough for one pot to be placed within it at a time. The trial was conducted over two days: first day, treatment (0 mm spike configuration, i.e., flush with bottom of collar); second day, control with no spike. Observations of pup interactions with pots were made from a vantage point above the rock pool. Interactions were recorded differently to those at Hopkins Island. For pups, interactions were categorised as a *pass* when a pup passed over the top of the pot and either paused to look in through the neck or lowered its head into the neck of the pot. An interaction where the pup fully entered the pot was categorised as an *entry*.

Industry trials

The effect of the sea lion exclusion spikes on the catch rate and size distribution of rock lobsters caught under commercial fishing conditions was tested by undertaking industry trials between November 2008 and February 2009. Twelve vessels and 13 fishers from the Northern Zone fishery participated in the trials. One pot belonging to each fisher was modified to contain a sea lion exclusion spike, designated as the treatment pot, and another pot was tagged as the control. Treatment pots had spike heights that extended up to either 20 mm below the bottom of the collar, 0 mm (flush with bottom of collar) or 70 mm above the base of the collar (i.e., -20 mm, 0 mm, +70 mm). Fishers were given a logbook to record the number of rock lobster caught and their carapace length. The treatment pot was deployed within 50 m of the control pot to maximise the likelihood that both pots were being set on the same bottom type and were potentially accessible to the same pool of rock lobsters. An independent observer also accompanied a number of these vessels to verify that data were being collected appropriately.

Data analysis

Sea lion pot interaction trials

Sea lion pot-interaction trials undertaken at Olive Island were analysed using G-tests to determine if there was an interaction between sea lion entry success and the

presence of a spike (treatment) compared to its absence (control). Regression analysis was used to determine the nature of the relationship between the rate of successful pot entry and the height of the spike. For pot-interaction trials directed at pups, data were arranged in a 2x2 contingency table, with the classifications control and treatment, and success of entry into the pot. Because the expectations in two of the four data cells of the 2x2 table were small (i.e., less than 5), the data were analysed using the exact test to calculate the probability of obtaining the observed deviation (or greater) from expectation by chance alone (Bailey 1959).

Industry trials

Two-way analysis of variance (ANOVA) was initially used to test if sex and or pottreatment significantly influenced the catch-rate (number of individual lobsters caught per pot) and size range (carapace length) of the catch. The treatments were set at 0 = control, 1 =-20 mm, 2 = 0 mm, 3 = +70 mm, where the measurements represent height of the spike above or below the bottom of the collar. In these analyses, it was assumed that the sizes of lobsters in the same pot were independent of each other.

Where a two-way ANOVA showed that sex was a significant treatment, one-way ANOVAs were used to assess the effect of pot-treatment on catch-rate and on size range of males and females, separately. Post hoc pair-wise comparisons were undertaken using Fisher's Protracted Least Significance Difference (PLSD) tests to determine which treatment/control groups differed significantly (Quinn & Keough 2002).

Results

Southern rock lobster pot dimensions and spike height configurations

The standard beehive pot used by SA southern rock lobster fishers has a circular base about 870 mm in diameter with a domed top extending about 400 mm from the centre of the base (Figures 6.1). A plastic collar is attached to the top of the pot, the opening having an inside diameter of 275 mm and depth of 173 mm. The collar is slightly tapered and narrows to 271 mm at its base. The distance from the base of the collar to the bottom of the pot is about 230 mm. The objective of the sea lion exclusion spike is to reduce the size of the opening of the collar to prevent sea lion

spikes of different configurations reduce the size of the opening of the pot at the base of the collar is presented in Table 6.1. Because the collar material is slightly flexible, these measurements represent minimum distances and sea lions are likely to be able to make an opening slightly larger. Their ability to achieve this is likely to increase as the distance between the base of the collar and the spike increases, and their ability is likely to decrease when the spike extends into the collar.

Pup morphometric measurements

Morphometric data for 14 tagged pups are presented in Table 6.2. The 2008 breeding season at Dangerous Reef extended from February to November, and lasted at least nine months (Goldsworthy et al. 2009b). Pups were tagged in May when most were between 1 and 3 months of age (Goldsworthy et al. 2009b). Therefore the pups recaptured at English Island were most likely 4-5 months when measured.

The dorso-ventral measurements of the head (mean = 93 mm, range 86-98 mm) and shoulders (mean = 159 mm, range 145-180 mm) represented the narrowest body diameters of measured pups. Male pups had significantly greater dorso-ventral (t = 3.137, df = 13, P = 0.009) and lateral (t = 3.199, df = 13, P = 0.008) head measurements compared to females, but there was no significant difference between the shoulder dimensions, length or girth measurements of the male and female pups.

Based on the dimension of the head and shoulders, even the largest pups would be able to pass through the collar of an unprotected pot of diameter 271 mm. Pups would also be able to extend their head into the body of the pot, even with a spike extending to the base of the collar (0 mm), which reduces the minimum opening to 135.5 mm (Table 6.1). This minimum opening should prevent the body of the smallest pup measured (145 mm dorso-ventral shoulder diameter) from fully entering the pot, but this does not take into account any flexibility in the collar material that may enable pups to force a larger opening.

Sea lion pot interaction trials

A total of 1799 attempts to enter the rock lobster pots by Australian sea lions were observed during the pot-interaction trials, with1522 entry attempts made on treatment pots compared to only 277 at the control pot (Table 6.3). The smaller

number of attempts to enter control pots was due to sea lions being able to quickly remove lobsters within them in the absence of a spike, resulting in subsequent disinterest once all the lobsters had been eaten. Due to the reduced number of control observations within each treatment replicate, data from the two replicates of each treatment/control pair were pooled. Almost all attempts were made by juveniles of approximately 0.9 to 1.4 m length and of undetermined sex. Some larger sub-adult and adult animals were present, but did not attempt to enter the pots.

In general, the rate of success of juvenile sea lions at entering pots fitted with spikes declined as the height of the spike increased (Table 6.3, Figure 6.6). G-tests demonstrated a significant interaction between sea lion entry success and the presence of a spike (treatment) compared to its absence (control), with the exception of the -30 mm spike/ control experiment (Table 6.3). The entry success for each treatment group was noticeably less than for its control for spike heights extending 140 mm above the collar to 10 mm below it (Table 6.3, Figure 6.6, Figure 6.7). The reduction in pot entry with increasing spike height best fitted a negative sigmoidal relationship, with a marked reduction in pot entry success as spike height varied relative to the bottom of the collar (Figure 6.7, $X^2 = 99.123$, $r^2 = 0.983$).

The pot-interaction trials undertaken with sea lion pups at Olive Island produced 325 observed interactions. Of these, 193 were with the control pot and resulted in 191 passes (no-entry) and 2 pot entries. The two pups that entered the pot panicked as they attempted to escape through the side of the pot rather than out through the neck. On both occasions the pot was quickly removed from the water and the pup released unharmed. For the treatment pot, of 132 observed interactions none resulted in an entry. Thus the frequency of entry into the treatment pots was zero and that for the control pots was 1.05%. In this instance the probability of obtaining the observed or greater deviation from expectation by chance is 35%, assuming that the interactions are independent, which they probably aren't given that the control pot was used one day and the treatment the next. There was no statistical difference between the control and the treatment in the likelihood of pot entry by pups.

To obtain a statistically significant result with the same frequency of entry into the pots, it would have been necessary to undertake about 900 independent trials. With only 323 trials (as used in these tests), the result would have been statistically significant if the frequency of entry into the control pots were three times as great (i.e., 3.14%) and none of the treatment pots were entered. Irrespective of the

statistical results, the trial results highlight three key points. Firstly, that sea lion pups can enter and become entrapped within rock lobster pots. Secondly, the entry of two pups into a pot within an 8-hour period suggests that the potential for entrapment could be high when pots are set near sea lion breeding colonies. Thirdly, the results provide additional quantitative support that appropriately configured spikes can reduce the likelihood of sea lion pot entry.

Industry trials

A total of 500 control and 489 treatment pots were sampled as part of the industry trials in the Northern Zone of the SA southern rock lobster fishery, for a total of 989 trials. Summary data comparing the catch-rate and size of lobsters by sex and by treatment are presented in Table 6.4.

For rock lobster catch rates, a two-way ANOVA indicated that both sex and pottreatment had a significant effect (Table 6.5, Figure 6.8). Because the catch rates of males were significantly greater than for females across control and treatment pots, male and female catch data were examined separately. For male lobsters, one-way ANOVA indicated that the treatment significantly affected catch rate. However, pairwise comparison (Table 6.6) indicated that there was only a significant difference between the catch-rate with 0 mm and +70 mm spike treatments.

Similarly, a one-way ANOVA indicated that treatment significantly affected the catch rate of female lobsters. However, pair-wise comparisons indicated that this was only due to the lower catch-rates of 70 mm treatment pots, which differed significantly from control and other treatment pots (Table 6.5 and 6.6; Figure 6.8). In general, catch-rates increased slightly between control, -20 mm and 0 mm treatment pots for both male and female lobsters, but these increases were not significant (Table 6.4, 6.5, 6.6; Figure 6.8).

For the size (carapace length) of rock lobsters caught in control and treatment pots, a two-way ANOVA indicated that sex was a significant factor; male lobsters were larger than females (Table 6.4, 6.8, Figure 6.9). Therefore, male and female size data were examined separately. One-way ANOVA indicated that there was no effect of pot-treatment on the size of male lobsters caught, but it detected a significant effect of pot-treatment on the size of female lobsters caught (Table 6.7 and 6.8; Figure 6.9). In females, pair-wise comparisons indicated that lobsters caught in the

70 mm treatment were significantly larger than those caught in the control and other treatment groups (Table 6.8, Figure 6.9). There was no significant difference in the size of females caught in control, -20 mm and 0 mm treatment pots (Table 6.4, 6.8, 6.9; Figure 6.9).

Discussion

Introduction of a spike in rock lobster pots to prevent sea lion entrapment follows early developments by SA rock lobster fishers to limit the removal of baits from pots (Anon 1996), and subsequent methods developed by Campbell (2004) and Campbell et al. (2008a) in the Western Australian west coast rock lobster fishery. Campbell (2004) tested a number of different sea lion exclusion devices, including a solid batten secured across the top of the neck of a pot, an upright steel bar (spike) with "T" bar and a plain steel spike. Although not the most successful exclusion device, the 'spike' was chosen for broader industry trials, because it had the least affect on fishing operations and catch rate (Campbell 2004, Campbell et al. 2008a). It was noted that sea lions could still remove rock lobsters from a pot fitted with a spike (Campbell 2004).

The critical findings of this study directed at the southern rock lobster fishery in SA essentially follow those of Campbell et al. (2008a). Sea lion pot-interaction trials demonstrate the propensity and ability of sea lions to enter rock lobster pots, and in the absence of any pot-protection measures, remove lobsters. The trials clearly demonstrate a marked reduction in entry success as spike height (relative to the bottom of the pot-collar) increases. Experiments undertaken in this study were directed at a size range of sea lions at lower risk of entrapment (drowning), so these experiments were not able to determine the minimum spike height configuration required to prevent the entry of smaller sea lions. These data were derived indirectly by measuring the minimum diameter of the body of young pups (4-5 months old) known to be capable of interacting with lobster pots by virtue of their capacity to travel at least 20km to a nearby colony. These results indicated that, based on the dimension of the head and shoulders, even the largest pups measured would be able to pass through the collar of an unprotected pot. With a spike extending to the base of the collar (0 mm) the minimum opening of the pot is reduced from 271 mm to 135.5 mm. This minimum opening should prevent the body of the smallest pup

measured (145 mm dorso-ventral shoulder diameter) from fully entering the pot, but does not take into account any flexibility in the collar material that may enable sea lions to force a larger minimum opening.

Follow-up pot-interaction trials confirmed that small pups could become easily entrapped in unprotected pots, and although comparisons between the pot entry success of pups interacting with control and treatment pots were not significantly different (though our experiments had low statistical power), no pups successfully entered or became entrapped in the treatment pot trialled. The results provide additional support that appropriately configured spikes can reduce the likelihood of pot entry by a juvenile sea lion.

Industry trials demonstrated that the addition of a spike extending to just below (-20 mm) or flush with the pot-collar (0 mm) had no significant effect on the catch rate or size of lobsters caught. The catch rates of pots fitted with a spike that extended high up into the collar (+70 mm from base) were significantly lower than other treatment and control pots. These results indicate that a correctly fitted spike extending to the base of the pot collar will significantly reduce the likelihood of sea lion entrapment (bycatch mortality) while having no effect on the catch rate and size selectivity of the fishery.

From records of dates of capture of sea lions provided by fishers in the west coast lobster fishery in WA, Campbell et al. (2008a) was able to estimate the age distribution of sea lions vulnerable to bycatch mortality in the fishery. Based on these data, the ages ranged from 5 to 22 months (2.5 years), indicating that pups (<18 m old) were the predominant age class vulnerable to bycatch in the fishery (Campbell et al. 2008a). These sea lions were caught in lobster pots set up to 28 km from the nearest breeding colony, providing further evidence of the mobility of pups and their heightened vulnerability to bycatch in the fishery (Fowler et al. 2006, Fowler et al. 2007, Campbell et al. 2008a). The spike configuration used in the west coast rock lobster fishery was set at 20 mm below the pot collar, and Campbell et al. (2008a) indicated that this would have resulted in virtual elimination of entry by vulnerable sized sea lions by reducing the collar opening dimension to 132 mm. Due to differences in pot dimensions in the western and southern rock lobster fisheries, this is slightly (5mm) smaller than the minimum diameter achieved with a similarly configured southern rock lobster pot (Table 6.1).

The diving behaviour of pups and juveniles on the west coast of WA, indicated that at least 90% of dives occurred in waters <20 m depth (Campbell et al. 2008a). Based on these results, a SLED (sea lion exclusion device) zone was declared mandatory in waters <20 m, and introduced into the fishery in the 2006/07 fishing season (Campbell et al. 2008a). Campbell et al. (2008a) noted that the diving range of the west coast WA sea lions differs markedly from the foraging depth of pups, juveniles and adult females studied at Kangaroo Island in South Australia, where dive depths are 2 -3 time greater (Costa & Gales 2003, Fowler et al. 2006, 2007, Campbell et al. 2008a). Fowler et al. (2006) reported mean maximum dive depths of 29 m, 68 m and 78 m for 6.1 month (5.4 - 7.1), 14.5 month (13.4 - 15.7) and 22.6 month (22.1 - 22.9) pups and juveniles at Seal Bay, Kangaroo Island, respectively. The mean maximum distance that the same 14.5 month old pups and 22.6 month old juveniles travelled from the Seal Bay colony was 28.2 and 36.5 km, respectively (Fowler et al. 2007).

Given the greater depth and distance range of sea lion pups and juveniles in SA waters, consideration should be given to the implementation of sea lion spikes across the range of the Northern Zone of the SARLF.

Table 6.1. The minimum pot opening achieved from different spike height configurations in rock lobster pots. Minimum pot opening is based on a 271 mm collar base diameter, and is calculated as the hypotenuse (using the Pythagorean theorem) of a right-angle triangle with one side measuring 135.5 mm and the other side of variable length based on the distance from the collar base to the top of the spike. Note that spike lengths in this table are those that achieved the desired distance from the base of the collar to the top of the spike. These measurements may vary among pots used in the fishery.

Distance	Approx	Minimum
from collar base	spike	pot
to spike top	length	opening
(mm)	(mm)	(mm)
0	230	135.5
-5	225	135.6
-10	220	135.9
-15	215	136.3
-20	210	137.0
-25	205	137.8
-30	200	138.8
-35	195	139.9
-40	190	141.3
-45	185	142.8
-50	180	144.4
-55	175	146.2
-60	170	148.2
-65	165	150.3
-70	160	152.5
-75	155	154.9
-80	150	157.4
-85	145	160.0
-90	140	162.7
-95	135	165.5
-100	130	168.4
-105	125	171.4
-110	120	174.5
-115	115	177.7
-120	110	181.0
-125	105	184.4
-130	100	187.8
-135	95	191.3

Capture	Tag No.		He	ead	The	orax		
date		Sex	Dorso-		Dorso-		Axillary	Standard
			ventral	Lateral	ventral	Lateral	Girth	Length
20-Jun-08	665	М	97	110	180	195	589	783
20-Jun-08	625	М	90	110	170	205	650	850
23-Jun-08	732	М	98	108	165	290	585	905
23-Jun-08	642	F	89	99	145	260	610	875
23-Jun-08	612	М	97	101	145	265	585	890
24-Jun-08	609	F	90	98	150	235	605	880
2-Jul-08	669	М	95	105	165	290	660	965
2-Jul-08	637	F	94	101	156	250	630	891
4-Jul-08	726	М	86	97	145	245	581	891
6-Jul-08	587	М	98	109	170	225	690	999
6-Jul-08	706	F	88	101	150	260	655	952
6-Jul-08	633	F	91	100	150	240	635	844
10-Jul-08	588	F	90	100	160	255	623	906
10-Jul-08	684	М	93	105	170	270	644	877
Mean			93	103	159	249	624	893
Min-Max			86-98	97-110	145-180	195-290	581-690	783-999

Table 6.2. Morphometric data from 14 pups tagged on Dangerous Reef on 19 May 2008 that were captured and measured at English Island at later dates. Pups were estimated to be 4-5 months old when measured. Measurements in mm.

Table 6.3. Results of pot-interaction trials with Australian sea lions undertaken off Hopkins Island. The spike-height configurations of treatment pots are detailed, along with the number of pot entry attempts observed (observations), the number that were successful and unsuccessful and the proportion of entry success. Results from pair-wise comparisons of the entry success of treatment and control pots using the G-test are presented with the G-adjust statistic and significance level (P).

	Spike height		Treatment	Treatment			Control		Entry			
	From collar base	From bottom of pot	Observations	Successful	Unsuccessful	Success	Observations	Successful	Unsuccessful	Success	G-adj	Ρ
Combined	140	370	173	0	173	0.00	30	29	1	0.97	143.59	<0.001
	70	300	322	22	300	0.07	55	55	0	1.00	208.30	<0.001
	0	230	220	31	189	0.14	95	62	33	0.65	80.05	<0.001
	-10	220	168	35	133	0.21	55	52	3	0.95	101.99	<0.001
	-30	200	272	193	79	0.71	18	14	4	0.78	0.39	NS
	-50	180	367	284	83	0.77	24	22	2	0.92	3.18	<0.05
Total observations			1522				277					

Table 6.4. Summary results of Northern Zone SARLF pot-trials comparing the mean, standard deviation (SD) and sample size (n) of lobster catch-rate and size data from control pots (no spike) and treatment pots with spike height set at -20 mm, 0 mm, +70 mm. Data are separated by lobster sex.

Sex	C (lobs	atch-rate sters/pot-lif	t)	Lol (carapa)	Lobster size (carapace length mm)			
	Mean	SD	n	Mean	SD	n		
Males								
Control	0.642	0.98	500	119.1	28.2	321		
-20 mm	0.646	1.028	209	115.3	26.3	135		
0 mm	0.793	1.224	121	113.9	29.2	96		
+70 mm	0.465	0.744	159	115.5	17.5	74		
Females								
Control	0.558	0.982	500	105.0	16.9	279		
-20 mm	0.608	0.975	209	104.1	16.9	127		
0 mm	0.62	0.968	121	103.6	15.8	75		
+70 mm	0.195	0.568	159	114.4	13.6	31		

Table 6.5. Results of analysis of variance (ANOVA) of industry pot trials examining the influence of treatment (set at 0 = control, 1 = -20 mm, 2 = 0 mm, 3 = +70 mm) and sex (males, females) as factors on lobster catch rates (individuals per pot-lift). Combined data indicated a strong sex effect, requiring male and female data to be analysed separately.

			Sum of	Mean		
	Factor	DF	squares	square	F value	Р
All data	Sex	1	7.5514	7.514	8.184	0.004
	Treatment	3	24.997	8.332	9.075	<0.001
	Sex x Treatment	3	2.984	0.995	1.083	0.355
	Residual	1970	1808.726	0.918		
Males	Treatment Residual	3 985	7.654 966.112	2.551 0.981	2.601	0.051
Females	Treatment Residual	3 985	20.326 842.614	6.775 0.855	7.92	<0.001

Table 6.6. Post-hoc pair-wise comparisons using Fisher's PLSD tests to test for difference in lobster catch rates (individuals per pot-lift) between control and treatment groups. * indicates significant test.

Pair-wise		Mal	es		Fem		
Со	mparison	Mean diff	Crit. Diff	Р	Mean diff	Crit. Diff	P
Control	-20 mm	-0.004	0.16	0.962	-0.05	0.15	0.515
Control	0 mm	-0.151	0.197	0.132	-0.062	0.184	0.51
Control	+70 mm	-0.177	0.177	0.051	0.363	0.165	<0.001*
-20 mm	0 mm	-0.147	0.222	0.193	-0.012	0.207	0.908
-20 mm	+70 mm	0.181	0.205	0.084	0.413	0.191	<0.001*
0 mm	+70 mm	0.328	0.234	0.006*	0.425	0.219	<0.001*

Table 6.7. Results of analysis of variance (ANOVA) of industry pot trials examining the influence of treatment (set at 0 = control, 1 = -20 mm, 2 = 0 mm, 3 = +70 mm) and sex (males, females) as factors on lobster size (carapace length mm). Combined data indicated a strong sex effect, requiring male and female data to be analysed separately. These analyses indicate no significant effect of treatment (control, -20mm, 0mm, +70 mm) on the size of male lobsters, but a significant effect of treatment on the size of females. Post-hoc analyses indicate that females in the +70 mm treatment were significantly larger compared to other groups (control, -20mm, 0mm).

		Sum of		Mean		
	Factor	DF	squares	square	F value	Р
All data	Sex	1	146989.693	14698.693	28.114	<0.001
	Treatment	3	3198.161	1066.054	2.039	0.107
	Sex x Treatment	3	3427.33	1142.443	2.185	0.088
	Residual	1130	590801.667	523.833		
Males	Treatment	3	2853.051	951 017	1 31	0 270
Males	Residual	622	451674.176	726.164	1.51	0.270
Female	Treatment	3	2973.477	991.159	3.619	0.013
	Residual	508	139127.492	273.873		

Table 6.8. Post-hoc pair-wise comparisons using Fisher's PLSD tests to test for difference in lobster size (carapace length) between control and treatment groups.

P	air-wise	Mal	es	Females			
Co	mparison	Mean diff	Crit. Diff	Р	Mean diff	Crit. Diff	P
Control	-20 mm	3.744	5.428	0.176	0.863	3.48	0.627
Control	0 mm	5.177	6.156	0.099	1.344	4.229	0.533
Control	+70 mm	3.603	6.824	0.300	-9.43	6.155	0.002*
-20 mm	0 mm	1.433	7.065	0.691	0.481	4.735	0.842
-20 mm	+70 mm	-0.141	7.654	0.971	-10.293	6.513	0.002*
0 mm	+70 mm	-1.574	8.186	0.706	-10.774	6.942	0.002*



Figure 6.1. An example of a 'bee-hive' pot used in the southern rock lobster fishery in South Australia. Note the plastic pot-collar inserted into the top of the pot (Photo Matthew Hoare).



Figure 6.2. Map of Southern Spencer Gulf indicating the location of Hopkins Island where the Australian sea lion pot-interaction trials were undertaken, and English Island where tagged pups that had swum from Dangerous Reef were measured. The location of a third sea lion breeding colony (Lewis Island) is also indicated.



Figure 6.3. The location where lateral and dorso-ventral morphometric measurements were made of Australian sea lion pups (photo D. Hamer).



Figure 6.4. Schematic cross-section of a rock lobster pot, indicating the relative size of the pot-collar (red) and the various sea lion exclusion spike configurations used in this study, and their measurement given as distance from the base of the collar (left) and from the bottom of the pot (right). Note, due to slight variations between pots, the spike height required to achieve desired distance from the base of the collar may vary slightly between pots.



Figure 6.5. Australian sea lion juveniles participating in southern rock lobster pot-trials off Hopkins island (Photo: D. Gibas).



Figure 6.6. Histogram of pot-entry success of Australian sea lion juveniles undertaken at Hopkins Island.



Figure 6.7. The effect of spike height on the pot entry success of juvenile Australian sea lions. A negative sigmoidal regression of the data is also presented.



Figure 6.8. Results of SA Northern Zone of the Southern Rock Lobster Fishery pot-trials comparing the mean, standard error and sample size (n) of lobster catch-rate from control (no spike) and treatment (-20 mm, 0 mm, +70 mm) pots. Data are separated by lobster sex.



Figure 6.9. Results of SA Northern Zone of the Southern Rock Lobster Fishery pot-trials comparing the mean, standard error and sample size (n) of lobster size (carapace length) from control (no spike) and treatment (-20 mm, 0 mm, +70 mm) pots. Data are separated by lobster sex.

7 ASSESSMENT AND IMPACT OF BYCATCH IN THE GILLNET SECTOR OF THE GHAT FISHERY ON AUSTRALIAN SEA LION SUBPOPULATIONS OFF SOUTH AUSTRALIA

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Introduction

The aims of this study were to provide a quantitative assessment of the current extent and impacts of Australian sea lion (ASL) bycatch mortality in the demersal gillnet fishery off South Australia.

The approach used was to:

- 1. develop a model of the spatial distribution of ASL foraging effort using all available satellite tracking data for South Australian subpopulations;
- integrate this model with data from a dedicated sea lion bycatch observer program to develop a bycatch rate estimation model for regions differing in ASL foraging effort;
- apply the bycatch rate estimation model to detailed spatial data on the distribution of fishing effort from January 2006 to July 2009 to estimate the bycatch mortality of ASL in the fishery; and
- 4. assess the implications of this bycatch on ASL subpopulations using population viability analyses (PVA).

Methods

Approach

To assess the current extent and impacts of ASL bycatch mortality in the demersal gillnet fishery off South Australia, the approach taken was to collate the data and analyses available on population abundances, foraging behaviour, bycatch rates and the distribution of fishing effort. A simplified flowchart of how these various data sets and analyses (components) were integrated to estimate overall and subpopulation bycatch, and assess the implications of such bycatch on population viability is presented in Figure 7.1. Methods applied to each of these core components is detailed below.

Seal distribution and population size

Breeding sites and subpopulation estimates

The location of ASL breeding colonies, and the pup production at each breeding site (subpopulation) within South Australian waters was based on the most recent data set provided by Goldsworthy et al. (2009a) (see Appendix 1). These data are summarised in Table 7.1. The size of individual subpopulations including the number of females and males was based on life-tables and Leslie matrices developed by McIntosh (2007)(Tables 7.2 and 7.3). Her study provides the only data on agespecific survival rates for ASL, based on demographic analyses of the Seal Bay (Kangaroo Island) subpopulation. Age-specific survival estimates were based upon the resight/return rates of tagged and marked individual sea lions at Seal Bay. McIntosh (2007) found that pup survival to about 1.5 years (weaning) was low (~0.35 based on 6 cohorts), but was relatively constant for females and males between 3 and 14 years (although lower in males) (Table 7.2). Based on ageing analyses of sectioned post-canine teeth from dead ASL, female mortality peaks at 12 years of age, with maximum longevity of 24 years, while male mortality peaks at 16 years of age, with maximum longevity of 21.5 years (McIntosh 2007). In the absence of any anthropogenic mortality, the minimum growth of subpopulations was assumed to be stable (0% growth per breeding season). As McIntosh's (2007) 'Good' Leslie matrix was based on a declining subpopulation, survival values for each age-stage in this study were multiplied in the life-table and Leslie matrix by 1.0026 in order to achieve a stable growth (i.e. an intrinsic rate of growth of r = 0 where, over the long-term and

on average, the subpopulation is stable). As ASL breed about every 17.5 months (Shaughnessy et al. 2006), survival was calculated for every 1.458 years.

Distribution of sea lion foraging effort

ASL satellite telemetry data

Satellite telemetry data from instrumented ASLs provided the raw data from which the distribution of foraging effort was modelled. Numbers of individual adult female, adult male and juvenile ASL tracked from each subpopulation or site are presented in Table 7.4, along with the total and mean number (sd and range) of foraging trips monitored, and the primary sources of data used in the analyses. In total, data from 210 individual ASL deployments were used, including 157 adult females from 17 subpopulations, 31 adult males from 9 subpopulations and 22 juveniles from 4 subpopulations. These amounted to 3,321 individual foraging trips, 2,334 from adult females, 566 from adult males and 421 from juveniles (Table 7.4). Most telemetry data were derived from ARGOS linked platform transmitting terminals (PTTs), with more recent data derived from fully archival or archival/ARGOS linked GPS tags (Table 7.4). Overall, a total of 100,934 satellite derived locations were available for analysis.

Filtering and analysis of time spent in areas

PTT satellite location data were obtained through CLS ARGOS (Toulouse, France). The location-class Z positions were omitted due to the magnitude of their error (Sterling and Ream 2004), leaving location classes B, A, 0, 1, 2, 3 for subsequent analyses. For GPS telemetry units, location data were solved either using the LocSolve (Wildlife Computers, Redmond, Washington USA) or Sirtrack (Havelock North, New Zealand) software packages. The R statistical software (version 2.8.1, R Development Core Team, R Foundation for Statistical Computing, Vienna) and the Trip package (M. D. Sumner, University of Tasmania, Hobart) were used to apply a speed filter as described by McConnell et al. (1992) to remove erroneous positions. The maximum horizontal speed considered possible was 11.0 km/h. In order to remove all time on land and restrict subsequent analyses to data on foraging trips only, the departure and arrival times, and locations of successive foraging trips were calculated following the methods detailed by Goldsworthy et al. (2009d). To determine key areas used during foraging trips, a grid of cells $(1.5 \times 1.5 \text{ km})$ was developed using the Trip package, and the amount of time that each sea lion spent within each cell area (2.25km^2) was calculated assuming a constant horizontal speed based on the distance and duration between successive filtered locations and interpolated new positions for each 15 minutes (of time) along the satellite track. The number of original and interpolated positions located within these cells were summed and assigned to the central node. To ensure the different deployment durations recorded for different sea lions did not bias comparisons, the amount of time spent in each cell was converted to a proportion of the total time spent at sea for each individual, subpopulation and/or age-sex group. A finer grid (of 1 x 1 km) could not be used because calculations using it exceeded the memory space of the R statistical package.

Model development

Statistical models using data distributions were used to estimate the spatial distribution of foraging effort of ASL subpopulations throughout South Australia. This approach was favoured because it estimated foraging effort from distributions of the tracking observations and, as such, was less prone to over-dispersion than other techniques. Alternate approaches using general linear models and generalised additive models were trialled, but could not capture the over-disperse nature of the observations, resulting in unrealistic truncations at natural limits to foraging distance and foraging depth. Only the spatial distribution and depth of foraging effort of juveniles, adult females and adult males were modelled. Although the foraging abilities of pups have been shown to develop markedly from 6m to 18m of age (Fowler et al. 2006), information about their distribution of foraging effort is still limited.

Continental shelf and slope waters in SA were overlaid with a 1 x 1km grid and the distance from each subpopulation to each node in the array was calculated. The depth at each cell node was also calculated using bathymetric data from GeoScience Australia. For each subpopulation, the time spent at distance and depth from the subpopulation site was examined using density plots created within R. The fits of observations to the normal probability

$$f(x;\mu,\sigma) = \frac{1}{\sqrt{2\pi\sigma^2}} e^{-\left(\frac{(x-\mu)^2}{2\sigma^2}\right)},$$

and gamma probability density functions,

$$f(x;k,\theta) = x^{k-1} \frac{e^{\frac{-x}{\theta}}}{\theta^k \Gamma(k)},$$

were examined using the MASS package. The means (μ) and standard deviations (σ) were calculated for normal probability distributions, while the shape (k) and scale (θ) functions were determined for gamma distributions. The x variable represents either depth (m) or distance (km). Where distance or depth distributions appeared bimodal, mixture models of two normal distributions were fitted using maximum likelihood in R (MASS package). Where there was support for two distributions, means and standard deviations were estimated for each and the proportion each distribution contributed to the overall distribution was calculated. Distance and depth distributions were examined for all females, and all juveniles, as well as all western Eyre Peninsula males (West), Spencer Gulf and Gulf St Vincent males (Gulf) and Kangaroo Island males (KI).

The probability of an animal from a given subpopulation foraging in a particular cell (see above text for description) was modelled as a continuous variable on the range [0,1]. The probabilities were calculated as the joint probability (i.e., product) of distance and depth, based on the distance of the node from the subpopulation and its depth, after standardising each onto the range [0,1]. For adult females, subpopulation models were used where tracking data from more than two individuals from that subpopulation were available. For all other subpopulations, the combined model (all females) was used to model the foraging distribution of females. For adult males, three pooled models were used as described above (West, Gulf and KI). Because of the limited data available for juveniles, a pooled model was used to model the distribution of foraging effort of juveniles from all subpopulations. Another assumption used in this modelling was that models for depth and distance were independent.

Each foraging model was constrained by the upper limits of the observed distance and depth in the data on which it was based. For subpopulations in the lower Eyre Peninsula, Spencer Gulf and Kangaroo Island regions, distances from subpopulations were corrected to follow the minimum coastal route where the shortest distance was over land. The distribution of foraging effort was apportioned for each subpopulation in proportion to the pup production, the number of individual seals from each age stage and gender, and the proportion of time they spent at sea (Tables 7.1, 7.2, 7.5). This enabled the estimation of total foraging effort (seal days/yr) for each subpopulation and its adult female, male and juvenile components. Estimates of the proportion of time spent at sea by adult females, adult males and juveniles were based on those calculated by Goldsworthy et al. (2007a) and Goldsworthy and Page (2007) (Table 7.5).The product of the adult female, male and juvenile foraging probabilities at each node for each subpopulation, and their total foraging effort provided the final enumeration of the estimated spatial distribution of foraging effort. For any 1 x1 km node in the array, this enabled the estimation of total ASL foraging effort and the proportion of effort attributable to females and males from any subpopulation.

Bottom-time foraging effort

The above measures of the distribution of foraging effort include all aspects of at-sea behaviour, including the descent, bottom and ascent phases of each dive, and the inter-dive interval. As demersal gillnets are set on the seabed and extend only 3-4 m up into the water column, the period during which ASL are most vulnerable to bycatch is during the bottom phase of each dive. ASL are benthic foragers and typically maintain a relatively constant bottom time duration independent of depth by increasing the duration of dives (Costa & Gales 2003). However, inter-dive intervals may increase with depth and as such the total amount of bottom time may decrease with increasing depth. To account for the potential effect of depth on bottom time, we examined data files from11 time-depth recorder (TDR, MK-7 TDRs Wildlife Computers, Redmond, Washington, USA) deployments available for adult female ASL, and 4 files available for adult males. Dive files were analysed using Instrument Helper (Version 1.0.0.5, Wildlife Computers) to derive data on the dive depth duration, bottom time (set as the time spent deeper than 80% of the maximum depth of each dive) and inter-dive interval. Percent bottom time for each dive was then calculated as the duration of bottom time, divided by the total dive duration plus the previous inter-dive interval. The effect of depth (log transformed) on percent bottom time (complementary log-log transformed) was examined using generalised linear mixed-effects models (GLMMs), using the Ime4 package in R. A function describing how the proportion of bottom time varied with depth was derived and applied to each node within the foraging distribution model to provide an estimate of the total bottom time. For any 1 x1 km node in the array, this enabled the estimation of total ASL

bottom time foraging effort (the total part of foraging effort when seals are vulnerable to bycatch mortality in the gillnet sector GHAT fishery). As with overall foraging effort estimates, the proportion of bottom-time effort attributable to females and males from any subpopulation for any node could also be estimated.

Foraging effort models were visualised in MapInfo[™] (Version 9, MapInfo Corporation, New York, USA) and then interpolated (triangular irregular network interpolation with 5th order polynomial) and plotted using VerticalMapper[™] (Version 3.0, Northwood Geosciences Ltd, Nepean, Ontario, Canada).

Core foraging areas

Core foraging areas were estimated by sorting the grid node values of proportion of time spent in areas for adult females, adult males and juveniles per subpopulation from highest to lowest values, then calculating the cumulative sum of successive node values from highest to lowest. These were visualised as contour plots in 10 percentile increments in MapInfo[™] and then interpolated (triangular irregular network interpolation with 5th order polynomial) and plotted using VerticalMapper[™]. In this way, percentiles of core foraging area could be described as the minimum area in which a certain percentage of foraging effort occurred.

Spatial and temporal distribution of fishing effort

Prior to 2006, fishermen in the gillnet sector of the GHAT were only required to record catch and effort data within individual marine fishery areas (MFAs) which were roughly based around a 1° x 1° grid. However, in 2006 latitude/longitude recording of catch and effort was mandated by AFMA, and on 1 July 2007 the vessel monitoring system (VMS) was introduced to all vessels. Catch and effort data reported by latitude and longitude (to the nearest minute) were obtained from AFMA for the period 1 January 2006 to 25 July 2009 (3.56 years). Effort data was reported in metres of net-set, and the duration of net-sets (soak-time minutes) was estimated based on the difference between the recorded time between the commencement of net-set to the commencement of net-haul. Two measures of fishing effort were calculated based on these data, the net-set length (km) and net-set length x soak-time duration (km.hrs). Catch data for the target species (gummy shark) were only available for the 2006-2008 calendar years when this report was prepared.

The recorded positions of net-sets and the corresponding effort data (km and km.hrs) and catch-per unit effort of the target species (CPUE, kg/km and kg/km.hr) were plotted in MapInfo. Net-sets reported on land or in waters deeper than 183m (the limit of fishery) were omitted (127 (0.7%) of 14,398 records). Logbook records were plotted on a 1' x 1' array (extending outside the bounds of the fishery) that included zero values for nodes not fished. This dataset was interpolated in VerticalMapper[™], using the inverse distance weighting method to smooth the data for visualisation purposes (so that the location of individual net-sets could not be easily resolved).

Effort and CPUE data were also interpolated using the triangular irregular network interpolation method (with 5th order polynomial), and using the point-inspection feature in VerticalMapper[™]. Fishing effort and CPUE data were extracted onto the 1 km² ASL foraging grid, which enabled fishing effort, CPUE and ASL foraging effort to be compared for each 1 km² cell. At this resolution, fishing effort data were summed for all cells and standardised onto the range [0,1] so that the proportion of fishing effort per cell (per year) could be calculated. Effort data excluded because their positions were incorrectly reported could then be allocated based on the proportional distribution of fishing effort across all nodes.

Modelling sea lion bycatch

Independent ASL bycatch observer program

Observers accompanied shark gillnet vessels in SA shelf waters on 10 trips between February 2006 and January 2008. Observations were made from slightly outboard of the gunwale to obtain an unimpeded view of the net ascending vertically through the upper water column and onto the net roller during net-hauls (Figure 7.2). The observer recorded the time and location of each of the 234 hauls, and the presence of drowned ASLs in the net when it was hauled. Where possible, the sex and age class of drowned ASLs were recorded. The observed ASL bycatch mortality rate was calculated using two units of fishing effort: 1) seals/km net-set, by dividing the total number of ASL by-catch mortalities observed by the total number of ASL by-catch mortalities observed by the total number of ASL by-catch mortalities observed.

Bycatch rate equations

The latitude and longitude positions of the 234 independently observed net-hauls were plotted onto the modelled distribution of bottom-time foraging effort of ASL in MapInfo, to enable the value of the estimated ASL bottom-time foraging effort to be extracted for each observed net-haul, using the point-inspection feature in VerticalMapper[™]. Observer data were then sorted from least to most seal bottom-time foraging days, and then successive ranges in ASL foraging effort were examined in terms of the number of ASL bycatch mortalities and total fishing effort. Bycatch mortality rates for each successive range were then calculated in terms of net-set length (seals/km net-set) and net-set length x duration of soak-time duration (seals/km.hr net-set). Equations to estimate bycatch rate (the bycatch rate estimator) and to model the relationship between ASL foraging effort and the bycatch per unit of fishing effort were examined using linear regression.

Estimation of total bycatch

Bycatch was estimated using two approaches. The first approach multiplied the bycatch rates derived directly from the observer data by the total fishing effort to derive a simple approximation of total bycatch. The second approach estimated ASL bycatch by applying the bycatch rate estimator equations to the values of sea lion foraging effort and fishing effort for each 1km² cell, and then summing the total values for cells across the entire array.

The foraging distribution models of adult females, adult males and juveniles enable the total foraging effort at each node to be apportioned by sex and subpopulation. From this it was possible to estimate the total female and male bycatch, and to estimate it for each subpopulation. Based on the ASL life table, and the number and foraging days of juveniles seals, total female bycatch at any node was calculated as the total adult female bycatch + (0.414108 x total juvenile bycatch); and total male bycatch as the total adult male bycatch + (0.585892 x total juvenile bycatch).

Estimating impacts of sea lion bycatch on subpopulations

Leslie matrix and population model development

McIntosh's (2007) 'Good' Leslie matrix for the Seal Bay subpopulation was used as the basis to model changes in the abundance of all South Australian ASL subpopulations through time, using the RAMAS[®] Metapop software (Version 3.0, Applied Biomathematics, Setauket, New York; Akçakaya and Root 1998). Only the female part of subpopulations was modelled, and therefore pup production was halved (assuming 1:1 sex-ratio at birth). For each subpopulation being modelled, initial population abundances were set so that the estimated numbers in the first stage (pups) equalled half of the estimated pup production for that subpopulation (Table 7.1). Final stage survival rates were set to zero, and a standard deviation of 0.01 set for all stage survival and fecundity estimates to provide a measure of environmental stochasticity (Akçakaya 1998). Age-specific fecundity is poorly understood in ASL, and the estimates of McIntosh (2007) used in the model were based on estimates derived from the limited data from ASL, together with estimates from other otariid seals (Higgins & Gass 1993, Goldsworthy et al. 2003, Goldsworthy & Page 2007).

Population viability analysis (PVA)

Density-independent population viability analyses (PVAs) were used to investigate the potential impacts of different levels of bycatch on ASL subpopulations. The justification for using density-independent models is that populations of ASL are believed to be well below their carrying capacity following significant range and population reductions, and incomplete recovery from historic sealing (Gales et al. 1994, Ling 1999, Goldsworthy et al. 2003, Goldsworthy et al. 2009a). Furthermore, as pre-sealing or carrying capacity population estimates are unavailable, it is unclear at what population threshold each density-dependent factor would become more significant. Given the largest ASL subpopulation at Dangerous Reef (more than twice the size of any other subpopulation) is currently increasing at about 5% per breeding season, and that most subpopulations are comparatively small, we believe present density levels would not elicit a significant feedback on a subpopulation's vital rates, although there is evidence for density dependence in pup mortality in some subpopulations (Ling 1999, Campbell 2005). Allee effects (where there is a positive relationship between aspects of fitness and population size) may be important in inhibiting the recovery of reduced subpopulations (Stephens & Sutherland 1999), but due to limited data on ASL and other pinnipeds, we have chosen to exclude them from subpopulation modelling.

Individual subpopulations were modelled separately, and assumed to be closed (i.e., no immigration or emigration). For ASL, there is good evidence to support this assumption, with population genetic data indicating that the species demonstrates one of the highest levels of population subdivision among pinnipeds, with very high levels of mtDNA haplotype fixation among subpopulations (Campbell 2003, Campbell et al. 2008c). These findings suggest that ASL females display extreme levels of philopatry, with little or no interchange of females among breeding colonies. Demographic stochasticity was simulated within RAMAS[®] Metapop, by sampling the number of survivors from a binomial distribution and young from a Poisson distribution (Akçakaya 1998).

PVA was used to investigate the potential implication of additional bycatch mortality on the status of each subpopulation. This was achieved by applying virtual harvests of female seals and determining the level of additional mortality required to increase the risk of extinction. Conditional harvests within the population management feature of RAMAS[®] Metapop were used to simulate the impacts of different levels of fishery bycatch, defined as the proportion of the total number of females >1.5 years of age in a subpopulation removed per breeding season (1.458 years). Conditional harvests select only whole (integer) animals and select them from across all stages (>1.5years) relative to their abundance within the subpopulation at the beginning of each modelled time step.

As the underlying rates of intrinsic growth are unknown for most ASL subpopulations, the implications of different bycatch rates were estimated for three intrinsic growth rates: stable, medium and high (0%, 2.5% and 5% per breeding season, respectively). In the absence of any anthropogenic mortality, the minimum growth of subpopulations was assumed to be stable (0% growth per breeding season). The high growth (5% per breeding season) approximates the growth rate observed in the Dangerous Reef ASL subpopulation, the only one known to be increasing (Goldsworthy et al. 2009b). Medium growth was set midway between stable and high growth. As abundance trends using the 'Good' Seal Bay Leslie matrix describe a declining population (McIntosh 2007), the different population growth models were simulated by adjusting relative survival levels and then calculating the resultant population trajectory (500 replicates of 100 stages, or 145.8 years). Relative survival

multipliers of 1.0026, 1.0331 and 1.0666 were used to simulate stable, medium and high population trajectories, respectively.

PVA provides a means to predict future population abundances, the time to extinction (or a prescribed level of reduced abundance) and the probability of extinction or reaching an abundance threshold within a specified period. These are usually undertaken using stochastic simulation models (Shaffer 1981, Gilpin & Soulé 1986, Reed et al. 2002). Two measures of risk were calculated, terminal extinction risk (TER - the probability that a population will go extinct during a specified time period) and *guasi-extinction time* (QET- the time for the median of the simulated population trajectory replicates to go quasi-extinct) (Akcakaya 1998). TER was calculated as the probability that a subpopulation will go extinct over a period of 100 stages (breeding seasons) or 145.8 years. We defined quasi-extinction as occurring when the number of females in a subpopulation fell to, or below a threshold of 10, which equates to a female pup production of 2 and total pup production of 4. This value was set as it represents the change in the classification of a breeding site from 'breeding colony' (minimum of 5 pups) to a 'haul-out site with occasional pupping' (1-4 pups born), based on guidelines developed in March 2004 by the National Seal Strategy Group (NSSG) (National-Seal-Strategy-Group & Stewardson 2007). In this study, no distinction is made between a 'breeding colony' and a 'haul-out site with occasional pupping'. Because there is evidence that ASL population levels have been reduced by a combination of indiscriminate harvesting following the arrival of Europeans and, more recently by fishery interactions, we believe that many of sites where pups have been recorded may have been larger in the past.

Non-pup stages were excluded from population totals at each time step to provide a time-series of estimated pup production for each simulation, because pup production is the principal metric used to estimate the status and trends in abundance of ASL populations. As a further measure of risk to subpopulations, the trajectory of pup production was calculated over the first 20 breeding cycles. These were expressed as the exponential rate of increase (*r*), calculated from the slope of the exponential regression of pup numbers over time (breeding cycles); it was expressed as a percentage using the formula ($e^r - 1$) x 100.

For species with overlapping generations, generation time is defined as the mean age of mothers of all newborn females, assuming a stable distribution, i.e., the mean interval between the birth of a mother and the birth of her offspring, weighted by the
proportion of individuals in each age class (Caughley 1977). Generation time for ASL was calculated using the 'Good' Seal Bay Leslie matrix in PopTools (Version 2.7.5) (Hood 2006); it resulted in a generation time of 7.6 breeding cycles or 11.1 years.

Results

Population distribution and abundance

The distribution of ASL subpopulations and their estimated pup production are presented in Figure 3.1 and Table 7.1. There are 48 known breeding sites (subpopulations) in South Australia, ranging from near the WA-SA border in the west to The Pages Islands just east of Kangaroo Island. Pup production per breeding cycle ranges from 1 to 709 in the smallest and largest (Dangerous Reef) sites. Most subpopulations are very small, with the majority (52%) producing fewer than 25 pups, and 27% produce fewer than 10 pups. Only eight (17%) subpopulations produce more than 100 pups: Dangerous Reef, South Page Is, North Page Is, Seal Bay, Olive Is, West Waldegrave Is, Purdie Is, Lewis Is (Table 7.1, Figure 3.1).

Total pup production in South Australia per breeding cycle is estimated to be 3,107, with 70% of it in the eight large subpopulations that produce >100 pups. The remaining 30% of pup production is spread amongst the other 40 (83%) breeding sites (Table 7.1). Overall mean pup production in South Australian subpopulations is 64.7 (sd = 121.0), with a median of 20.5.

Based on the life table used for this study, the total South Australian ASL population size is 11,903 individuals, of which 6,634 are female (55.7%) and 5,269 are male (44.3%)(Table 7.2). Based on this, the multiplier of pup production to obtain total population size is 3.83.

Models describing the distribution of ASL foraging effort

The distribution of the raw satellite tracking data, the speed-filtered corrected tracks and the calculated time-spent in area distributions for 157 adult females, 31 adult males and 22 juvenile ASL are presented in Figures 7.3 -7.5. Details of the parameters of the normal and gamma probability density functions used to model the distributions of foraging effort of adult females, adult males and juveniles are presented in Table 7.6, and examples of some of the density distributions of time spent at distance and depth are presented in Figures 7.6 and 7.7. The particular models used for adult females, adult males and juveniles for each subpopulation are presented in Table 7.7, together with the distance and depth limits where model outputs were truncated. Reasons for this choice of models follows.

Due to smaller tracking datasets for juvenile ASLs, a single juvenile model was used to describe their foraging distribution for all subpopulations (Table 7.7). For adult males, three models were developed and used (referred to as West, Gulf and KI). Subpopulations where they were applied are shown in Table 7.7.

Because of the larger data set for adult females, several subpopulation and regionspecific models could be utilised. Colony specific female models were used to estimate the distribution of foraging effort of adult females at Purdie Is, West Is, Lounds Is, Breakwater Reef, Blefuscu Is, Lilliput Is, Olive Is, Waldegrave Is, Liguanea Is, Dangerous Reef, Seal Bay and Seal Slide (Table 7.7). For the Bunda Cliffs region, the model for subpopulation B8 was used to model the distribution of foraging effort of adult females in the four western-most subpopulations (B6-B9), while the B5 model was used for the five eastern subpopulations (B1-B5, Table 7.7).

Adult females from South Page Island displayed two types of foraging behaviour: for some females foraging was focused north-west of the island within Backstairs Passage north of Kangaroo Island, while others foraged south of the island in mid-outer shelf waters (see Figure 7.3 and Hamer et al. 2007). Consequently, an inshore and offshore model were used for both South Page and North Page Islands. As the numbers of individual females undertaking inshore or offshore foraging within each of these subpopulations is presently unknown, equal weighting was given to both models (i.e. 50% of the foraging effort apportioned to each model).

Gliddon Reef is less than 5km from Breakwater Is and hence the Breakwater model was applied to females there (Table 7.7). The Liguanea model was applied to other subpopulations between southern Spencer Gulf and western Kangaroo Island (Four Hummocks Is, Price, East Is, South Neptune Is and Casuarina Is) which are close to the 100m depth contour. The Dangerous Reef model was used to estimate the distribution of foraging effort of females for other subpopulations in southern Spencer Gulf, including English Is, Lewis Is, North Islet, and Peaked Rocks (Table 7.7). The

Seal Bay model was applied to other subpopulations on Kangaroo Is west and just east of Seal Bay, including Cape Bouguer, Cave Point and Black Point (Table 7.7). For adult females of all other subpopulations, the 'All female' model was used (Table 7.7).

Raw data showing the relationship between maximum dive depth and proportion of bottom-time for adult females and males is presented in Figure 7.8. Generalised linear mixed-effects models (GLMMs) of complementary log-log transformed data (proportion bottom-time) indicated that for both females and males, the effect of individual seal (random effects) on proportion of bottom-time was significant, and examination of individual seal data indicated this was due to differences in their preferred depth range. The fixed effects models for females and males indicated that proportion of bottom-time decreased with depth (Figure 7.8). The model functions for females and males to estimate proportion of bottom-time with depth are included in Figure 7.8. As no dive data were available for juveniles, we have assumed the relationship of proportion bottom-time with depth is the same as for adult females. These functions were applied to the foraging distribution models to estimate bottom-time foraging effort.

The final models of the estimated distribution of the bottom-time foraging effort and core foraging areas of adult females, adult males and juveniles are presented in Figures 7.9-7.14. The overall model of all the foraging distribution of all ASL in South Australia is presented in Figure 7.15. A contour plot of the minimum foraging distance from subpopulations is presented in Figure 7.16.

Distribution of fishing effort and catch, and overlap with ASL foraging effort

Summaries of the total fishing effort in the gillnet component of the gillnet sector of the GHAT fishery off South Australia between 1 January 2006 and 25 July 2009 (3.56 years) are presented in Table 7.8. Based on these data, the mean annual fishing effort over 3.56 years represents 4,959 net-sets (range 4,467-5,612), 17,823 km of net-set length (range 16,549-20,401) and 105,452 km.hrs (range 98,785-120,934). Length of net-sets ranged between 1.0 and 6.2 km, with the most common lengths being 4.2 km (67.3%), 1.8 km (17.5%), 3.5 km (4.3%) and 2.4 km (3.8%, Figure 7.17). The duration of net-sets (soak-time) averaged 5.9 hrs (sd = 2.6, range 0-23.8, Figure 7.17). The combination of the length and duration of net-sets provides

a fishing effort metric in km.hrs, shown in Figure 7.17, which averaged 21.3 km.hrs (sd = 11.5, range 0.3-102.0) per net-set.

Catch data for the target species (gummy shark) were available for the 2006-2008 calendar years; catches averaged 473,302 kg (range 419,316-509,952), and mean catch per unit effort (CPUE) was 26.2 kg/km and 4.4 kg/km.hr (Table 7.8).

The spatial distribution of fishing effort in terms of net-set (km and km.hr), CPUE (kg/km and kg/km.hr) and core CPUE (kg/km and kg/km.hr) are presented in Figures 7.18 and 7.19, respectively. These figures identify the regions east and south of Kangaroo Island and the near coastal waters along the south and west Eyre Peninsula as key concentrations of effort and high CPUE. Comparisons of fishing effort, catch and CPUE for five geographic regions (East KI, South KI, North KI, Eyre Peninsula and GAB) are presented in Table 7.9. 45% of the fishing effort and 44% of the gummy shark catch occurs south and east of Kangaroo Island. Similarly, 47% of the effort and 45% of catch occur in the southern and western Eyre Peninsula, between Kangaroo Island and Pt Fowler (Table 7.9).

Comparison of the distribution of fishing effort (km.hrs) and the foraging effort of adult female, adult male and juvenile ASLs relative to depth and the minimum distance from ASL subpopulation sites are presented in Figure 7.20. Areas east of 139° longitude were excluded from analyses as there are no ASL subpopulations there. Comparisons indicate complete overlap in fishing and ASL foraging effort for all agesex groups in both the depth range and distance from subpopulation sites.

The extent of overlap in fishing effort and CPUE of gummy shark with the core foraging areas of female ASL is presented in Figure 7.21. For areas west of 139° longitude that constitute the majority of ASL foraging range within South Australia, almost all (>99%) of the fishing effort and CPUE occur within the entire estimated range of female foraging effort. Although the peaks in fishing effort within the 20-30% core foraging area corresponded to a peak in CPUE, the peak in effort at 90-100% core foraging area did not (Figure 7.21).

General Linear Modelling of CPUE (kg/km.hr) indicated a high correlation between fishing effort and depth, female foraging effort and core female habitat ($F_{1,3}$ = 38.204, P< 0.001, r² = 0.006). Although the variance explained by this model was low, the coefficients for female foraging effort were positive, while those for depth and core female habitat were negative, suggesting that CPUE tended to be highest in shallower waters, associated with higher female foraging effort and their minimum core habitat.

Bycatch rates

Observed bycatch rates

Observer data was collected over 146 sea days on ten trips (Table 7.10). A total of 994 km and 5,794 km.hrs of net was observed hauled during 234 shots, which equated to 2.4% of all gillnet fishing effort over the 24 month period. Twelve ASL bycatch mortalities were recorded. Ten (83%) of the 12 ASL bycatch mortalities dropped-out of the gillnet before or on making contact with the net roller, as they ascended from the water. The two (17%) ASL that made it onto the deck of the vessel were small juveniles (one female, one male). Eight of ten ASL that dropped out of the gillnet were able to be sexed based on their size and colouration. Of the ten that were sexed, nine were female and one was male. The overall bycatch mortality rates based on the pooled observer data equated to 0.0513 seals/net-set; 0.0127 seals/km and 0.0021 seals/km.hr (Table 7.10).

Bycatch rate estimating method

The foraging effort of Australian sea lions (seal days/yr) at the latitude and longitude positions of 234 independently observed net-sets was estimated using the modelled distribution of bottom-time foraging effort of the ASL population in South Australia (Figure 7.22). Because of the small sample of observed net-sets and sea lion bycatch mortalities (12 individuals) and the large variation in bottom-time foraging effort (0-43 d), individual observed net-sets were sorted based on the estimated annual bottom-time foraging effort at their location, and divided into successive groups (bins) of increasing bottom-time foraging effort. Six models were compared with bin size ranging from three to eight (Table 7.11). The sample size (number of net-sets observed) within each bin was approximately equal for each model (Table 7.11). Within each bin the number of seal bycatch mortalities, and the total fishing effort observed (expressed as km and km.hrs) were calculated. From these, two bycatch-rates were calculated for each bin within each model as a function of fishing effort (seals/km and seals/km.hr, Table 7.11). As there were fewer observed net-sets

in regions of higher bottom-time foraging effort, the net sets observed (in km and km.hrs) decreased with increasing bottom-time foraging effort (Table 7.11).

The above approach sought to maintain equal sample sizes of bins, irrespective of the range in foraging effort within them. An alternative approach that sought a balance between the sample size and foraging range within bins was also examined. We term these two approaches the *equal sample size approach* and the *trade-off approach*. The best model based on the trade-off approach was a 6-bin model (Table 7.12).

Bycatch rate (as seals/km and seals/km.hr net-set) was significantly related to the underlying likelihood of encountering sea lions (bottom-time foraging effort) for all models (Tables 7.11, 7.12; Figures 7.23 - 7.25). Within the bottom-time foraging effort range, the relationship with bycatch rate (seals/km and seals/km.hr) was linear and there was support for models with regression lines passing through the origin (Figure 7.23 - 7.25). This enabled the slopes of all models to be easily compared (Table 7.13).

Bycatch rate estimation equations for the mean and \pm 95% CL took the following form:

$$B_r = A \times btfe \times FE$$
,

where B_r is the bycatch rate (expressed in either km or km.hrs), A is the slope coefficient, *btfe* is sea lion bottom-time foraging effort (seal days/yr) and *FE* is fishing effort (expressed in either km or km.hrs net-set).

Equal sample size approach

Using the equal sample size approach, the slopes of all models were similar (Table 7.11). As such, bycatch rate estimator equations (as a function of km and km.hrs fishing effort) were calculated as the mean of all slopes, with the range of estimates set as the minimum and maximum of the 95% CL calculated for all six models (Table 7.11). The statistical strength of these relationships supports the use of the regression equations to estimate the likely level of sea lion bycatch that would result from any level of fishing effort from any given region.

The 1 x 1 km array of ASL foraging effort contained 258,235 nodes, with bottom-time foraging effort in the nodes ranging from 0-712 seal days/year. Although the bottom-time foraging effort at the locations of the 234 net-sets observed ranged from 0-43 seal days/year, only 0.5% of the ASL foraging effort nodes had values >43 seal days/yr. As no data are available to determine if the rates of sea lion bycatch per unit of fishing effort are the same as those described above in regions with higher (>43 seal days/yr) bottom-time foraging effort, we set the upper limit of the means and \pm 95% CL to that for 43 seal days/yr. As such, where ASL foraging effort exceeded 43 seals days/yr, the bycatch rates were fixed at: 0.138687 seals/km (\pm 95% CL 0.096480 and 0.207768, respectively), and 0.021979 seals/km.hr ((\pm 95% CL 0.016287 and 0.029753, respectively). This approximation will likely under-estimate the bycatch mortality rate in areas of very high fishing effort.

Trade-off approach

The bin structure and the sample sizes for the best model using the trade-off approach are presented in Table 7.12, with linear models and box-plots of the bin structure presented in Figure 7.25. The linear models produced very similar slope coefficients to those in the equal sample size approach, even when the last data point with the highest foraging effort was excluded (Table 7.13, Figure 7.25). As for models using the equal sample size approach, where ASL foraging effort exceeded 43 seals days/yr, the bycatch rates were fixed at: 0.168302 seals/km (±95% CL 0.139930 and 0.196671, respectively), and 0.023203 seals/km.hr (±95% CL 0.021878 and 0.024527, respectively).

Total ASL bycatch mortality in SA

Three estimates of ASL bycatch mortality for all of SA are presented. The first is based on observer bycatch rates, the second and third are based on bycatch rate estimation following the equal sample size and trade-off approaches. Each of these estimates is calculated using two measures of fishing effort, net length (km) and net-length x soak time (km.hrs). Bycatch estimates are given for the total 3.56 year period over which latitude and longitude reporting of effort was available to this study (January 2006-July 2009), as well as averages on an annual and per ASL breeding cycle (17.5 month) basis.

Observed bycatch rates

Based on the observed ASL bycatch rates (Table 7.10), the estimated number of bycatch mortalities in SA shelf waters over the 3.56 year period, annually and per breeding cycle are 807, 226 and 330, respectively, based on km net-sets; based on km.hr net-sets they are 778, 218 and 318, respectively, (Table 7.14).

Bycatch rate estimation- equal sample size approach

Bycatch estimates using the bycatch rate estimation – equal sample size approach for both km and km.hr fishing effort measures are presented in Table 7.14. Estimates of total bycatch were about 7.6% higher using km compared to km.hr measures of fishing effort. Estimates of the bycatch of females and males were 7.3% and 7.8% higher, respectively, using the net length (km) measure of fishing effort. The range between lower and upper 95% CL (i.e., the confidence interval) was 1.4 times higher using km net-sets, compared to the km.hr measures of fishing effort (Table 7.14). Because of the large variance in net-soak time, the km.hr measure of fishing effort is considered the most appropriate for enumerating bycatch mortality in this fishery. However, using km of net-set still provides a valid approximation where soak time data are not available (e.g. if applied to historic fishing effort data).

Based on the km.hr measures of fishing effort, 914 (665-1237 ±95% CL) ASL bycatch mortalities are estimated to have occurred in the fishery over the 3.56 year period between January 2006 and July 2009 (Table 7.14). This represents an estimated annual bycatch mortality of 256 (187-347 ±95% CL) ASL, or a perbreeding cycle bycatch mortality of 374 (272-506 ±95% CL) (Table 7.14). Female ASL accounted for 52.6% of the total estimated bycatch mortality, with an estimated 197 (142-266, ±95% CL) bycatch mortalities per breeding cycle. This represents about 3.9% (2.8-5.2%, ±95% CL) of the total SA ASL female population older than 1.5 years each breeding cycle. The natural mortality rates of females >1.5 yrs per breeding cycle based on stable, medium and high of intrinsic population growth, is 10.9%, 9.0% and 7.4%, respectively (Table 7.15). With the addition of the estimated level of female bycatch mortality, these rates increase to 14.7%, 12.2% and 9.9%, respectively (Table 7.15). Thus, the estimated level of juvenile and adult female bycatch mortality represents about a 35% (mean range 33.4-35.7%) increase above natural mortality levels (Table 7.15).

Bycatch rate estimation - trade-off approach

Bycatch estimates using the bycatch rate estimation with the trade-off approach were about 5% greater than those derived from the equal sample size approach (Table 7.14). A histogram of the distribution of bycatch mortalities relative to foraging effort is presented in Figure 7.21. This demonstrates that most (88%) of the bycatch mortality occurs within a foraging effort of 0-20 seal days/per year bottom time, with 70% occurring between 0-10 seal days/year (Figure 7.25). The limited observer coverage in high ASL foraging areas, where most of the bycatch mortalities were recorded, could potentially lead to a bias in linear models; with strong leverage effects from the outer-most data point (see Figures 7.24, 7.25). To examine the potential of this, the 6th bin in the model was omitted and a new linear model developed with the remaining five data points (Figure 7.25). This removed 18 (7.7%) observed net-sets with the highest foraging efforts and 5 (42%) of the 12 observed bycatch mortalities. From the coefficients of the slopes and ±95% CL of this linear model (Figure 7.25), a new bycatch mortality estimate of 365 (319-407) total ASL, comprising 192 (167-214) females and 173 (150-193) males per breeding cycle was estimated. These estimates are 8% less than those derived from the model with the 6th bin included, and only 2% less than those estimates derived using the equal sample size approach. Importantly, 78% of the estimated bycatch mortality occurs within the foraging effort range (0-13 seal days/year) of the reduced model, and demonstrates that the bycatch mortalities recorded in the higher foraging effort areas are not unduly biasing the well supported relationship between bycatch rate and sea lion foraging density.

The small observer sample size and the uneven distribution of observations across the ASL foraging effort distribution, create significant analytical challenges. The trade-off approach method partly addresses these issues by balancing the variance in sample size and the range in bottom-time foraging effort values within bins. Its main disadvantage is that it likely under-estimates the variability of the relationship between mortality rates per unit of fishing and ASL foraging effort. The advantage of the equal sample size approach is that it provides a range of alternate regression models that better capture the real variance in the relationship between mortality rates per unit of fishing and ASL foraging effort. For this reason, the equal sample size approach method is used as the principal means to estimate ASL bycatch numbers, and in PVA and closure option assessments.

Subpopulation bycatch mortality

The estimated breakdown of ASL bycatch mortality for each subpopulation per breeding cycle is presented in Table 7.16. For each subpopulation, the estimated number of male and female ASL taken as bycatch is presented, as well as the percentage of females >1.5 years. The eight major subpopulations that produce >100 pups per breeding cycle and account for 70.3% of the total pup production of the ASL population in South Australia, accounted for most of the estimated bycatch mortality (70.7% in total, 69.7% females, 71.8% males). For these subpopulations, the estimated percentage of females taken as bycatch per breeding cycle averaged 4.5% and ranged from 0% (Dangerous Reef, where there was no fishing effort) to 8.3% (Seal Bay, ±95% CL, 6.0-11.3%) (Table 7.16, Figure 7.26). For subpopulations producing 25 or fewer pups per breeding cycle, which make up 54% of ASL subpopulations in South Australia, the per breeding cycle percentage of females taken as bycatch averaged 4.8% and ranged from 0.5% (Gliddon Reef, ±95% CL 0.3-0.6) to 12.8% (Price Is, ±95% CL, 9.2-17.3%) (Table 7.16, Figure 7.26). Across all subpopulations, an average of 4.3% (3.1-5.9%, ±95% CL) of the total female population (older than 1.5 years), are estimated to be taken as bycatch per breeding cycle (Table 7.16).

Nineteen (39.5%) subpopulations are estimated to have < 2% females older than 1.5 years taken as bycatch per breeding cycle, nine (18.8%) subpopulations have 2% to 5% females taken and another 20 (41.7%) of subpopulations have >5% females taken as bycatch per breeding cycle (Figure 7.27).

Impact of bycatch on subpopulations

Population Viability Analyses (PVAs) were examined under three different scenarios of intrinsic growth: stable, medium and high growth (0%, 2.5% and 5% per breeding season, respectively)(Figures 7.28-7.31, Tables 7.17-7.19). The terminal extinction risks (TER) of ASL subpopulations based on the estimated level of bycatch mortalities under the three growth scenarios are presented in Table 7.17 and Figure 7.28. The extent of TER attributable to subpopulation size alone, relative to that attributable to bycatch mortality for the three growth scenarios is presented in Figure 7.29 (A-C). Under a stable growth scenario in the absence of fishery bycatch mortality, 50% of subpopulations are estimated to have greater than a 10% probability of extinction within 100 breeding cycles (Figure 7.28, 7.29, Table 7.17,

7.20). With the addition of the current estimated bycatch mortality, 77% (73-81% \pm 95% CL) are estimated to have greater than a 10% probability of extinction within 100 breeding cycles (Figure 7.28, 7.29, Table 7.17, 7.20).

Under either increasing growth scenario (medium and high) and in the absence of bycatch mortality, none of the subpopulations have a TER >10% within 100 breeding cycles. But with the addition of the current estimated bycatch mortality, 40% (31-48% \pm 95% CL) and 31% (19-38% \pm 95% CL) have a TER greater than 10% over the next 100 breeding cycles (Figure 7.29, Tables 7.17, 7.20). Based on these assessments, subpopulations adjacent to regions of higher fishing effort, especially off western and southern Eyre Peninsula, and in the Kangaroo Island region, appear most vulnerable to extinction (Table 7.17, Figures 7.28, 7.29).

In the absence of fishery bycatch mortality, 65%, 60% and 58% (with stable, medium and high growth, respectively) of ASL subpopulations in South Australia are estimated to fall below the quasi-extinction threshold (QET) of <5 pups within 33 years (~3 generations) (Tables 7.18, 7.20). With the addition of the current estimated fishery bycatch mortality, the percentage of subpopulations expected to decline to below a pup production of 5 within 33 years is 81%, 69% and 63% under the three growth scenarios, respectively (Figure 7.30, Tables 7.18, 7.20). The QET of individual subpopulations both reflect their present pup production and the rate of subpopulation decline expected based on the extent of fishery bycatch mortality (Figure 7.26).

In these analyses with the absence of fishery bycatch mortality, none of the ASL subpopulations will have negative growth because intrinsic growth rates have been fixed at either stable (0%), medium (2.5%) or high (5%) growth. Based on the present distribution of fishing effort and estimated bycatch mortality, 96%, 50% and 42% of subpopulations are estimated to decline over the next 20 breeding cycles (~29 years) under the three growth scenarios, respectively (Tables 7.19, 7.20). The rates of decline vary among subpopulations, with those off the western and southern Eyre Peninsula and in the Kangaroo Island region expected to have the greatest rates of decline (Figure 7.31).

Discussion

Assessment of extent of ASL bycatch and its implication

This report has endeavoured to provide the most thorough assessment possible of the extent and impacts of bycatch mortality of Australian sea lions (ASL) in the gillnet sector of the GHAT fishery off South Australia. This has been done by providing extensive analyses and modelling of three primary data sets: i) all of the available satellite tracking data for the species in South Australia to provide the best estimation of the distribution of foraging effort; ii) data from a dedicated sea lion bycatch observer program in the gillnet sector of the GHAT fishery; and iii) detailed spatial data on the distribution of fishing effort from January 2006 to July 2009. Bycatch mortality rates based on observer data were highly correlated with estimated sea lion bottom-time foraging density, enabling overall levels of bycatch mortality to be estimated (with confidence limits). These estimates, when used in conjunction with population viability analyses, have provided the first quantitative assessment of the risks to ASL subpopulations from bycatch mortality in the gillnet sector of the GHAT fishery off South Australia.

Spatial analyses indicate almost complete overlap between the distributions of ASL foraging and gillnet GHAT fishing effort (Figure 7.20). In particular, almost all of the present fishing effort occurs within the depth and distance limits of foraging adult female ASL, with most of the fishing effort and areas of greatest CPUE occurring within their top 50% core foraging areas (Figure 7.21). The only subpopulations where overlap is likely to be low are in southern Spencer Gulf. Adult females and juveniles from the Dangerous Reef and English Island subpopulations are the only age/sex classes of ASL where interactions with the fishery are likely to be negligible. Males from these subpopulations would interact with the fishery when foraging outside of Gulf waters. Other subpopulations in lower Spencer Gulf located near the boundary of Internal State Waters and the gillnet GHAT fishery (Lewis Is, Albatross Is, North Islet, Peaked Rocks) may also have reduced interactions, depending on the extent of their foraging effort beyond Internal State Waters. Existing net-closures in the fishery in the Nuyts Archipelago (Murat Bay Schedule 1 – SESSF Fishery Closures Directions 2008) and in Backstairs Passage (Schedule 10 - SESSF Fishery Closures Directions 2008) are likely to afford parts of these subpopulations some protection, especially those animals foraging in inshore or shallow waters.

The several methods used to estimate ASL bycatch all produced similar results.

- 318 ASL (per breeding cycle) based on the simple multiplication of observed bycatch rates with total fishing effort,
- 374 (272-506 ±95%CL) based on the equal sample size approach bycatch rate estimation method,
- 395 (366-417 ±95%CL) based on the trade-off approach bycatch rate estimation method, and
- 365 (319-407 ±95%CL), based on the reduced model.

The confidence limits based on the preferred model (equal sample size approach) encompasses all other estimates. The benefit in using the bycatch rate estimation method developed here is that bycatch numbers are estimated based on the spatial distribution of fishing effort, not on observed rates of bycatch. Observed rates of bycatch are dependent on the level and distribution of fishing effort observed. Estimates based on this approach assume bycatch rates are constant irrespective of the underlying sea lion foraging density, and may include fishing effort in areas where sea lions may not occur.

Based on the current distribution of fishing effort and using bycatch rate estimation, this study has estimated that 374 (272-506, \pm 95%CL) ASL bycatch mortalities occur off South Australia each breeding cycle (17.5 months). A little over half (52.6%) of these 197 (142-266, \pm 95%CL) are females. Based on this, it is estimated that 3.9% (2.8-5.2%, \pm 95%CL) of all females in the SA population older than 1.5 years are removed as bycatch mortality each breeding cycle. This represents about a 35% increase over natural mortality levels. Most bycatch mortalities are from the largest subpopulations. However, the per subpopulation percentage of females removed to larger ones. The percentage of females removed as bycatch mortality in subpopulations per breeding cycle ranged from 0 to 12.8%.

The estimated impact of this level of bycatch mortality varied considerably among subpopulations depending on their foraging distributions and their proximity to fishing effort. In the absence of fishing bycatch mortality, the risk of subpopulation extinction is directly related to the size of the subpopulations. However, because of the heterogeneous distribution of fishing effort and ASL foraging effort off South Australia, the extent of impact from bycatch varied considerably among subpopulations. As such, size of subpopulation was not necessarily a good predictor of its extinction risk. With respect to bycatch vulnerability, SA subpopulations of ASL can be broadly categorised into three groups.

The *highly vulnerable* group includes subpopulations in close proximity to the higher effort regions in the fishery, along western and southern Eyre Peninsula (Streaky Bay to the Neptune Islands) and in the Kangaroo Island region. For all these subpopulations, based on the current distribution of fishing effort, subpopulation growth rates are estimated to be negative or close to zero, with high terminal extinction risks (TER), even under the most optimistic intrinsic growth-rate scenarios. These subpopulations include from west to east: Olive Is, Nicolas Baudin Is, Pt Labatt, Jones Is, Dorothee Is, Pearson Is, Ward Is, Waldegrave Is, Four Hummock Is, Rocky North Is, Price Is, Liguanea Is, East Is, South Neptune Is, North Casuarina Is, Cape Bouguer, Cave Pt, Seal Bay, Black Point, Seal Slide, South Page Is and North Page Is (Figure 7.32).

The *medium vulnerable* group includes subpopulations that are presently exposed to lower levels of fishing effort where growth rates may be negative or positive depending on the intrinsic growth-rate, and where terminal extinction rates are generally lower than 10%, except under the stable growth scenario. These subpopulations include from west to east: B9-B1, Nuyts Reef West, Nuyts Reef East, Pt Fowler, Purdie Is, West Is, Fenelon Is and Blefuscu Is (Figure 7.32). Also included is Albatross Is which is just within Internal State Waters in southern Spencer Gulf. Increases in the fishing effort near these subpopulations would increase their vulnerability to extinction.

The *least vulnerable* group includes subpopulations that are estimated to forage largely within areas closed to the fishery. These include those in Internal State Waters of lower Spencer Gulf (English Is, Dangerous Reef, Lewis Is, North Islet, Peaked Rocks), and some subpopulations in the Nuyts Archipelago (Murat Bay Schedule 1 – SESSF Fishery Closures Directions 2008) where the majority of female foraging effort is in inshore waters (Lounds Is, Breakwater Is, Gliddon Reef, Lilliput Is) (Figure 7.32).

Overall, bycatch models and PVA suggest that between 42 and 96% of ASL subpopulations are presently in decline due to bycatch mortality, that most (65-81%)

subpopulations will decline to below 5 pups within 3 generations (i.e., in the next 33.3 years), and that between 31 and 77% of subpopulations will be extinct within 100 breeding cycles. These results indicate that the majority of ASL subpopulations in SA are presently exposed to unsustainable levels of bycatch mortality and, if current levels and distribution of fishing effort are not modified, further population declines, subpopulation extinctions and reductions in range are likely to occur. These findings are consistent with previous risk assessments of the potential impacts from historic and current bycatch mortality in the gillnet GHAT fishery (Goldsworthy & Page 2007) and of bycatch rates and projected impacts of gillnet fishing on ASL subpopulations in the Great Australian Bight Marine Park (Goldsworthy & Page 2007, Hamer et al. 2009).

Catch and effort records for this fishery in SA and adjacent Commonwealth waters extend back to 1973, although monofilament gillnet was not introduced into the shark fishery until 1964 (Kailola et al. 1993, Larcombe & McLoughlin 2007). In the 32 years between 1973 and 2004, effort in the fishery has totalled approximately 634,500 km net-sets, averaging about 20,000 km net-sets per year, with effort peaking in the late 1980s and early 1990s at about 43,000 km net-sets in 1987 (Goldsworthy et al. 2007a, Goldsworthy & Page 2007)(see Figure 3.4). Given historic levels of effort in the shark gillnet fishery, bycatch impact on ASL subpopulations has likely been substantial and is probably the most significant factor contributing to the sequential depletion (and possible extinction) and the lack of recovery of subpopulations across SA over the last 36 years. The extent of this impact is difficult to estimate, as it would require information on the size and distribution of subpopulations prior to the introduction of gillnetting. Such information is not available.

The independent observer data highlights a critical issue relating to reporting of sea lion interactions by fishers and by AFMA independent observers. There is a high drop-out rate for ASL bycatch in this fishery: ten (83%) of the 12 observed sea lion bycatch mortalities dropped out of the gillnet before reaching the deck. This may largely explain the low level of bycatch reported in industry log-books and more recently by AFMA observers. Based on our results, fewer than 20% of bycatch animals reach the deck of vessels. The size of ASL caught in gillnets is likely to be the main factor determining the likelihood of drop-out, as the two animals observed to reach the deck were small juveniles. Drop-out may not just be a factor when bycatch animals reach the surface. It is likely that some animals drop-out of gillnets below the surface during hauling operations, and would be undetectable to an observer on the

vessel. As such the bycatch models and estimates made here based on observer data may underestimate the actual level of ASL bycatch in the fishery. Clearly the issue of drop-out is critical to assessing both historic and current fishery dependent and independent (AFMA) reporting of ASL bycatch in this fishery. The sample size here (12 seals) is insufficient to adequately assess how drop-out impacts on observed rates of bycatch. Further research to assess the importance of seal size (mass), fishing operation (e.g. net tension, haul-speed), environmental (sea conditions) and other factors that contribute to drop-out are needed. This information would be very difficult to obtain and, as proxies for seals would have to be used in experiments, including replicating the entanglement pattern of bycatch seals, the validity of the outcomes might always be questionable.

Trend data are available for three ASL subpopulations (Seal Bay, Dangerous Reef and The Pages), although the time series for each of these is much shorter than the history of the fishery. Goldsworthy et al. (2007b) compared and contrasted the status and trends in abundance of ASL subpopulations at Dangerous Reef and Seal Bay. While the Dangerous Reef subpopulation has been increasing steadily since 2001 (Goldsworthy et al. 2009b), the Seal Bay subpopulation has declined by a least 12.6% between 1985 and 2002-03 (Shaughnessy et al. 2006), and currently is declining by about 3.3 to 4.5% per breeding season (McIntosh et al. 2006, Goldsworthy et al. 2008a).

At Dangerous Reef, the major period of increase in pup production coincided with gillnet fishing effort being reduced to almost zero, following management changes in the fishery in 2001 (Goldsworthy et al. 2007b). Although some SA Marine Scalefish large mesh (>15cm) gillneting continues, it has only averaged between 1-3 boat days effort annually between 2001-2007 (Goldsworthy et al. 2009a). Furthermore, there was a significant negative relationship between fishing effort and pup abundance at Dangerous Reef from 1994-95 to 2006-07 (Goldsworthy et al. 2007b). In contrast, over continental shelf waters south of Seal Bay where ASL forage (Fowler et al. 2006, 2007), and where gillnet GHAT fishing effort has remained relatively high, there is evidence for ongoing interactions and the subpopulation has been declining (Page et al. 2004, Shaughnessy et al. 2006, McIntosh 2007, Goldsworthy et al. 2008a). At present rates of decrease (3.3 to 4.5%), its population size is expected to halve over the next 24 to 32 years (McIntosh et al. 2006, Goldsworthy et al. 2008a). There is corroboration between these rates of decline and those estimated based on bycatch estimates for Seal Bay (~35 females per breeding cycle) for intrinsic growth

rates of between 2.5% (-5.3 (-8.1 to -3.1% \pm 95%CL) and 5% (-3.2 -6.1 to -0.9% \pm 95%CL) (see Table 7.17). This corroboration between observed and estimated rates of decline based on bycatch estimates and the underlying intrinsic growth is significant, because it suggests that if female bycatch was eliminated from this subpopulation, it should recover (i.e., maintain an intrinsic growth rate of >2.5% per breeding cycle).

At the Pages Islands (North and South Page combined), counts of live and dead pups are available for 13 seasons between 1986 and 2007. Pup numbers range from 381 to 607 and average 474 ± 67 , but there is no significant trend, which suggests that the subpopulations are stable (Shaughnessy & Goldsworthy 2007). Because the surveys are based on count data alone, their accuracy cannot be assessed. Recently developed methods of surveying pup production using markrecapture methods can provide estimates with confidence limits (Goldsworthy et al. 2008a, 2008b, 2009a, 2009b, 2009d). Tracking data available for adult females at South Page Island suggest that a large portion of the foraging effort of this subpopulation is directed into Backstairs Passage north of Kangaroo Island (Hamer et al. 2007). The introduction of the AFMA fisheries closure in Backstairs Passage in 2008 (Schedule 10 – SESSF Fishery Closures Directions 2008) is likely to provide some protection for adult females in this subpopulation, although the proportion of foraging effort in unprotected waters over the continental shelf is currently unknown. As such, part of this subpopulation (females foraging in protected inshore waters) may be undergoing recovery, while other parts (those foraging in offshore waters) may be in decline, and the current proportion of the subpopulation foraging in inshore and offshore waters may reflect their relative risk to bycatch.

The available trend and foraging data for ASL subpopulations suggest that vulnerability to bycatch mortality is tightly coupled to foraging distributions. Subpopulations and individual sea lions within them with foraging behaviours and distributions that closely match the distribution of fishing effort are likely to have been highly selected against over the 36+ years of the gillnet fishery. Based on estimates of bycatch mortality since 2006, this has likely inhibited recovery and caused significant declines in the size of some subpopulations, and the potential extinction of others. However, the high diversity of foraging behaviours observed both within and among subpopulations (Goldsworthy et al. 2009a, 2009d), may also have reduced the likelihood of extinction of many subpopulations, by ensuring that some individuals remain that have foraging behaviours and distributions that put them at lower risk of

bycatch mortality. This variability in the extent of bycatch selectivity of individuals and subpopulations fits the present distribution of abundance across the range of the species in South Australia. This distribution is typified by a small number of large subpopulations scattered amongst predominantly small, depleted subpopulations, and gives additional line of evidence that sequential depletion of subpopulations from bycatch mortality has significantly contributed to the present distribution of abundance of the species.

Study limitations

This study has compiled, synthesised and modelled a considerable amount of information on the size, demography and foraging ecology for South Australia's ASL subpopulations. The findings of this report should therefore be viewed within the context of the constraints and limitations of the data and analyses.

For ASL, although the relative size of subpopulations is generally understood, the quality of data on the pup production of different subpopulations is typically poor. There are a number of reasons for this (Shaughnessy et al. 2005, Goldsworthy et al. 2009a). Firstly, because of the species' asynchronous and non-annual breeding cycle, the timing of breeding is not well understood for most ASL subpopulations. Secondly, the species has a protracted (5-9 month) breeding season that means that by the end of the season, some pups will have died, moulted and/or dispersed, making it difficult to determine total pup production. Thirdly, pup production estimates (the only means of estimating subpopulation size) are typically based on the maximum number of live pups seen on single or multiple counts made during a breeding season, and where possible, cumulative numbers of dead pups are added to produce a final estimate. In the most recent surveys, alternate methods using mark-recapture techniques are being used where appropriate (McIntosh et al. 2006, Goldsworthy et al. 2007b, 2008a, 2009b, 2009c). These methods provide improved estimates of abundance with confidence limits. Finally, some subpopulations have not been surveyed more than once, and some have not been surveyed for more than a decade.

The demographic models used to estimate the size of ASL subpopulations were constructed based on limited data for the species. All the information on age-structure, survival and fecundity are from the Seal Bay subpopulation (Higgins 1990, Higgins & Gass 1993), which is presently in decline (Higgins 1990, Higgins & Gass

1993, Shaughnessy et al. 2006, McIntosh 2007, Goldsworthy et al. 2008a). The Dangerous Reef subpopulation, where bycatch mortality and other anthropogenic impacts are suspected to be having negligible effect on population growth, represents the only subpopulation where the underlying intrinsic growth rate can be estimated. For the other two subpopulations where population growth data are available (Seal Bay, The Pages Islands), bycatch mortality is likely to be impacting on the observed population growth rates, particularly Seal Bay, which is in decline (Shaughnessy et al. 2006, McIntosh 2007, Goldsworthy et al. 2008a). The underlying intrinsic growth rates for most of the subpopulations are unknown and, as such, there is a high degree of uncertainty in the extent to which bycatch mortality is impacting affected subpopulations and the total SA population, although its effect is likely to fall within the ranges estimated from our stable, medium and high growth scenarios.

For the majority (58%) of subpopulations that are very small (e.g., <30 pups), we recommend assuming a stable growth model (0% growth). The reasons for this are: a) there is presently no data to support the capacity for small subpopulations to recover; and b) recovery of these subpopulations will take a very long time. For example, assuming the most optimistic growth rates used in these analyses of 5% per breeding cycle and no additional bycatch mortality, a subpopulation would take between 20-30 years, to double in size. Furthermore, c) due to their size, small subpopulations are at greater risk from stochastic events and other threatening processes for a long period due to slow recovery; and d) Allee effects could exert additional pressures on the recovery of small subpopulations. These could include genetic inbreeding; difficulty in finding mates; and disruption of social structure, all of which could reduce the potential for small subpopulations to recover and hasten their extinction. Clearly, the small population paradigm is a key feature for managing the recovery of ASL populations, and until such time as quantitative data on the recovery potential of small subpopulations becomes available, we recommend that the recovery potential of small subpopulations is considered to be limited.

The demographic models used as part of the PVAs assumed density dependence processes are not a significant factor regulating the size of subpopulations. Although there may be some basis to this assumption (e.g., subpopulations are almost certainly well below their carrying capacity, the largest subpopulation having the highest known growth rate), it may be an important factor limiting the recovery of some subpopulations. Allee effects were not incorporated into demographic models, primarily because of their unknown role in regulating pinniped populations. The resultant models used were therefore relatively conservative (i.e., presenting more positive growth), because density dependence would reduce the rate at which subpopulations can grow, while Allee effects would tend to reduce the growth potential of small and declining subpopulations. The demographic uncertainties detailed above should be taken into account when interpreting the PVAs presented in this study, as there are often large uncertainties involved in predicting the probability of extinction of populations or species, especially of small populations (Taylor 1995, Ludwig 1999, Ellner et al. 2002). As such, we consider the estimates of growth rates, which have been projected over shorter time periods (20 breeding cycles), provide the most useful measure of the impact of current bycatch levels on subpopulations.

There are several important limitations to the models of the distribution of foraging effort. Firstly, the foraging effort and distribution of pups (ASL younger than 1.5 years) was not modelled, principally because there is large uncertainty in the amount of time they spend at sea and on-shore, and the relative distance pups travel at various developmental stages between birth and weaning. Available data indicate that pups are proficient swimmers by 6 months of age and may spend a considerable proportion of their time undertaking foraging trips between 6 and 18 months of age (Fowler et al. 2006). Not including pups in the foraging models underestimates the total ASL foraging effort, especially that in close proximity to subpopulations. If pups were included in the foraging models, estimates of ASL bycatch mortality would be higher.

Although this study utilised all of the available satellite telemetry data available for ASL in South Australia (210 individuals and over 100,000 satellite positions), the data set provided information from only 17 of 48 subpopulations and, for most of these, the sample size of adult females tracked was usually small (5-10 individuals). Furthermore, the subpopulation coverage and sample size was even less for juveniles and adult males. Although the data sets cover some individuals from most regions across the species' range in SA (Bunda Cliffs, Nuyts Archipelago, western and southern Eyre Peninsula, Spencer Gulf and Kangaroo Island), the representativeness of the tracks available for this analysis is unknown. Page et al. (2009), determined based on analyses of 34 females satellite-tracked at Dangerous Reef, that 52 foraging trips were required to be monitored in order to cover 95% of the foraging area used by an individual female at a 1 x1 km scale. Thirty-eight individual females were required to be tracked in order to describe 95% of the foraging space used by all females within the subpopulation. The number of individuals and the duration of deployments decreased with reduced scale (Page et al. 2009). The tracking of 38 individuals for 52 foraging trips each would be a substantial and costly tracking effort for one subpopulation, but indicates how variable foraging behaviour in this species can be, and the extent of tracking effort required to be confident of the representativeness of the data.

Tracking studies of ASL have identified marked diversity of foraging behaviours both within and among subpopulations. A key feature is the observed polymorphism in foraging behaviour among females at six subpopulations in the Nuyts Archipelago (Goldsworthy et al. 2009d), where two markedly different foraging ecotypes were identified, inshore and offshore. These foraging behaviours were highly correlated with the morphology (size) of individual sea lions. Similar diversity in foraging ecotypes has been observed at South Page Island (Hamer et al. 2007). This diversity of foraging behaviours has an important bearing on the foraging models developed; because we used a series of statistical models (i.e., used distributions to inform our outcomes) they are constrained by the limited data currently available for most sites. There is likely to be much more variation in foraging behaviours than we have currently measured. Furthermore, the ability of the overall model to describe the distribution of foraging effort at sites not tracked is unknown. Because the models only used depth and distance parameters (and not direction) it is likely that they identify many of the foraging distributions not presently tracked, although this could be tested in future tracking studies. Although distance and depth are clearly important in determining the distribution of foraging effort of individual ASL and subpopulations, it is likely that the distribution of foraging effort of individual ASL is more influenced by habitat features at much finer scales than we have measured or modelled. At present there is little information available on the actual foraging habitats that ASL are attracted to within their broader foraging areas, and this represents a significant knowledge gap that should be addressed.

Finer scale analyses using analytical methods such as individual based modelling, could be highly informative in identifying critical ASL foraging areas and habitats. Time-constraints prevented their application in this study, but they could provide a better means to estimate distribution of foraging effort, and should also be examined in future.

An additional limitation of the current foraging models is that they remain fixed, and do not change in response to changes in the size of subpopulations modelled using PVAs. In the current model, the relative proportions of ASL from different subpopulation at each node remained fixed through time, whereas in reality these proportions would change slightly from one time step to the next, in response to different subpopulation growth trajectories and bycatch mortality rates. In order to minimise the influence of these changes over time, we estimated growth rates over relatively short times series (20 time steps). A fully integrated spatial and temporal foraging, demographic and PVA model would need to be constructed in order to minimise these limitations, but was beyond the scope of this study. Such a model would be very complex, require many more parameters, and would be very unlikely to alter the conclusions reached in this study

Finally, the independent fishery observer data sets used in this study were restricted to the west coast of the Eyre Peninsula and the Great Australian Bight region. No observer data were collected from fishing undertaken south and south-east of Kangaroo Island, which is clearly an important part of the fishery in terms of effort and catch. However, given that the range of underlying seal foraging density in the areas where observer data were collected are representative of those values for >99% of the 1 km² cells across the fishery, we are confident that the relationship between bycatch rate and seal foraging density would be the same for regions where fishing effort was not observed. Nevertheless, better spatial representation in independent observer effort should be considered in the future.

Recommendations

This report has endeavoured to provide the best assessment of the extent and impacts of bycatch mortality of Australian sea lions (ASL) in the gillnet sector of the GHAT fishery off SA, by integrating and modelling: all of the available satellite tracking data to estimate distribution of foraging effort; the data from a dedicated ASL fishery bycatch observer program; and detailed spatial data on the distribution of fishing effort. Bycatch mortality rates based on observer data were highly correlated with ASL foraging density, enabling the levels of bycatch mortality to be estimated. In conjunction with population viability analyses, this project has provided the first quantitative assessment of the risks to ASL subpopulations from bycatch mortality in the gillnet GHAT fishery off South Australia.

This study has identified almost complete overlap in the foraging distribution of ASL and gillnet fishing effort, and high levels of bycatch mortality which are likely to be causing declines in most subpopulations and/or impeding the recovery of others. Present bycatch levels are unsustainable to the broader population. Based on estimated levels and distribution of bycatch, it is possible that the current distribution of abundance, characterised by large numbers of depleted subpopulations, largely reflects vulnerability to bycatch mortality and the distribution of fishing effort over the last 36 or so years.

If the likelihood of further subpopulations declines and potential extinctions is to be minimised, and the capacity for the species to recover enhanced, then management arrangements should seek to significantly reduce ASL bycatch mortality in the gillnet GHAT fishery as soon as possible. In order to achieve this, the principal goal for management arrangements should be to substantially reduce female bycatch mortality. Unless female bycatch is reduced to zero, some subpopulations are likely to be exposed to further declines.

A further concern relates to the potential impact of displaced fishing effort that may result from incomplete closures of female foraging areas. Such arrangements may result in increased fishing effort in some female ASL foraging areas and, as such, potentially lead to increases in female bycatch mortality and extinction risk to subpopulations. There is uncertainty relating to the impact that bycatch of males may have on the viability of individual subpopulations, or gene flow among subpopulations. However, we have assumed that the loss of some males may have limited impact on these factors, and will not limit pup production or the recovery of subpopulations.

There are legislative requirements under the EPBC Act to manage fisheries interactions and ensure they do not adversely affect the survival or recovery of a threatened species, including ASL. Based on this assessment of the impacts of bycatch mortality in the gillnet GHAT fishery off South Australia on ASL subpopulations, we recommend the following:

 If the likelihood of further subpopulations declines and potential extinctions is to be minimised, and the capacity for the species to recover enhanced, then management arrangements should seek to significantly reduce ASL bycatch mortality in the gillnet GHAT fishery as soon as possible.

- To achieve this, we recommend that management arrangements need to reduce female bycatch mortality to zero. If this is not achieved, some subpopulations are likely to decline further.
- Male bycatch mortality should also be considered in management arrangements, because the impact of significant male bycatch mortality on subpopulation structure and recovery potential is uncertain.
- With current fishing methods, significant reductions in ASL bycatch mortality will require substantial contraction in the area of the gillnet GHAT fishery off SA, particularly in shallow, inshore waters in proximity to ASL subpopulations.
- The level of fishing effort in other areas in the fishery that overlap with ASL foraging effort will need to be carefully managed.
- The effectiveness of management arrangements to mitigate ASL bycatch mortality will need to be carefully monitored through a comprehensive subpopulation monitoring program.

Table 7.1. Summary of South Australian subpopulations of ASL, including subpopulation name and how they are referred to in this report, the location (Lat, Long) and estimated pup production per breeding cycle, survey year of the pup production estimate. Numbers of pups among the Bunda Cliffs subpopulations in the Great Australian Bight (GAB) have been apportioned using the approach of Goldsworthy et al. (2003).

No.	Subpopulation	Referred to as	Lat	Long	Year of	Pup
				_0.1g	survev	count
1	Bunda Cliffs B9	B9	-31.647	129.311	1995	17
2	Bunda Cliffs B8	B8	-31.640	129.381	1995	38
3	Bunda Cliffs B7	B7	-31.625	129,511	1994	3
4	Bunda Cliffs B6	B6	-31 609	129 762	1995	12
5	Bunda Cliffs B5	B5	-31 585	130 031	1995	43
6	Bunda Cliffs B4	B4	-31 586	130.061	1995	2
7	Bunda Cliffs B3	B3	-31 582	130 126	1005	21
2 2	Bunda Cliffe B2	B2	-31 586	130 581	1005	5
a	Bunda Cliffs B1	B1	-31 518	131 061	1005	15
10	Nuvts Reef (west)		-32 110	132 131	2004	12
10	Nuyte Roof (middlo)		-32.119	132.131	2004	2
	Point Fowler ('Camel-foot		-32.139	132.141	1990	3
10		Dt Foudor	22 01 1	122 120	1004	1
12	Day) Durdio lo	PURDio	-32.011	102.400	1994	122
13		Fulue	-32.270	100.220	2005	132
14		Vvest	-32.511	133.251	2005	50
15	Fenelon Is	Fenelon	-32.581	133.282	2008	40
16	Lounds Is	Lounds	-32.273	133.366	2008	34
17	Breakwater Is	B'water	-32.316	133.530	2005	1/
18	Gliddon Reef	Gliddon	-32.322	133.561	2005	7
19	Blefuscu Is	Blefuscu	-32.467	133.644	2005	84
20	Lilliput Is	Lilliput	-32.434	133.693	2005	67
21	Olive Island	Olive	-32.719	133.970	2006	206
22	Nicolas Baudin Is	N Baudin	-33.016	134.133	2006	98
23	Point Labatt	Pt Labatt	-33.152	134.261	2005	6
24	Jones Is	Jones	-33.185	134.367	2007	15
25	Dorothee Is	Dorothee	-34.005	134.245	1996	1
26	Pearson Is	Pearson	-33.962	134.267	2005	35
27	Ward Is	Ward	-33.741	134.285	2006	45
28	West Waldegrave Is	Waldegrave	-33.596	134.762	2003	157
		Four				
29	Four Hummocks (North) Is	Hummocks	-34.758	135.042	1996	12
30	Rocky Island (North)	Rocky North	-34.259	135.261	1996	16
31	Price Is	Price	-34.708	135.290	1996	25
32	Liguanea Is	Liguanea	-34.998	135.620	2004	43
33	Lewis Is	Lewis	-34.957	136.032	2007	131
34	North Neptune - East Is	East Island	-35.228	136.077	2005	14
35	South Neptune (Main) Is	South Neptune	-35.330	136.112	2008	6
36	Albatross Is	Albatross	-35.069	136.181	2005	15
37	English Is	English	-34.638	136.196	2005	27
38	Dangerous Reef	Dangerous	-34.815	136.212	2007	709
39	North Islet	North Islet	-35.121	136.476	2005	28
40	Peaked Rocks-west	Peaked Rocks	-35.185	136.482	1990	24
41	North Casuarina Is	N Casuarina	-36.068	136.703	1996	3
42	Cape Bouquer, Kangaroo Is	Cape Bouquer	-36.042	136.909	1999	3
43	Cave Point, Kangaroo Is	Cave Point	-36.026	136.957	1990	3
44	Seal Bay, Kangaroo Is	Seal Bay	-35 995	137 317	2007	260
45	Black Point, Kangaroo Is	Black Point	-36.038	137,406	2002	1
46	Seal Slide, Kangaroo Is	Seal Slide	-36.026	137 536	2007	16
47	South Page Is	S Page	-35.777	138,292	2005	331
48	North Page Is	N Page	-35,759	138,301	2005	258
			00.100		Total	3 107

Table 7.2. Life-table used to estimate the age-stage abundances for male and female ASL, indicating age-specific survival (*S*), and numbers (N) per stage. The starting pup production is based on the total estimate for all South Australian subpopulations (3,107; Table 7.1) and a 1:1 sex-ratio at birth. Stage-specific survival rates are based on a life-table developed for the Seal Bay subpopulation by McIntosh (2007), but multiplied by 1.0026 in order to achieve stable growth.

Pups 0 1.000 1554 Juvenile female 1.5 0.355 551 Juvenile female 3 0.298 463 Adult female 4.5 0.282 438 Adult female 6 0.267 414 Adult female 7.5 0.253 392 Adult female 9 0.239 371 Adult female 12 0.214 333 Adult female 15 0.189 293 Adult female 15 0.189 293 Adult female 18 0.159 247 Adult female 19.5 0.143 223 Adult female 21 0.115 179 Adult female 22.5 0.081 125 Adult female 24 0.049 75 Adult female 27 0.000 0 Female total 6,634 Males Pups 0 1.000 1554 Juvenile male 3 0.299 464 J	Females	Age (y)	S	Ν
Juvenile female 1.5 0.355 551 Juvenile female 3 0.298 463 Adult female 4.5 0.282 438 Adult female 6 0.267 414 Adult female 9 0.239 371 Adult female 9 0.239 371 Adult female 10.5 0.226 351 Adult female 13.5 0.203 315 Adult female 15 0.189 293 Adult female 16.5 0.174 271 Adult female 18 0.159 247 Adult female 19.5 0.143 223 Adult female 21 0.115 179 Adult female 22.5 0.081 125 Adult female 24 0.049 75 Adult female 25.5 0.024 38 Adult female 3 0.299 464 Juvenile male 1.5 0.355 551 Juvenile male 1.5	Pups	0	1.000	1554
Juvenile female 3 0.298 463 Adult female 4.5 0.282 438 Adult female 6 0.267 414 Adult female 7.5 0.253 392 Adult female 9 0.239 371 Adult female 10.5 0.226 351 Adult female 12 0.214 333 Adult female 15 0.189 293 Adult female 16.5 0.174 271 Adult female 18 0.159 247 Adult female 125 0.081 125 Adult female 22.5 0.081 125 Adult female 24 0.049 75 Adult female 27 0.000 0 Female total $6,634$ $$	Juvenile female	1.5	0.355	551
Adult female 4.5 0.282 438 Adult female 6 0.267 414 Adult female 9 0.239 371 Adult female 10.5 0.226 351 Adult female 12 0.214 333 Adult female 15 0.189 293 Adult female 16.5 0.174 271 Adult female 18 0.159 247 Adult female 19.5 0.143 223 Adult female 21 0.115 179 Adult female 24 0.049 75 Adult female 22.5 0.081 125 Adult female 27 0.000 0 Female total 6,634 $$	Juvenile female	3	0.298	463
Adult female 6 0.267 414 Adult female 7.5 0.253 392 Adult female 9 0.239 371 Adult female 10.5 0.226 351 Adult female 12 0.214 333 Adult female 15 0.189 293 Adult female 15 0.189 293 Adult female 18 0.159 247 Adult female 19.5 0.143 223 Adult female 21 0.115 179 Adult female 22.5 0.081 125 Adult female 25.5 0.024 38 Adult female 27 0.000 0 Female total 6,634 Males Males Males Adult female 3 0.299 Adult female 1.5 0.355 551 Juvenile male 1.5 0.220 341 Adult female 9 0.198 308	Adult female	4.5	0.282	438
Adult female 7.5 0.253 392 Adult female 9 0.239 371 Adult female 10.5 0.226 351 Adult female 12 0.214 333 Adult female 15 0.189 293 Adult female 16.5 0.174 271 Adult female 18 0.159 247 Adult female 19.5 0.143 223 Adult female 21 0.115 179 Adult female 22.5 0.081 125 Adult female 24.4 0.049 75 Adult female 27 0.000 0 Female total 6,634 6,634 Males 1.5 0.355 551 Juvenile male 1.5 0.220 341 Adult male 6 0.243 378 Adult male 7.5 0.220 341 Adult male 10.5 0.179 278 Adult male 12 0.161 251 Adult male 12	Adult female	6	0.267	414
Adult female 9 0.239 371 Adult female 10.5 0.226 351 Adult female 12 0.214 333 Adult female 13.5 0.203 315 Adult female 15 0.189 293 Adult female 16.5 0.174 271 Adult female 18 0.159 247 Adult female 19.5 0.143 223 Adult female 21 0.115 179 Adult female 22.5 0.081 125 Adult female 25.5 0.024 38 Adult female 27 0.000 0 Female total 6,634 Males Pups 0 1.000 1554 Juvenile male 1.5 0.355 551 Juvenile male 4.5 0.270 419 Adult male 7.5 0.220 341 Adult male 9 0.198 308 Adult male 10.5 0.179 278	Adult female	7.5	0.253	392
Adult female 10.5 0.226 351 Adult female 12 0.214 333 Adult female 13.5 0.203 315 Adult female 15 0.189 293 Adult female 16.5 0.174 271 Adult female 18 0.159 247 Adult female 19.5 0.143 223 Adult female 21 0.115 179 Adult female 24 0.049 75 Adult female 22.5 0.081 125 Adult female 24 0.049 75 Adult female 27 0.000 0 Female total 6,634 6,634 Males 1.5 0.355 551 Juvenile male 1.5 0.220 341 Adult male 6 0.243 378 Adult male 9 0.198 308 Adult male 10.5 0.179 278 Adult male 12 0.161 251 Adult male 15	Adult female	9	0.239	371
Adult female 12 0.214 333 Adult female 13.5 0.203 315 Adult female 15 0.189 293 Adult female 16.5 0.174 271 Adult female 18 0.159 247 Adult female 19.5 0.143 223 Adult female 21 0.115 179 Adult female 24 0.049 75 Adult female 24 0.049 75 Adult female 27 0.000 0 Female total 6,634 6,634 Males 1.5 0.355 551 Juvenile male 3 0.299 464 Juvenile male 3 0.299 464 Juvenile male 4.5 0.270 419 Adult male 6 0.243 378 Adult male 10.5 0.179 278 Adult male 10.5 0.179 278 Adult male 13.5 0.146 226 Adult male 15	Adult female	10.5	0.226	351
Adult female 13.5 0.203 315 Adult female 15 0.189 293 Adult female 16.5 0.174 271 Adult female 18 0.159 247 Adult female 19.5 0.143 223 Adult female 21 0.115 179 Adult female 24 0.049 75 Adult female 25.5 0.024 38 Adult female 27 0.000 0 Female total 6,634 6,634 Males 1.5 0.355 551 Juvenile male 1.5 0.220 341 Adult male 6 0.243 378 Adult male 9 0.198 308 Adult male 12.5 0.413 275 Juvenile male 13.5 0.179 278 Adult male 12.5 0.220 341 Adult male 13.5 0.146 226 Adult male 13.5 0.146 226 Adult male 16.5	Adult female	12	0.214	333
Adult female 15 0.189 293 Adult female 16.5 0.174 271 Adult female 18 0.159 247 Adult female 19.5 0.143 223 Adult female 21 0.115 179 Adult female 22.5 0.081 125 Adult female 24 0.049 75 Adult female 25.5 0.024 38 Adult female 27 0.000 0 Female total 6,634 6,634 Males 1.5 0.355 551 Juvenile male 1.5 0.299 464 Juvenile male 4.5 0.270 419 Adult male 6 0.243 378 Adult male 10.5 0.179 278 Adult male 12 0.161 251 Adult male 15 0.117 181 Adult male 15 0.117 181 Adult male 15 0.117 181 Adult	Adult female	13.5	0.203	315
Adult female 16.5 0.174 271 Adult female 18 0.159 247 Adult female 19.5 0.143 223 Adult female 21 0.115 179 Adult female 22.5 0.081 125 Adult female 24 0.049 75 Adult female 25.5 0.024 38 Adult female 27 0.000 0 Female total 6,634 6,634 Males Pups 0 1.000 1554 Juvenile male 1.5 0.355 551 Juvenile male 3 0.299 464 Juvenile male 4.5 0.270 419 Adult male 6 0.243 378 Adult male 10.5 0.179 278 Adult male 10.5 0.179 278 Adult male 13.5 0.146 226 Adult male 15 0.036 57 Adult male 18 0.061	Adult female	15	0.189	293
Adult female 18 0.159 247 Adult female 19.5 0.143 223 Adult female 21 0.115 179 Adult female 22.5 0.081 125 Adult female 24 0.049 75 Adult female 25.5 0.024 38 Adult female 27 0.000 0 Female total 6,634 Males Pups 0 1.000 1554 Juvenile male 1.5 0.355 551 Juvenile male 3 0.299 464 Juvenile male 4.5 0.270 419 Adult male 6 0.243 378 Adult male 7.5 0.220 341 Adult male 10.5 0.179 278 Adult male 10.5 0.117 181 Adult male 13.5 0.146 226 Adult male 15 0.117 181 Adult male 18 0.061 94 Adult male	Adult female	16.5	0.174	271
Adult female 19.5 0.143 223 Adult female 21 0.115 179 Adult female 22.5 0.081 125 Adult female 24 0.049 75 Adult female 25.5 0.024 38 Adult female 27 0.000 0 Female total $6,634$ Males Pups 0 1.000 1554 Juvenile male 1.5 0.355 551 Juvenile male 3 0.299 464 Juvenile male 4.5 0.270 419 Adult male 6 0.243 378 Adult male 9 0.198 308 Adult male 10.5 0.179 278 Adult male 12 0.161 251 Adult male 15 0.117 181 Adult male 15 0.117 181 Adult male 18 0.061 94 Adult male 19.5 0.036 57	Adult female	18	0.159	247
Adult female 21 0.115 179 Adult female 22.5 0.081 125 Adult female 24 0.049 75 Adult female 25.5 0.024 38 Adult female 27 0.000 0 Female total 6,634 Males 6,634 Pups 0 1.000 1554 Juvenile male 1.5 0.355 551 Juvenile male 3 0.299 464 Juvenile male 4.5 0.270 419 Adult male 6 0.243 378 Adult male 7.5 0.220 341 Adult male 10.5 0.179 278 Adult male 12 0.161 251 Adult male 13.5 0.146 226 Adult male 16.5 0.089 138 Adult male 18 0.061 94 Adult male 19.5 0.036 57 Adult male 19.5 0.036 57 Adult male<	Adult female	19.5	0.143	223
Adult female 22.5 0.081 125 Adult female 24 0.049 75 Adult female 25.5 0.024 38 Adult female 27 0.000 0 Female total $6,634$ Males $6,634$ Pups 0 1.000 1554 Juvenile male 1.5 0.355 551 Juvenile male 3 0.299 464 Juvenile male 4.5 0.270 419 Adult male 6 0.243 378 Adult male 9 0.198 308 Adult male 10.5 0.179 278 Adult male 12 0.161 251 Adult male 15 0.117 181 Adult male 16.5 0.089 138 Adult male 18 0.061 94 Adult male 19.5 0.036 57 Adult male 12.5 0.000 0 Male total 22.5 </td <td>Adult female</td> <td>21</td> <td>0.115</td> <td>179</td>	Adult female	21	0.115	179
Adult female 24 0.049 75 Adult female 25.5 0.024 38 Adult female 27 0.000 0 Female total $6,634$ Males 1.000 1554 Pups 0 1.000 1554 Juvenile male 1.5 0.355 551 Juvenile male 3 0.299 464 Juvenile male 4.5 0.270 419 Adult male 6 0.243 378 Adult male 9 0.198 308 Adult male 10.5 0.179 278 Adult male 12 0.161 251 Adult male 15 0.117 181 Adult male 15 0.0365 57 Adult male 18 0.061 94 Adult male 19.5 0.036 57 Adult male 12.5 0.000 0 Male total 22.5 0.000 0 <td>Adult female</td> <td>22.5</td> <td>0.081</td> <td>125</td>	Adult female	22.5	0.081	125
Adult female 25.5 0.024 38 Adult female 27 0.000 0 Female total $6,634$ Males $$	Adult female	24	0.049	75
Adult female 27 0.000 0 Female total 6,634 Males	Adult female	25.5	0.024	38
Female total 6,634 Males Pups 0 1.000 1554 Juvenile male 1.5 0.355 551 Juvenile male 3 0.299 464 Juvenile male 4.5 0.270 419 Adult male 6 0.243 378 Adult male 7.5 0.220 341 Adult male 9 0.198 308 Adult male 10.5 0.179 278 Adult male 12 0.161 251 Adult male 13.5 0.146 226 Adult male 15 0.117 181 Adult male 16.5 0.089 138 Adult male 18 0.061 94 Adult male 21 0.018 28 Adult male 22.5 0.000 0	Adult female	27	0.000	0
Males 0 1.000 1554 Pups 0 1.000 1554 Juvenile male 1.5 0.355 551 Juvenile male 3 0.299 464 Juvenile male 4.5 0.270 419 Adult male 6 0.243 378 Adult male 7.5 0.220 341 Adult male 9 0.198 308 Adult male 10.5 0.179 278 Adult male 12 0.161 251 Adult male 13.5 0.146 226 Adult male 15 0.117 181 Adult male 16.5 0.089 138 Adult male 18 0.061 94 Adult male 19.5 0.036 57 Adult male 21 0.018 28 Adult male 22.5 0.000 0 Male total 5,269 54 54	Fomalo total			6 634
Males Pups 0 1.000 1554 Juvenile male 1.5 0.355 551 Juvenile male 3 0.299 464 Juvenile male 4.5 0.270 419 Adult male 6 0.243 378 Adult male 7.5 0.220 341 Adult male 9 0.198 308 Adult male 10.5 0.179 278 Adult male 12 0.161 251 Adult male 13.5 0.146 226 Adult male 15 0.117 181 Adult male 16.5 0.089 138 Adult male 18 0.061 94 Adult male 19.5 0.036 57 Adult male 21 0.018 28 Adult male 22.5 0.000 0				0,034
Pups 0 1.000 1554 Juvenile male 1.5 0.355 551 Juvenile male 3 0.299 464 Juvenile male 4.5 0.270 419 Adult male 6 0.243 378 Adult male 7.5 0.220 341 Adult male 9 0.198 308 Adult male 10.5 0.179 278 Adult male 12 0.161 251 Adult male 13.5 0.146 226 Adult male 15 0.117 181 Adult male 16.5 0.089 138 Adult male 19.5 0.036 57 Adult male 21 0.018 28 Adult male 22.5 0.000 0 Male total 5,269 57	Males			
Juvenile male 1.5 0.355 551 Juvenile male3 0.299 464 Juvenile male 4.5 0.270 419 Adult male6 0.243 378 Adult male 7.5 0.220 341 Adult male9 0.198 308 Adult male 10.5 0.179 278 Adult male 12 0.161 251 Adult male 13.5 0.146 226 Adult male 15 0.117 181 Adult male 15 0.089 138 Adult male 18 0.061 94 Adult male 19.5 0.036 57 Adult male 21 0.018 28 Adult male 22.5 0.000 0 Male total $5,269$ 576	Pups	0	1.000	1554
Juvenile male3 0.299 464 Juvenile male 4.5 0.270 419 Adult male 6 0.243 378 Adult male 7.5 0.220 341 Adult male 9 0.198 308 Adult male 10.5 0.179 278 Adult male 12 0.161 251 Adult male 13.5 0.146 226 Adult male 15 0.117 181 Adult male 15 0.018 28 Adult male 19.5 0.036 57 Adult male 21 0.018 28 Adult male 22.5 0.000 0 Male total $5,269$ $5,269$ $5,269$	Juvenile male	1.5	0.355	551
Juvenile male 4.5 0.270 419 Adult male 6 0.243 378 Adult male 7.5 0.220 341 Adult male 9 0.198 308 Adult male 10.5 0.179 278 Adult male 12 0.161 251 Adult male 13.5 0.146 226 Adult male 15 0.117 181 Adult male 16.5 0.089 138 Adult male 18 0.061 94 Adult male 19.5 0.036 57 Adult male 21 0.018 28 Adult male 22.5 0.000 0	Juvenile male	3	0.299	464
Adult male6 0.243 378 Adult male7.5 0.220 341 Adult male9 0.198 308 Adult male10.5 0.179 278 Adult male12 0.161 251 Adult male13.5 0.146 226 Adult male15 0.117 181Adult male16.5 0.089 138Adult male18 0.061 94Adult male19.5 0.036 57Adult male21 0.018 28Adult male22.5 0.000 0Male total $5,269$ $5,269$	Juvenile male	4.5	0.270	419
Adult male 7.5 0.220 341 Adult male 9 0.198 308 Adult male 10.5 0.179 278 Adult male 12 0.161 251 Adult male 13.5 0.146 226 Adult male 15 0.117 181 Adult male 16.5 0.089 138 Adult male 18 0.061 94 Adult male 19.5 0.036 57 Adult male 22.5 0.000 0 Male total 22.5 0.000 0	Adult male	6	0.243	378
Adult male 9 0.198 308 Adult male 10.5 0.179 278 Adult male 12 0.161 251 Adult male 13.5 0.146 226 Adult male 15 0.117 181 Adult male 16.5 0.089 138 Adult male 18 0.061 94 Adult male 19.5 0.036 57 Adult male 21 0.018 28 Adult male 22.5 0.000 0	Adult male	7.5	0.220	341
Adult male 10.5 0.179 278 Adult male 12 0.161 251 Adult male 13.5 0.146 226 Adult male 15 0.117 181 Adult male 16.5 0.089 138 Adult male 18 0.061 94 Adult male 19.5 0.036 57 Adult male 21 0.018 28 Adult male 22.5 0.000 0 Male total 5,269 544.002	Adult male	9	0.198	308
Adult male 12 0.161 251 Adult male 13.5 0.146 226 Adult male 15 0.117 181 Adult male 16.5 0.089 138 Adult male 18 0.061 94 Adult male 19.5 0.036 57 Adult male 21 0.018 28 Adult male 22.5 0.000 0 Male total 5,269 57	Adult male	10.5	0.179	278
Adult male 13.5 0.146 226 Adult male 15 0.117 181 Adult male 16.5 0.089 138 Adult male 18 0.061 94 Adult male 19.5 0.036 57 Adult male 21 0.018 28 Adult male 22.5 0.000 0 Male total 5,269 5269	Adult male	12	0.161	251
Adult male 15 0.117 181 Adult male 16.5 0.089 138 Adult male 18 0.061 94 Adult male 19.5 0.036 57 Adult male 21 0.018 28 Adult male 22.5 0.000 0 Male total 5,269 5269	Adult male	13.5	0.146	226
Adult male 16.5 0.089 138 Adult male 18 0.061 94 Adult male 19.5 0.036 57 Adult male 21 0.018 28 Adult male 22.5 0.000 0 Male total 5,269 5,269	Adult male	15	0.117	181
Adult male 18 0.061 94 Adult male 19.5 0.036 57 Adult male 21 0.018 28 Adult male 22.5 0.000 0 Male total 5,269 5,269	Adult male	16.5	0.089	138
Adult male 19.5 0.036 57 Adult male 21 0.018 28 Adult male 22.5 0.000 0 Male total 5,269 5,269	Adult male	18	0.061	94
Adult male 21 0.018 28 Adult male 22.5 0.000 0 Male total 5,269 Total Deputation Estimate 14.002	Adult male	19.5	0.036	57
Adult male 22.5 0.000 0 Male total 5,269 Total Deputation Estimate 11,002	Adult male	21	0.018	28
Male total 5,269	Adult male	22.5	0.000	0
Total Dopulation Estimate 44.000	Male total			5 260
	Total Population Estimate			11 903

Table 7.3. Leslie Matrix for ASL population based on McIntosh's (2007) 'Good' model. The first row indicates the stage (age) of females in years. The second row indicates stage-specific fecundity (proportion of female pups born to each female per stage) and the diagonal cells denote stage-specific survival (proportion of the previous stage surviving to the next stage) (note final stage 25.5-27 years has a survival of 0). Note: survival multipliers of 1.0026, 1.0331 and 1.0666 were applied to each stage to simulate stable (0%), medium (2.5%) and high (5%) population trajectories, respectively.

Stage	0-1.5	1.5-3	3-4.5	4.5-6	6-7.5	7.5-9	9-10.5	10.5-12	12-13.5	13.5-15	15-16.5	16.5-18	18- 19.5	19.5-21	21-22.5	22.5-24	24-25.5	25.5-27
0-1.5	0.000	0.000	0.200	0.270	0.340	0.380	0.410	0.420	0.420	0.420	0.410	0.400	0.375	0.340	0.290	0.200	0.100	0
1.5-3	0.354	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3-4.5	0	0.837	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4.5-6	0	0	0.944	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6-7.5	0	0	0	0.944	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7.5-9	0	0	0	0	0.944	0	0	0	0	0	0	0	0	0	0	0	0	0
9-10.5	0	0	0	0	0	0.944	0	0	0	0	0	0	0	0	0	0	0	0
10.5-12	0	0	0	0	0	0	0.944	0	0	0	0	0	0	0	0	0	0	0
12-13.5	0	0	0	0	0	0	0	0.944	0	0	0	0	0	0	0	0	0	0
13.5-15	0	0	0	0	0	0	0	0	0.944	0	0	0	0	0	0	0	0	0
15-16.5	0	0	0	0	0	0	0	0	0	0.930	0	0	0	0	0	0	0	0
16.5-18	0	0	0	0	0	0	0	0	0	0	0.920	0	0	0	0	0	0	0
18- 19.5	0	0	0	0	0	0	0	0	0	0	0	0.910	0	0	0	0	0	0
19.5-21	0	0	0	0	0	0	0	0	0	0	0	0	0.900	0	0	0	0	0
21-22.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0.800	0	0	0	0
22.5-24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.700	0	0	0
24-25.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.600	0	0
25.5-27	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.5	0

Table 7.4. Summary of the ASL satellite tracking data used in this study, indicating the sex and age class of animals (F- adult female, M-adult males and J-juvenile), subpopulation site, the number of animals tracked and the total and mean number (sd and range) of foraging trips monitored. The type of units deployed (PTT – platform transmitting terminals; GPS – geographic positioning system) and the source of the data are also presented (with two sources for each of two sites).

Sex	Subpopulation/	Individuals	Foraging trips sampled			Telemetry	Data		
	Site	tracked	Ν	Mean	sd	min	max	method	source
F	Blefuscu	6	292	48.7	46.4	2	132	PTT(4),GPS(2)	1 (4), 2 (2)
F	Breakwater	4	83	20.8	10.9	9	35	PTT	1
F	Dangerous	34	583	17.1	17.5	3	91	PTT	1
F	B8	5	212	42.4	11.9	29	59	PTT	3
F	B5	5	85	17.0	5.8	10	23	PTT	3
F	Lewis	2	28	14.0	0.0	14	14	PTT	4
F	Liguanea	7	113	16.1	7.0	9	25	GPS	3
F	Lilliput	15	148	9.9	9.4	1	33	PTT(5),GPS(10)	1 (5); 2 (10)
F	Lounds	7	140	20.0	41.9	1	114	PTT	1
F	Olive	10	122	12.2	3.0	8	18	PTT	3
F	Page	10	178	17.8	12.3	2	43	PTT	3
F	Pearson	2	29	14.5	0.7	14	15	PTT	4
F	Purdie	5	49	9.8	8.9	2	25	PTT	1
F	Seal Bay	27	68	2.5	1.2	1	5	PTT	5
F	Seal Slide	5	63	12.6	2.1	11	16	GPS	3
F	Waldegrave	8	75	9.4	5.6	1	19	GPS	3
F	West	5	66	13.2	2.2	11	16	PTT	1
J	Dangerous	7	171	24.4	12.5	11	40	PTT	1
J	Lilliput	5	58	11.6	5.0	4	17	PTT	1
J	Purdie	5	101	20.2	11.3	10	38	PTT	1
J	West	5	91	18.2	6.9	11	29	PTT	1
М	Blefuscu	6	6	3.0	1.4	2	4	PTT	1
М	Dangerous	8	389	48.6	34.4	2	96	PTT	1
М	Glenelg	1	21	-	-	-	-	PTT	4
М	Lewis	1	1	-	-	-	-	PTT	4
М	Lilliput	3	27	9.0	5.6	4	15	PTT	1
М	Purdie	4	21	5.3	2.5	4	9	PTT	1
М	Seal Bay	1	5	-	-	-	-	PTT	4
Μ	Seal Slide	2	48	24.0	24.0	7	41	PTT	4
Μ	West	5	48	9.6	5.7	4	18	PTT	1
Total	females	157	2,334						
Total	juveniles	22	421						
Total	males	31	566						
Total	All	210	3,321						

Data sources: ¹ Goldsworthy et al. (2009d); ² Lowther unpublished data; ³Hamer et al.(2007) and unpublished data; ⁴ Page and Goldsworthy unpublished data; ⁵ Costa and Fowler, University of California, Santa Cruz, USA.

Table 7.5. Estimates of the number of juvenile, adult female and adult male ASL in the South Australian population and the proportion of time they spent at sea and onshore based on satellite tracking data (Goldsworthy et al. 2007a, Goldsworthy & Page 2007), and their estimated overall total foraging effort (sea days/yr).

	Estimated			Seal	
	number of	ber of Proportion of time			
	ASL	At sea	Onshore	days/yr	
Juvenile	2,449	0.471	0.529	421,270	
Adult	4,066	0.517	0.483	767,628	
Adult male	2,281	0.580	0.420	482,895	
Total	8,796			1,671,793	

Table 7.6. Foraging models developed for ASL in South Australia, and the parameter estimates for either the gamma (shape and scale) or normal probability (mean, sd) distributions for distance and depth. Where mixture models provided the best fit to the data, means and standard deviations are presented for both distributions and the proportion that each distribution contributed to the overall distribution is provided. The maximum observed distance and depth values within each data set are also presented.

Subpopulation/ sex model	Distance (km)	Max Range	Gamma di	istribution	Normal di	stribution	Contribution	
	Depth (m)	5	Shape	Scale	Mean	sd		
All females	Distance	189	0.715	41.718				
	Depth	132			53.532	23.559		
Blefuscu females	Distance	143	0.816	36.785				
	Depth	95			37.788	24.692		
Breakwater females	Distance 1	30			1.124	1.009	0.430	
	Distance 2				13.419	4.515	0.570	
	Depth	50	1.410	7.408				
Dangerous females	Distance	98	0.752	16.241				
-	Depth	87	8.114	3.335				
B8 females	Distance	188			69.893	46.626		
	Depth	87			46.784	6.185		
B5 females	Distance 1	84			10.096	4.584	0.296	
	Distance 2				40.857	17.203	0.704	
	Depth	59			49.024	6.603		
Lewis females	Distance	30			11.712	10.103		
	Depth	24			15.524	6.551		
Liguanea females	Distance	46	0.796	14.863				
3	Depth	123	10.014	7.849				
Lilliput females	Distance	54	1.170	7.888				
	Depth	72	0.863	14.350				
Lounds females	Distance	38	1.353	8.615				
	Depth	55	0.892	17.384				
Olive females	Distance	109	0.556	27.289				
	Depth	88			25.493	24.574		
S Page females - inshore	Distance	98			28.115	28.480		
	Depth	60	8.657	2.679				
S Pages females - offshore	Distance	146			45.905	40.482		
	Depth 1	86			61.148	3.788	0.541	
	Depth 2				26.066	7.753	0.459	
Purdie females	Distance	92			21.678	18,744		
	Depth	78			39.180	18.637		
Seal Bay females	Distance	98			30.677	24.369		
	Depth	167			57.375	34.088		
Seal Slide females	Distance	122	1.699	14.974				
	Depth	84			45.328	18.295		
Waldegrave females	Distance	88	0.883	25.700				
	Depth	88			39.197	20.023		
West females	Distance	55	0.696	13.192				
	Depth	75	1.490	20.442				
Gulf males	Distance	185	0.892	54.322				
	Depth	997	1.749	27.025				
West males	Distance	339	0.616	118.122				
	Depth	138	-		57.741	33.186		
KI males	Distance	213	0.663	110.511				
	Depth	952			69.029	51.394		
All Juveniles	Distance	118	0.732	17.439				
	Depth	91	1.466	18.499				

Adult females

Subpopulation

estima sea lior s trunc	estimate the distribution of foraging effort for adult ea lions for all South Australian subpopulations. The s truncated are also included.										
	Adult males			Juveniles							
	Model										
Depth	used	Distance	Depth	Model used	Distance	Depth					
120	West	350	140	All juveniles	120	100					
120	West	350	140	All juveniles	120	100					
120	West	350	140	All juveniles	120	100					
120	West	350	140	All juveniles	120	100					
120	West	350	140	All iuveniles	120	100					

Table 7.7. Particular foraging models used to females, adult males and juvenile Australian s distances and depth at which each model was

	Model used	Distance	Depth	used	Distance	Depth	Model used	Distance	Depth
B9	B8 females	200	120	West	350	140	All juveniles	120	100
B8	B8 females	200	120	West	350	140	All juveniles	120	100
B7	B8 females	200	120	West	350	140	All juveniles	120	100
B6	B8 females	200	120	West	350	140	All juveniles	120	100
B5	B5 females	200	120	West	350	140	All juveniles	120	100
B4	B5 females	200	120	West	350	140	All juveniles	120	100
B3	B5 females	200	120	West	350	140	All juveniles	120	100
B2	B5 females	200	120	West	350	140	All juveniles	120	100
B1	B5 females	200	120	West	350	140	All juveniles	120	100
NR W	All females	200	120	West	350	140	All juveniles	120	100
NR E	All females	200	120	West	350	140	All juveniles	120	100
Pt Fowler	All females	200	120	West	350	140	All juveniles	120	100
Purdie	Purdie females	200	120	West	350	140	All juveniles	120	100
West	West females	200	120	West	350	140	All juveniles	120	100
Fenelon	All females	200	120	West	350	140	All juveniles	120	100
Lounds	Lounds females	200	120	West	350	140	All juveniles	120	100
B'water	Breakwater females	200	120	West	350	140	All juveniles	120	100
Gliddon	Breakwater females	200	120	West	350	140	All juveniles	120	100
Blefuscu	Blefuscu females	200	120	West	350	140	All juveniles	120	100
Lilliput	Lilliput females	200	120	West	350	140	All juveniles	120	100
Olive	Olive females	200	120	West	350	140	All juveniles	120	100
N Baudin	All females	200	120	West	350	140	All juveniles	120	100
Pt Labatt	All females	200	120	West	350	140	All juveniles	120	100
Jones	All females	200	120	West	350	140	All juveniles	120	100
Dorothee	All females	200	120	West	350	140	All juveniles	120	100
Pearson	All females	200	120	West	350	140	All juveniles	120	100
Ward	All females	200	120	West	350	140	All juveniles	120	100
Waldegrave	Waldegrave females	200	120	West	350	140	All juveniles	120	100
Four	Liguanea females	200	130	West	350	140	All juveniles	120	100
Rocky North	All females	200	130	West	350	140	All juveniles	120	100
Price	Liguanea females	200	130	West	350	140	All juveniles	120	100
Liguanea	Liguanea females	200	130	West	350	140	All juveniles	120	100
Lewis	Dangerous females	100	120	Gulf	350	1000	All juveniles	120	100
East Island	Liguanea females	200	130	Gulf	350	1000	All juveniles	120	100
South Neptune	Liguanea females	200	130	Gulf	350	1000	All juveniles	120	100
Albatross	All females	200	120	Gulf	350	1000	All juveniles	120	100
English	Dangerous females	100	120	Gulf	350	1000	All juveniles	120	100
Dangerous	Dangerous females	100	120	Gulf	350	1000	All juveniles	120	100
North Islet	Dangerous females	100	120	Gulf	350	1000	All juveniles	120	100
Peaked Rocks	Dangerous females	100	120	Gulf	350	1000	All juveniles	120	100
N Casuarina	Liguanea females	200	120	KI	350	1000	All juveniles	120	100
Cape Bouguer	Seal Bay females	200	120	KI	350	1000	All juveniles	120	100
Cave Point	Seal Bay females	200	120	KI	350	1000	All juveniles	120	100
Seal Bay	Seal Bay females	200	120	KI	350	1000	All juveniles	120	100
Black Point	Seal Bay females	200	120	KI	350	1000	All juveniles	120	100
Seal Slide	Seal Slide females	200	120	KI	350	1000	All juveniles	120	100
South Page	S Page females	200	120	KI	350	1000	All juveniles	120	100
South Page	S Page females	150	120						
North Page	S Page females	200	120	KI	350	1000	All juveniles	120	100
North Page	S Page females	150	120						

Table 7.8. Summary of fishing effort, gummy shark catch and gummy shark catch per unit effort (CPUE) in the gillnet sector of the GHAT fishery off South Australia between 1 January 2006 and 25 July 2009, based on fishery logbook data provided by AFMA. Effort data for 2009 extend to 25 July; the yearly mean is therefore the average of 3.56 years. Catch data were not available for 2009 at the time of writing.

Year	Fishing effort	(net-set)		Catch	CPUE	
	(km)	(km.hrs)	(No.)	(kg)	(kg/km)	(kg/km.hr)
2006	20,401	120,934	5,612	509,952	25.0	4.2
2007	16,549	98,785	4,467	419,316	25.3	4.2
2008	17,336	103,581	4,881	490,639	28.3	4.7
2009*	9,242	52,572	2,716			
Total	63,528	375,873	17,676	1,419,906		
Yearly mean	17,823	105,452	4,959	473,302	26.2	4.4

*Partial year summary (1 Jan- 25 Jul, 0.56 years)

Table 7.9. Comparison of fishing effort, gummy shark catch and gummy shark catch per unit effort (CPUE) in five geographic regions in the gillnet sector of the GHAT fishery off South Australia between 1 January 2006 and 31 December 2008. Data based on fishery logbook data provided by AFMA. 'East KI' refers to waters east of Cape Willoughby (>138.123° longitude); 'South KI' waters south of Kangaroo Island (between 136.530° and 138.150° long); 'North KI waters north of Kangaroo Island (between 138.150° long); Eyre Peninsula between Point Fowler and Kangaroo Island (between 132.261° and 136.530°) and 'GAB' waters in the Great Australian Bight west of 132.261° longitude.

Region	Effort		Catch	CPUE	
	(km)	(km.hrs)	(kg)	(kg/km)	(kg/km.hr)
				07.4	
East KI	16,243 (30.9%)	100,092 (31.0%)	440,306 (31.0%)	27.1	4.4
South KI	7,631 (14.1%)	45,906 (14.2%)	189,649 (13.4%)	24.9	4.1
North KI	880 (1.6%)	4,831 (1.5%)	32,432 (2.3%)	36.9	6.7
Eyre Peninsula	25,285 (46.6%)	147,019 (45.5%)	637,743 (44.9%)	25.2	4.3
GAB	4,246 (7.8%)	25,452 (7.9%)	119,776 (8.4%)	28.2	4.7

Table 7.10. Summary of the independent observer data collected in the shark gillnet GHAT fishery between February 2006 and February 2008.

	Observations	Bycatch rates
Trips	10	1.200
Observer days	146	0.082
Net-sets	234	0.051
Km	944	0.013
Km.hrs	5794	0.002
ASL bycatch	12	

Table 7.11. Summary data for six alternate bycatch estimation models using the *equal sample size approach*, with each varying in the number of data bins. Data for bottom-time foraging effort (mean, sd) the number, length (km) and length by duration (km.hrs) of net-sets and sea lion deaths observed (bycatch) and two measures of bycatch rates (seals/km and seals/km.hr net-set) are presented.

Model bin no.	Foraging effort (bo time) d/yr	ttom	Net-s	ets observ	ed	Bycatch No.	Bycatch rate	S
	mean (interval)	sd	n	(km)	(km.hr)		Seals/km	Seal/km.hr
3 bin	0.6 (0.1-1.2)	0.3	78	325.2	2129.3	1	0.0031	0.0005
	2.7 (1.3-4.3)	0.9	78	327.6	1962.6	2	0.0061	0.0010
	10.9 (4.3-43.3)	8.6	78	291.6	1702.6	9	0.0309	0.0053
4-bin	0.5 (0.1-0.7)	0.1	59	245.4	1682.3	0	0.0000	0.0000
	1.6 (0.8-2.7)	0.5	58	243.6	1435.1	1	0.0041	0.0007
	4 (2.7-5.7)	0.8	59	247.8	1406.8	2	0.0081	0.0014
	13 (5.7-43.3)	9.2	58	207.6	1270.3	9	0.0434	0.0071
5-bin	0.4 (0.1-0.6)	0.1	47	197.4	1366.1	0	0.0000	0.0000
	1.1 (0.6-1.7)	0.3	47	195.0	1232.2	1	0.0051	0.0008
	2.7 (1.7-3.6)	0.6	48	201.6	1103.6	2	0.0099	0.0018
	5 (3.8-6.9)	0.9	47	195.0	1112.7	2	0.0103	0.0018
	15 (7.1-43.3)	9.5	45	155.4	980.0	7	0.0450	0.0071
6-bin	0.4 (0.1-0.5)	0.1	40	168.0	1158.8	0	0.0000	0.0000
	0.8 (0.5-1.3)	0.3	39	161.4	1001.7	1	0.0062	0.0010
	2 (1.3-2.7)	0.4	40	168.0	1002.1	1	0.0060	0.0010
	3.6 (2.8-4.4)	0.5	39	163.8	996.2	1	0.0061	0.0010
	5.9 (4.5-7.7)	1.0	40	163.2	862.0	2	0.0123	0.0023
	16.9 (7.7-43.3)	9.8	36	120.0	773.8	7	0.0583	0.0090
7-bin	0.4 (0.1-0.5)	0.1	33	138.6	919.1	0	0.0000	0.0000
	0.7 (0.5-1)	0.1	33	136.2	945.4	0	0.0000	0.0000
	1.4 (1-1.9)	0.3	33	138.6	850.9	1	0.0072	0.0012
	2.6 (1.9-3.2)	0.4	33	138.6	784.1	1	0.0072	0.0013
	4 (3.3-4.7)	0.5	34	142.8	846.4	1	0.0070	0.0012
	6.3 (4.7-7.9)	0.9	34	138.0	720.8	2	0.0145	0.0028
	17.4 (8.2-43.3)	9.8	34	111.6	727.7	7	0.0627	0.0096
8-hin	0 4 (0 1-0 4)	0.1	28	117 6	730.5	0	0 0000	0 0000
0.011	0.6 (0.4-0.7)	0.1	30	123.6	929.4	0	0.0000	0.0000
	1.1 (0.7-1.6)	0.2	29	121.8	728.6	1	0.0082	0.0014
	2.1 (1.6-2.7)	0.4	 31	130.2	754.8	1	0.0077	0.0013
	3.3 (2.7-4.1)	0.4	30	126.0	751.2	1	0.0079	0.0013
	4.9 (4.1-5.9)	0.6	33	136.2	700.4	1	0.0073	0.0014
	7.6 (6-10.1)	1.0	28	110.4	654.7	1	0.0091	0.0015
	20.6 (10.2-43.3)	9.7	25	78.6	544.9	7	0.0891	0.0128

Table 7.12. Summary data of the bycatch estimation model using the *trade-off approach*. Data for bottom-time foraging effort (mean, sd) the number, length (km) and length by duration (km.hrs) of net-sets and sea lion deaths observed (bycatch) and two measures of bycatch rates (seals/km and seals/km.hr net-set) are presented.

Model bin no.	Foraging effort (bottom time) d/yr		Net-sets observed			Bycatch No.	Bycatch rates	
	mean (interval)	sd	n	(km)	(km.hr)		Seals/km	Seal/km.hr
6-bin	0.5 (0.1-0.7)	0.1	59	245.4	1682.3	0	0.0000	0.0000
	1.6 (0.8-2.5)	0.5	55	231.0	1364.4	1	0.0043	0.0007
	3.7 (2.6-4.9)	0.7	54	226.8	1326.6	2	0.0088	0.0015
	6.3 (5-7.7)	0.8	30	121.2	647.3	2	0.0165	0.0031
	9.6 (7.7-12.6)	1.6	18	70.8	398.9	2	0.0282	0.0050
	24.2 (12.8-43.3)	9.0	18	49.2	374.9	5	0.1016	0.0133

Table 7.13. Statistical and model coefficient outputs for alternate bycatch estimation models based on the number of data bins and their expression in terms of fishing effort (km and km.hrs). Comparison of the slope coefficients (\pm 95% CL), significance (P) and r² are presented, as is the mean slope coefficient and the minimum and maximum 95% CL.

Bin Model	Bycatch rate (seals/km-net set) /b	ottom-time	e effort	Bycatch rate (seals/km.hr-net set)/bottom-time effort			
Model	Slope (±95% CL)	Р	r ²	Slope (±95% CL)	Р	r ²	
Equal sample	ole size approach:						
3-bin	0.002794 (0.002244-0.003344)	0.002	0.996	0.000479 (0.000379-0.000578)	0.0230	0.995	
4-bin	0.003205 (0.002485-0.003924)	<0.001	0.985	0.000527 (0.000419-0.000635)	<0.001	0.998	
5-bin	0.002936 (0.002456-0.003415)	<0.001	0.986	0.000469 (0.000395-0.000542)	<0.001	0.987	
6-bin	0.003244 (0.002602-0.003886)	<0.001	0.965	0.000509 (0.000427-0.000591)	<0.001	0.981	
7-bin	0.00336 (0.002786-0.003935)	<0.001	0.972	0.000527 (0.00046-0.000595)	<0.001	0.984	
8-bin	0.003813 (0.002794-0.004832)	<0.001	0.918	0.000556 (0.000421-0.000692)	<0.001	0.996	
Mean	0.003225 (0.002244-0.004832)*			0.000511 (0.000379-0.000692)*			
Trade-off approach:							
6-bin	0.003914 (0.003254-0.004574)	<0.001	0.979	0.000540 (0.000509-0.00057)	<0.001	0.998	
Excluding last bin	0.002791 (0.002480-0.003102)	<0.001	0.994	0.000500 (0.000444-0.000556)	<0.001	0.994	
* lowest and highest 95%CL							

Table 7.14. Estimated ASL bycatch mortality in the gillnet sector of the gillnet sector GHAT fishery off South Australia based on observed bycatch rates (A), based on bycatch rate estimation (B and C). Two estimates from each are given based on net-length (km) and net-length x soak time (km.hrs). For B and C, estimates relate to the actual distribution and level of fishing effort between 1 January 2006 and 25 July 2009 (3.56 years). From these estimates, the mean bycatch mortalities have been estimated on an annual and per breeding cycle (1.5 year) basis.

Bycatch estimation method	Estimated total bycatch 2006- 2009* (±95% CL)	Estimated annual Bycatch (±95% CL)	Estimated breeding cycle bycatch (±95% CL)				
1. Observed bycatch rates							
Total sea lions (km)	807	226	330				
Total sea lions (km.hrs)	778	218	318				
2. Bycatch rate estimation – equal sample size approach							
A. Net length (km)							
Females	516 (359-773)	145 (101-217)	211 (147-316)				
Males	467 (325-700)	131 (91-196)	191 (133-286)				
Total sea lions	983 (684-1473)	276 (192-413)	402 (280-603)				
B. Net length x soak time (km.hrs)							
Females	481 (347-651)	135 (97-183)	197 (142-266)				
Males	433 (313-587)	122 (88-165)	177 (128-240)				
Total sea lions	914 (665-1237)	256 (187-347)	374 (272-506)				
3. Bycatch rate estimation - trade-off approach							
A. Net length (km)							
Females	626 (521-732)	176 (146-205)	256 (213-299)				
Males	567 (471-663)	159 (132-186)	232 (193-271)				
Total ASL	1193 (992-1394)	335 (278-391)	488 (406-570)				
B. Net length x soak time (km.hrs)							
Females	507 (466-536)	142 (131-150)	208 (191-219)				
Males	457 (420-484)	128 (118-136)	187 (172-198)				
Total ASL	965 (893-1020)	271 (251-286)	395 (366-417)				

* 1 Jan 2006- 25 July 2009 (3.56 years)

Table 7.15. The estimated number and percentage of female mortalities (>1.5yrs) per breeding cycle attributable to natural causes and bycatch mortality, under three different intrinsic growth scenarios. The relative increase in the mortality rate of females (>1.5yrs) due to the current estimated bycatch mortality in the gillnet sector of the gillnet sector GHAT fishery off South Australia is also presented.

Intrinsic growth rate	Female natural mortality/breeding cycle (>1.5yrs)	Female natural + mortality/breeding (>1.5yrs)	Increase in female mortality rate due to bycatch mortality (>1.5yrs)	
	No. (%)	No. (±95% CL)	% (±95% CL)	% (±95% CL)
0% (Stable)	551 (10.9%)	748 (693-817)	14.7 (13.6-16.1)	35.7 (25.8-48.2)
2.5% (Medium)	568 (9.0%)	765 (710-834)	12.2 (11.3-13.3)	34.7 (25-46.8)
5% (High)	590 (7.4%)	787 (732-856)	9.9 (9.2-10.8)	33.4 (24.1-45.1)
Table 7.16. Estimated bycatch mortality (total, males and females) of ASL per breeding cycle in the gillnet sector GHAT fishery off SA based on fishing effort distribution between 2006 - 2009. The size of subpopulations is indicated by their pup production and the estimated number of females (>1.5y). The estimated % of females removed as bycatch mortality per breeding cycle is also provided.

ASL subpopulation and estimated pup production		Bycatch of ASL per breeding cycle (17.5 months)				females in subpopulation and % caught as	
		All sea lions (±95% CL)	Males (±95% CL)	Females (±95% CL)	bycatcl breedir No.	n mortality per ng cycle % (±95% CL)	
B9	17	1 (0.7-1.3)	0.5 (0.3-0.6)	0.5 (0.4-0.7)	28	1.8 (1.3-2.4)	
B8	38	2 (1.4-2.7)	1 (0.7-1.3)	1.1 (0.8-1.4)	62	1.7 (1.2-2.3)	
B7	3	0.2 (0.1-0.2)	0.1 (0.1-0.1)	0.1 (0.1-0.1)	5	1.7 (1.2-2.3)	
B6	12	0.6 (0.4-0.8)	0.3 (0.2-0.4)	0.3 (0.2-0.5)	20	1.7 (1.2-2.3)	
B5	43	1.7 (1.2-2.3)	0.8 (0.5-1)	1 (0.7-1.3)	70	1.4 (1-1.9)	
B4	2	0.1 (0.1-0.1)	0 (0-0)	0 (0-0.1)	3	1.3 (1-1.8)	
B3	31	1.2 (0.8-1.6)	0.5 (0.4-0.7)	0.6 (0.5-0.9)	51	1.3 (0.9-1.7)	
B2	5	0.1 (0.1-0.2)	0.1 (0-0.1)	0.1 (0-0.1)	8	0.8 (0.6-1.1)	
B1	15	0.6 (0.4-0.8)	0.3 (0.2-0.5)	0.3 (0.2-0.4)	25	1.1 (0.8-1.5)	
NR W	12	0.8 (0.6-1)	0.4 (0.3-0.5)	0.4 (0.3-0.5)	20	2 (1.5-2.8)	
NR E	3	0.2 (0.1-0.2)	0.1 (0.1-0.1)	0.1 (0.1-0.1)	5	2 (1.5-2.7)	
Pt Fowler	1	0.1 (0-0.1)	0 (0-0)	0 (0-0)	2	2.1 (1.6-2.9)	
Purdie	132	10.1 (7.4-13.7)	4.7 (3.5-6.4)	5.4 (3.9-7.3)	216	2.5 (1.8-3.4)	
West	56	5.2 (3.8-7.1)	2.5 (1.8-3.4)	2.7 (2-3.7)	92	3 (2.2-4.1)	
Fenelon	40	3.9 (2.8-5.3)	1.8 (1.3-2.5)	2.1 (1.5-2.8)	65	3.2 (2.3-4.3)	
Lounds	34	1.8 (1.3-2.5)	1.3 (0.9-1.7)	0.5 (0.4-0.7)	56	1 (0.7-1.3)	
B'water	17	0.8 (0.6-1.1)	0.7 (0.5-0.9)	0.2 (0.1-0.2)	28	0.6 (0.4-0.8)	
Gliddon	7	0.3 (0.2-0.5)	0.3 (0.2-0.4)	0.1 (0-0.1)	11	0.5 (0.3-0.6)	
Blefuscu	84	9.4 (6.8-12.7)	4.2 (3.1-5.7)	5.2 (3.7-7)	137	3.8 (2.7-5.1)	
Lilliput	67	4.6 (3.3-6.2)	3.2 (2.3-4.4)	1.3 (1-1.8)	110	1.2 (0.9-1.7)	
Olive	206	32.7 (23.9-44.3)	14.2 (10.3-19.2)	18.6 (13.5-25.1)	337	5.5 (4-7.5)	
N Baudin	98	15.2 (11-20.6)	6.5 (4.7-8.8)	8.7 (6.3-11.7)	160	5.4 (3.9-7.3)	
Pt Labatt	6	1.1 (0.8-1.5)	0.5 (0.3-0.7)	0.7 (0.5-0.9)	10	6.7 (4.9-9.1)	
Jones	15	3.1 (2.2-4.2)	1.3 (0.9-1.7)	1.8 (1.3-2.4)	25	7.4 (5.4-10)	
Dorothee	1	0.2 (0.2-0.3)	0.1 (0.1-0.1)	0.1 (0.1-0.2)	2	7.8 (5.7-10.6)	
Pearson	35	8.2 (6-11.1)	3.6 (2.6-4.8)	4.6 (3.4-6.3)	57	8.1 (5.9-11)	
Ward	45	12.1 (8.9-16.4)	5.3 (3.9-7.2)	6.8 (5-9.2)	74	9.2 (6.8-12.5)	
Waldegrave	157	35.8 (26.1-48.4)	15.3 (11.2-20.8)	20.4 (14.9-27.6)	257	8 (5.8-10.8)	
Four Hummocks	12	4 (2.9-5.4)	1.5 (1.1-2.1)	2.5 (1.8-3.4)	20	12.7 (9.3-17.2)	
Rocky North	16	3.1 (2.2-4.1)	1.3 (0.9-1.7)	1.8 (1.3-2.4)	26	6.7 (4.9-9.1)	
Price	25	8 (5.8-10.9)	2.8 (2-3.8)	5.2 (3.8-7.1)	41	12.8 (9.2-17.3)	
Liguanea	43	8.1 (5.8-11)	3.9 (2.7-5.2)	4.3 (3-5.8)	70	6.1 (4.3-8.2)	
Lewis	131	3.2 (2.3-4.3)	2.9 (2.1-3.9)	0.3 (0.2-0.5)	214	0.2 (0.1-0.2)	
East Island	14	1.7 (1.2-2.2)	0.6 (0.4-0.8)	1.1 (0.8-1.5)	23	4.8 (3.5-6.4)	
South Neptune	6	0.5 (0.3-0.6)	0.2 (0.1-0.2)	0.3 (0.2-0.4)	10	3.1 (2.1-4.1)	
Albatross	15	1 (0.7-1.4)	0.4 (0.3-0.6)	0.6 (0.4-0.8)	25	2.4 (1.7-3.2)	
English	27	0.3 (0.2-0.4)	0.3 (0.2-0.4)	0 (0-0)	44	0 (0-0)	
Dangerous	709	9.9 (7.1-13.4)	9.6 (6.9-13)	0.3 (0.2-0.3)	1159	0 (0-0)	
North Islet	28	0.9 (0.6-1.2)	0.6 (0.4-0.8)	0.3 (0.2-0.4)	46	0.6 (0.4-0.9)	
Peaked Rocks	24	1 (0.7-1.4)	0.6 (0.4-0.8)	0.4 (0.3-0.6)	39	1.1 (0.8-1.5)	
N Casuarina	3	0.9 (0.6-1.2)	0.4 (0.3-0.5)	0.5 (0.4-0.7)	5	10.9 (7.8-14.8)	
Cape Bouguer	3	0.7 (0.5-1)	0.3 (0.2-0.4)	0.4 (0.3-0.5)	5	8.3 (5.9-11.2)	
Cave Point	3	0.7 (0.5-1)	0.3 (0.2-0.4)	0.4 (0.3-0.5)	5	8.1 (5.8-11)	
Seal Bay	260	63.5 (45.4-86)	28 (20-37.9)	35.5 (25.4-48)	425	8.3 (6-11.3)	
Black Point	1	0.2 (0.2-0.3)	0.1 (0.1-0.1)	0.1 (0.1-0.2)	2	8.5 (6.1-11.5)	
Seal Slide	16	4 (2.8-5.4)	1.6 (1.2-2.2)	2.3 (1.7-3.1)	26	8.9 (6.4-12)	
S Page	331	62.1 (44.7-84.1)	29.9 (21.5-40.5)	32.2 (23.2-43.6)	541	6 (4.3-8.1)	
N Page	258	47.1 (33.9-63.7)	22.6 (16.3-30.6)	24.4 (17.6-33.1)	422	5.8 (4.2-7.8)	
	3,107	374 (272-506)	177 (128-240)	197 (142-266)	5080	4.3 (3.1-5.9)	

Table 7.17. Estimated bycatch mortality of female ASL per breeding cycle in the gillnet GHAT fishery off SA based on fishing effort distribution between 2006 and 2009. Estimates (±95% CL) of the terminal extinction risk (TER) of each subpopulation based on stable (0%) medium (2.5%) and high (5%) intrinsic subpopulation growth rates are presented. In the two bottom rows, the overall means (±95% CL) for all subpopulations, and the percentage of subpopulations that exceed a 0.1 (10%) TER probability (±95% CL) are presented.

B9 0.5 (0.4-0.7) 0.14 (0.11-0.19) 0.01 (0.01-0.02) 0 (0-0)	
B8 1.1 (0.8-1.4) 0.07 (0.04-0.14) 0 (0-0.01) 0 (0-0)	
B7 0.1 (0.1-0.1) 0.48 (0.48-0.5) 0.06 (0.06-0.07) 0 (0-0)	
B6 0.3 (0.2-0.5) 0.25 (0.24-0.3) 0.01 (0-0.02) 0 (0-0)	
B5 1 (0.7-1.3) 0.03 (0.02-0.05) 0 (0-0) 0 (0-0)	
B4 0 (0-0.1) 0.48 (0.48-0.48) 0.06 (0.06-0.06) 0 (0-0)	
B3 0.6 (0.5-0.9) 0.05 (0.03-0.08) 0 (0-0) 0 (0-0)	
B2 0.1 (0-0.1) 0.37 (0.37-0.37) 0.03 (0.03-0.03) 0 (0-0)	
B1 0.3 (0.2-0.4) 0.15 (0.14-0.17) 0 (0-0) 0 (0-0)	
NR W 0.4 (0.3-0.5) 0.27 (0.24-0.34) 0.01 (0.01-0.03) 0 (0-0)	
NR E 0.1 (0.1-0.1) 0.49 (0.48-0.51) 0.06 (0.06-0.08) 0 (0-0)	
Pt Fowler 0 (0-0) 0.49 (0.48-0.52) 0.06 (0.06-0.08) 0 (0-0.02	1)
Purdie 5.4 (3.9-7.3) 0.04 (0.01-0.12) 0 (0-0.01) 0 (0-0)	.,
West 2.7 (2-3.7) 0.14 (0.06-0.3) 0.01 (0-0.05) 0 (0-0)	
Fenelon 2.1 (1.5-2.8) 0.25 (0.12-0.44) 0.03 (0.01-0.08) 0 (0-0.02	1)
Lounds $0.5(0.4-0.7)$ $0.04(0.03-0.05)$ $0(0-0)$ $0(0-0)$	• /
B'water 0.2 (0.1-0.2) 0.1 (0.1-0.1) 0.01 (0.01-0.01) 0 (0-0)	
Gliddon 0.1 (0-0.1) 0.36 (0.36-0.36) 0.02 (0.02-0.02) 0 (0-0)	
Blefuscu 5.2 (3.7-7) 0.22 (0.09-0.44) 0.03 (0-0.1) 0. (0-0.02	2)
$\begin{array}{cccccccccccccccccccccccccccccccccccc$	-)
Olive 18.6 (13.5-25.1) 0.37 (0.15-0.65) 0.08 (0.01-0.29) 0.01 (0-0) 1)
N Baudin 87 (63-117) 044 (02-069) 012 (003-036) 0.03 (0-0) 13)
Pt Labett $0.7 (0.5 - 0.9)$ $0.8 (0.65 - 0.9)$ $0.52 (0.00 - 0.00)$ $0.02 (0.00 - 0.00)$)7-0.5)
1.8 (1.3-2.4) = 0.83 (0.67-0.92) = 0.53 (0.26-0.78) = 0.22 (0.000) = 0.02 (0.200) = 0.02 (0.000) = 0.000) = 0.000 = 0.000 = 0.000 = 0.000 = 0.000) = 0.000 = 0.00000 = 0.00000 = 0.00000 = 0.000000 = 0.00000000)8-0.56)
Dorothee $0.1 (0.1-0.2)$ $0.87 (0.74-0.95)$ $0.64 (0.36-0.85)$ $0.36 (0.10)$	13-0.66)
Pearson $4.6(3.4-6.3)$ $0.83(0.65-0.92)$ $0.56(0.26-0.81)$ $0.28(0.026-0.81)$	08-0.61)
Ward 6.8 (5-9.2) 0.86 (0.72-0.94) 0.67 (0.37-0.87) 0.4 (0.14	4-0 72)
Waldegrave 20.4 (14.9-27.6) 0.72 (0.46-0.88) 0.37 (0.12-0.71) 0.14 (0.0)2-0 45)
Four Hummocks $2.5(1.8-3.4)$ $0.97(0.93-0.99)$ $0.9(0.74-0.97)$ $0.78(0.4)$	18-0.93)
Rocky North 1.8 (1.3-2.4) 0.77 (0.6-0.89) 0.47 (0.21-0.74) 0.19 (0.)6-0.46)
Price 5.2 (3.8-7.1) 0.95 (0.88-0.98) 0.89 (0.71-0.96) 0.78 (0.2	13-0.94)
Liguanea 4.3 (3-5.8) 0.64 (0.39-0.82) 0.26 (0.08-0.56) 0.08 (0.0)1-0 26)
Lewis $0.3(0.2-0.5)$ $0(0-0)$ $0(0-0)$ $0(0-0)$,,
East Island 11 (0.8-1.5) 0.59 (0.39-0.78) 0.21 (0.08-0.44) 0.04 (0.0)1-0 16)
South Nentune $0.3(0.2-0.4)$ $0.47(0.41-0.57)$ $0.09(0.05-0.19)$ $0.01(0.60)$) (3)
Albatross $0.6 (0.4-0.8)$ $0.26 (0.18-0.37)$ $0.01 (0-0.05)$ $0 (0-0)$	
English $0.(0-0)$ $0.03.(0.03-0.03)$ $0.(0-0)$ $0.(0-0)$	
Dangerous $0.3(0.2-0.3)$ $0(0-0)$ $0(0-0)$ $0(0-0)$	
North Islet $0.3(0.2-0.4)$ $0.03(0.03-0.03)$ $0(0-0)$ $0(0-0)$	
$\begin{array}{cccccccccccccccccccccccccccccccccccc$	
N Casuarina 0.5 (0.4-0.7) 0.95 (0.87-0.98) 0.87 (0.64-0.95) 0.69 (0.5	35-0.88)
Cape Bouquer $0.4 (0.3-0.5)$ $0.89 (0.75-0.96)$ $0.69 (0.38-0.88)$ $0.41 (0.10)$	15-0 71)
Cave Point $0.4 (0.3-0.5)$ $0.88 (0.74-0.95)$ $0.67 (0.37-0.87)$ $0.4 (0.14)$	1-0 69)
Seal Bay 35.5 (25.4-48) 0.72 (0.37-0.91) 0.42 (0.12-0.75) 0.14 (0.1)1-0 48)
Black Point $0.1 (0.1-0.2)$ $0.9 (0.77-0.96)$ $0.71 (0.41-0.88)$ $0.44 (0.42)$	16-0 73)
Seal Slide 2.3 (1.7-3.1) 0.88 (0.75-0.94) 0.72 (0.42-0.80) 0.44 (0.1	16-0 72)
SPage 32.2 (23.2-43.6) 0.38 (0.13-0.64) 0.00 (0.01-0.32) 0.12 (0.12-0.09) 0.140 (0.1	n () n ()
NPage 24.4 (17.6-33.1) 0.34 (0.1-0.09) 0.09 (0.01-0.32) 0.01 (0-0) 1)
$\begin{array}{cccccccccccccccccccccccccccccccccccc$)5-0 23)
% of subpops. 77 (73-81) 40 (31-48) 31 (19-3	8)

Table 7.18. Estimated bycatch mortality of female ASL per breeding cycle in the gillnet sector GHAT fishery off SA based on fishing effort distribution between 2006 and 2009. Estimates (\pm 95% CL) of the quasi-extinctions (QET) of each subpopulation based on stable (0%) medium (2.5%) and high (5%) intrinsic subpopulation growth rates is presented, as are the means (\pm 95% CL) for all subpopulations, and the percentage of subpopulations with a QET <3 generations (\pm 95% CL).

Subpopulation	Female bycatch	0% QET	2.5% QET	5% QET
B9	0.5 (0.4-0.7)	2 (2-2)	2 (2-2)	2 (2-2)
B8	1.1 (0.8-1.4)	20 (24-17)	145 (145-108)	145 (145-145)
B7	0.1 (0.1-0.1)	1 (1-1)	1 (1-1)	1 (1-1)
B6	0.3 (0.2-0.5)	1 (1-1)	1 (1-1)	1 (1-1)
B5	1 (0.7-1.3)	43 (53-33)	145 (145-145)	145 (145-145)
B4	0 (0-0.1)	1 (1-1)	1 (1-1)	1 (1-1)
B3	0.6 (0.5-0.9)	10 (10-9)	21 (24-19)	145 (145-145)
B2	0.1 (0-0.1)	1 (1-1)	1 (1-1)	1 (1-1)
B1	0.3 (0.2-0.4)	1 (1-1)	1 (1-1)	1 (1-1)
NR W	0.4 (0.3-0.5)	1 (1-1)	1 (1-1)	1 (1-1)
NR E	0.1 (0.1-0.1)	1 (1-1)	1 (1-1)	1 (1-1)
Pt Fowler	0 (0-0)	1 (1-1)	1 (1-1)	1 (1-1)
Purdie	5.4 (3.9-7.3)	85 (98-71)	130 (145-108)	145 (145-145)
West	2.7 (2-3.7)	25 (38-16)	86 (130-52)	145 (145-139)
Fenelon	2.1 (1.5-2.8)	13 (18-10)	55 (112-24)	128 (145-64)
Lounds	0.5 (0.4-0.7)	11 (12-11)	37 (52-24)	145 (145-145)
B'water	0.2 (0.1-0.2)	2 (2-2)	2 (2-2)	2 (2-2)
Gliddon	0.1 (0-0.1)	1 (1-1)	1 (1-1)	1 (1-1)
Blefuscu	5.2 (3.7-7)	42 (57-29)	86 (116-60)	145 (145-122)
Lilliput	1.3 (1-1.8)	79 (92-65)	145 (145-145)	145 (145-145)
Olive	18.6 (13.5-25.1)	63 (80-46)	87 (109-65)	145 (145-107)
N Baudin	8.7 (6.3-11.7)	34 (49-23)	59 (85-37)	118 (145-71)
Pt Labatt	0.7 (0.5-0.9)	1 (1-1)	1 (1-1)	1 (1-1)
Jones	1.8 (1.3-2.4)	1 (1-1)	1 (1-1)	1 (1-1)
Dorothee	0.1 (0.1-0.2)	1 (1-1)	1 (1-1)	1 (1-1)
Pearson	4.6 (3.4-6.3)	4 (6-4)	4 (6-4)	5 (10-5)
Ward	6.8 (5-9.2)	7 (7-7)	8 (13-7)	34 (59-15)
Waldegrave	20.4 (14.9-27.6)	35 (50-22)	50 (72-31)	77 (128-47)
Four Hummocks	2.5 (1.8-3.4)	1 (1-1)	1 (1-1)	1 (1-1)
Rocky North	1.8 (1.3-2.4)	1 (1-1)	1 (1-1)	1 (1-1)
Price	5.2 (3.8-7.1)	3 (3-2)	2 (2-2)	2 (3-2)
Liguanea	4.3 (3-5.8)	8 (12-6)	15 (34-8)	56 (88-32)
Lewis	0.3 (0.2-0.5)	141 (145-139)	145 (145-145)	145 (145-145)
East Island	1.1 (0.8-1.5)	1 (1-1)	1 (1-1)	1 (1-1)
South Neptune	0.3 (0.2-0.4)	1 (1-1)	1 (1-1)	1 (1-1)
Albatross	0.6 (0.4-0.8)	1 (1-1)	1 (1-1)	1 (1-1)
English	0 (0-0)	5 (5-5)	6 (6-6)	15 (15-15)
Dangerous	0.3 (0.2-0.3)	145 (145-145)	145 (145-145)	145 (145-145)
North Islet	0.3 (0.2-0.4)	4 (4-4)	6 (6-5)	12 (13-12)
Peaked Rocks	0.4 (0.3-0.6)	2 (2-2)	2 (2-2)	2 (2-2)
N Casuarina	0.5 (0.4-0.7)	1 (1-1)	1 (1-1)	1 (1-1)
Cape Bouguer	0.4 (0.3-0.5)	1 (1-1)	1 (1-1)	1 (1-1)
Cave Point	0.4 (0.3-0.5)	1 (1-1)	1 (1-1)	1 (1-1)
Seal Bay	35.5 (25.4-48)	32 (51-22)	88 (108-66)	86 (145-54)
Black Point	0.1 (0.1-0.2)	1 (1-1)	1 (1-1)	1 (1-1)
Seal Slide	2.3 (1.7-3.1)	1 (1-1)	1 (1-1)	1 (1-1)
SPage	32.2 (23.2-43.6)	60 (77-45)	101 (123-79)	145 (145-109)
NPage	24.4 (17.6-33.1)	53 (78-35)	110 (126-92)	145 (145-95)
Mean	197 (142-266)	20 (24-17)	36 (42-29)	51 (56-43)
% of subpops.		81 (73-83)	69 (65-73)	63 (60-65)

Table 7.19. Estimated bycatch mortality of female ASL per breeding cycle in the gillnet sector GHAT fishery off SA based on fishing effort distribution between 2006 and 2009. Estimates (\pm 95% CL) of the growth rate (calculated over 20 breeding cycles ~29 years) of each subpopulation based on stable (0%) medium (2.5%) and high (5%) intrinsic subpopulation growth rates is presented, as are the means (\pm 95% CL) for all subpopulations, and the percentage of subpopulations with negative growth (\pm 95% CL).

B9 $0.5 (0.4-0.7)$ $-1.5 (-2.11)$ $0.9 (0.2-1.4)$ $3.1 (2.5-3.6)$ B8 $1.1 (0.8-1.4)$ $-1.8 (-2.31.3)$ $0.8 (0.2-1.3)$ $3.2 (2.6-3.7)$ B7 $0.1 (0.1-0.1)$ $-0.3 (-0.60.1)$ $1.9 (1.5-2.1)$ $4 (3.5-4.3)$ B6 $0.3 (0.2-0.5)$ $-0.9 (-1.5-0.4)$ $1.2 (0.6-1.7)$ $3.6 (2.9-4.1)$ B5 $1 (0.7-1.3)$ $-1.4 (-1.81)$ $1.1 (0.6-1.5)$ $3.5 (3.1-3.9)$ B4 $0 (0-0.1)$ $-0.1 (-0.3-0)$ $2.1 (1.8-2.3)$ $4.2 (3.9-4.5)$ B3 $0.6 (0.5-0.9)$ $-3.3 (-3.5-3.2)$ $1.2 (0.7-1.5)$ $2.1 (1.8-2.3)$ B2 $0.1 (0-0.1)$ $0 (-0.3-0.2)$ $2 (1.7-2.2)$ $4.2 (3.9-4.4)$ B1 $0.3 (0.2-0.4)$ $-0.7 (-1.1-0.4)$ $1.6 (1.2-1.9)$ $3.8 (3.4-4.1)$ NR W $0.4 (0.3-0.5)$ $-1.2 (-1.9-0.6)$ $0.9 (0.2-1.4)$ $3.3 (2.5-3.8)$ NR E $0.1 (0.1-0.1)$ $-0.4 (-0.8-0.2)$ $1.7 (1.3-2)$ $3.8 (3.3-4.2)$ Pt Fowler $0 (0-0)$ $-0.5 (-0.8-0.2)$ $1.6 (1.2-2)$ $3.7 (3.1-4.1)$ Purdie $5.4 (3.9-7.3)$ $-2.4 (-3.2-1.7)$ $0.1 (-0.8-0.7)$ $2.5 (1.6-3.2)$ West $2.7 (2-3.7)$ $-2.9 (-3.9-2.1)$ $-0.5 (-1.8-0.1)$ $1.7 (0.6-2.6)$ Lounds $0.5 (0.4-0.7)$ $-1 (-1.4-0.8)$ $1.4 (1.1-1.7)$ $3.9 (3.5-4.1)$ Bifuscu $5.2 (3.7.7)$ $-3.6 (-4.8-2.6)$ $-1.2 (-2.5-0.2)$ $1.2 (-0.1-2.2)$ Liliput $1.3 (1-1.8)$ $-1.2 (-1.6-0.9)$ $1.2 (0.8-1.6)$ $3.8 (3.3-4.1)$ Olive $1.6 (1$
B81.1 $(0.8-1.4)$ -1.8 $(-2.3-1.3)$ 0.8 $(0.2-1.3)$ 3.2 $(2.6-3.7)$ B70.1 $(0.1-0.1)$ -0.3 $(-0.6-0.1)$ 1.9 $(1.5-2.1)$ 4 $(3.5-4.3)$ B60.3 $(0.2-0.5)$ -0.9 $(-1.5-0.4)$ 1.2 $(0.6-1.7)$ 3.6 $(2.9-4.1)$ B51 $(0.7-1.3)$ -1.4 $(-1.8-1)$ 1.1 $(0.6-1.5)$ 3.5 $(3.1-3.9)$ B40 $(0-0.1)$ -0.1 $(-0.3-0)$ 2.1 $(1.8-2.3)$ 4.2 $(3.9-4.4)$ B10.3 $(0.2-0.4)$ -0.7 $(-1.1-0.4)$ 1.6 $(1.2-1.9)$ 3.8 $(3.4-4.1)$ NR W0.4 $(0.3-0.5)$ -1.2 $(-1.9-0.6)$ 0.9 $(0.2-1.4)$ 3.3 $(2.5-3.8)$ NR E0.1 $(0.1-0.1)$ -0.4 $(-0.8-0.2)$ 1.7 $(1.3-2)$ 3.8 $(3.3-4.2)$ Pt Fowler0 $(0-0)$ -0.5 $(-0.8-0.2)$ 1.6 $(1.2-2)$ 3.7 $(3.1-4.1)$ Purdie5.4 $(3.9-7.3)$ -2.4 $(-3.2-1.7)$ 0.1 $(-0.8-0.7)$ 2.5 $(1.6-3.2)$ West2.7 $(2-3.7)$ -2.9 $(-3.9-2.1)$ -0.5 $(-1.5-0.3)$ 2 $(0.9-2.8)$ Fenelon2.1 $(1.5-2.8)$ -3.1 $(-4.1-2.3)$ -0.7 $(-1.8-0.1)$ 1.7 $(0.6-2.6)$ Lounds0.5 $(0.4-0.7)$ -1 $(-1.4-0.8)$ 1.4 $(1.1-1.7)$ 3.9 $(3.5-4.1)$ Bifuscu5.2 $(3.7-7)$ -3.6 $(-4.8-2.6)$ -1.2 $(-2.5-0.2)$ 1.2 $(-0.1-2.2)$ Lilliput1.3 $(1.1-8)$ -1.2 $(-1.5-0.3)$ -2.8 $(-4.7-1.4)$ Olive1.8 $(1.3-2.4)$ -6.8 $(-9.4-4.9)$ -4.6 $(-7.2-0.7)$ -2.5 $(-5.1-0.5)$ Dorothe0.1 $(0-0.1)$ 0.3 $(0-2.5)$ -2.4 $(-3.2-6.1)$ -4.6 $(4.4-4.7)$ Bifuscu5.2 $(3$
B70.10.10.30.60.61.9(1.5-2.1)4(3.5-4.3)B60.3(0.2-0.5)0.9(-1.5-0.4)1.2(0.6-1.7)3.6(2.9-4.1)B51(0.7-1.3)-1.4(-1.8-1)1.1(0.6-1.5)3.5(3.1-3.9)B40(0-0.1)-0.1(-0.3-0.2)2.1(1.8-2.3)4.2(3.9-4.5)B30.6(0.5-0.9)-3.3(-3.53.2)1.2(0.7-1.5)2.1(1.8-2.3)B20.1(0-0.1)0(-0.3-0.2)2(1.7-2.2)4.2(3.9-4.4)B10.3(0.2-0.4)-0.7(-1.1-0.4)1.6(1.2-1.9)3.8(3.4-4.1)NR W0.4(0.3-0.5)-1.2(1.9-0.6)0.9(0.2-1.4)3.3(2.5-3.8)NR E0.1(0.1-0.1)-0.4(-0.8-0.2)1.7(1.3-2)3.8(3.3-4.2)Pt Fowler0(0-0)-0.5(-3.2-1.7)0.1(0.8-0.7)2.5(1.6-3.2)West2.7(2-3.7)-2.9(-3.9-2.1)-0.5(-1.5-0.3)2(0.9-2.8)Fenelon2.1(1.5-2.8)-3.1(-4.1-2.3)-0.7(-1.8-0.1)1.7(0.6-2.6)Lounds0.5(0.4-0.7)-1(-1.4-0.8)1.4(1.1-1.7)3.9(3.5-4.1)Birdicou5.2(3.7-7)-3.6(-4.8-2.6)-1.2(-2.3-2.6)4.6(4.4-4.7)Birdicou0.1(0-0.2) <t< td=""></t<>
B6 $0.3 (0.2-0.5)$ $-0.9 (-1.5-0.4)$ $1.2 (0.6-1.7)$ $3.6 (2.9-4.1)$ B5 $1 (0.7-1.3)$ $-1.4 (-1.8-1)$ $1.1 (0.6-1.5)$ $3.5 (3.1-3.9)$ B4 $0 (0-0.1)$ $-0.1 (-0.3-0)$ $2.1 (1.8-2.3)$ $4.2 (3.9-4.5)$ B3 $0.6 (0.5-0.9)$ $-3.3 (3.55-3.2)$ $1.2 (0.7-1.5)$ $2.1 (1.8-2.3)$ B2 $0.1 (0-0.1)$ $0 (-0.3-0.2)$ $2 (1.7-2.2)$ $4.2 (3.9-4.4)$ B1 $0.3 (0.2-0.4)$ $-0.7 (-1.1-0.4)$ $1.6 (1.2-1.9)$ $3.8 (3.3-4.2)$ NR W $0.4 (0.3-0.5)$ $-1.2 (-1.9-0.6)$ $0.9 (0.2-1.4)$ $3.3 (2.5-3.8)$ NR E $0.1 (0.1-0.1)$ $-0.4 (-0.8-0.2)$ $1.7 (1.3-2)$ $3.8 (3.3-4.2)$ Pt Fowler $0 (0-0)$ $-0.5 (-0.8-0.2)$ $1.6 (1.2-2)$ $3.7 (3.1-4.1)$ Purdie $5.4 (3.9-7.3)$ $-2.4 (-3.2-1.7)$ $0.1 (-0.8-0.7)$ $2.5 (1.6-3.2)$ West $2.7 (2-3.7)$ $-2.9 (-3.9-2.1)$ $-0.5 (-1.5-0.3)$ $2 (0.9-2.8)$ Fenelon $2.1 (1.5-2.8)$ $-3.1 (-4.1-2.3)$ $-0.7 (-1.8-0.1)$ $1.7 (0.6-2.6)$ Lounds $0.5 (0.4-0.7)$ $-1 (-1.4-0.8)$ $1.4 (-1.1-1.7)$ $3.9 (3.5-4.1)$ B'water $0.2 (0.1-0.2)$ $-0.3 (-0.5-0.2)$ $2 (1.8-2.2)$ $4.3 (4.1-4.5)$ Gliddon $0.1 (0-0.1)$ $0.3 (0.2-0.5)$ $2.4 (2.3-2.6)$ $4.6 (4.4-4.7)$ Blefuscu $5.2 (3.7.7)$ $-3.6 (-4.8-2.6)$ $-1.2 (-2.5-0.2)$ $1.2 (-0.1-2.2)$ Lilliput $1.3 (1-1.8)$ $-1.2 (1.6-0.9)$ $1.2 (0.8-1.6)$ $3.8 (3.3-4.1)$ Olive
B51 (0.7.1.3) -1.4 (-1.81) 1.1 (0.6-1.5) 3.5 (3.1-3.9)B40 (0-0.1) -0.1 (-0.3-0) 2.1 (1.8-2.3) 4.2 (3.9-4.5)B30.6 (0.5-0.9) -3.3 (-3.53.2) 1.2 (0.7-1.5) 2.1 (1.8-2.3)B20.1 (0-0.1)0 (-0.3-0.2) 2 (1.7-2.2) 4.2 (3.9-4.4)B10.3 (0.2-0.4) -0.7 (-1.10.4) 1.6 (1.2-1.9) 3.8 (3.4-4.1)NR W0.4 (0.3-0.5) -1.2 (-1.9-0.6) 0.9 (0.2-1.4) 3.3 (2.5-3.8)NR E0.1 (0.1-0.1) -0.4 (-0.8-0.2) 1.7 (1.3-2) 3.8 (3.3-4.2)Pt Fowler0 (0-0) -0.5 (-0.8-0.2) 1.6 (1.2-2) 3.7 (3.1-4.1)Purdie 5.4 (3.9-7.3) -2.4 (-3.2-1.7) 0.1 (-0.8-0.7) 2.5 (1.6-3.2)West 2.7 (2-3.7) -2.9 (-3.9-2.1) -0.5 (-1.5-0.3) 2 (0.9-2.8)Fenelon 2.1 (1.5-2.8) -3.1 (-4.1-2.3) -0.7 (-1.8-0.1) 1.7 (0.6-2.6)Lounds 0.5 (0.4-0.7) -1 (-1.4-0.8) 1.4 (1.1-1.7) 3.9 (3.5-4.1)B'water 0.2 (0.1-0.2) -0.3 (-0.5-0.2) 2.4 (2.3-2.6) 4.6 (4.4-4.7)Befuscu 5.2 (3.7-7) -3.6 (-4.8-2.6) -1.2 (-2.5-0.2) 1.2 (-0.1-2.2)Lilliput 1.3 (1-1.8) -1.2 (-1.6-0.9) 1.2 (0.8-1.6) 3.8 (3.3-4.1)Olive 18.6 (13.5-25.1) -5.2 (-7-3.8) -2.8 (-4.7-1.4) -0.4 (-2.4-1)N Baudin 8.7 (6.3-11.7) -5.2 (-7-3.8) -2.7 (-4.61.3) -0.4 (-2.3-1.1)Pt Labatt
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B20.1 (0-0.1)0 (-0.3-0.2)2 (1.7-2.2)4.2 (3.9-4.4)B10.3 (0.2-0.4)-0.7 (-1.10.4)1.6 (1.2-1.9)3.8 (3.4-4.1)NR W0.4 (0.3-0.5)-1.2 (-1.90.6)0.9 (0.2-1.4)3.3 (2.5-3.8)NR E0.1 (0.1-0.1)-0.4 (-0.80.2)1.7 (1.3-2)3.8 (3.3-4.2)Pt Fowler0 (0-0)-0.5 (-0.80.2)1.6 (1.2-2)3.7 (3.1-4.1)Purdie5.4 (3.9-7.3)-2.4 (-3.21.7)0.1 (-0.8-0.7)2.5 (1.6-3.2)West2.7 (2-3.7)-2.9 (-3.92.1)-0.5 (-1.5-0.3)2 (0.9-2.8)Fenelon2.1 (1.5-2.8)-3.1 (-4.1-2.3)-0.7 (-1.8-0.1)1.7 (0.6-2.6)Lounds0.5 (0.4-0.7)-1 (-1.4-0.8)1.4 (1.1-1.7)3.9 (3.5-4.1)B'water0.2 (0.1-0.2)-0.3 (-0.5-0.2)2.4 (2.3-2.6)4.6 (4.4-4.7)Blefuscu5.2 (3.7-7)-3.6 (-4.82.6)-1.2 (-2.50.2)1.2 (-0.1-2.2)Lilliput1.3 (1-1.8)-1.2 (-1.6-0.9)1.2 (0.8-1.6)3.8 (3.3-4.1)Olive18.6 (13.5-25.1)-5.2 (-7-3.8)-2.8 (-4.7-1.4)-0.4 (-2.3-1.1)Pt Labatt0.7 (0.5-0.9)-4.9 (-6.7-3.6)-3.4 (-5.6-1.6)-1.5 (-3.8-0.3)Jones1.8 (1.3-2.4)-6.8 (-9.4-4.9)-4.6 (-7.2-2.7)-2.5 (-5.1-0.5)Dorothee0.1 (0.1-0.2)-3.1 (-4.4-2.2)-1.7 (-3.4-0.5)-0.5 (-2.5-1.1)Pearson4.6 (3.4-6.3)-7.8 (-10.6-5.7)-5.6 (-8.4-3.4)-3.3 (-6.11.1)Ward6.8 (5-9.2)-8.8 (-11.9-6.5)-5.2 (-7.9-3.1) <t< td=""></t<>
B10.3 (0.2-0.4)-0.7 (-1.1-0.4)1.6 (1.2-1.9)3.8 (3.4-4.1)NR W0.4 (0.3-0.5)-1.2 (-1.9-0.6)0.9 (0.2-1.4)3.3 (2.5-3.8)NR E0.1 (0.1-0.1)-0.4 (-0.8-0.2)1.7 (1.3-2)3.8 (3.3-4.2)Pt Fowler0 (0-0)-0.5 (-0.8-0.2)1.6 (1.2-2)3.7 (3.1-4.1)Purdie5.4 (3.9-7.3)-2.4 (-3.21.7)0.1 (-0.8-0.7)2.5 (1.6-3.2)West2.7 (2-3.7)-2.9 (-3.92.1)-0.5 (-1.5-0.3)2 (0.9-2.8)Fenelon2.1 (1.5-2.8)-3.1 (-4.1-2.3)-0.7 (-1.8-0.1)1.7 (0.6-2.6)Lounds0.5 (0.4-0.7)-1 (-1.40.8)1.4 (1.1-1.7)3.9 (3.5-4.1)B'water0.2 (0.1-0.2)-0.3 (-0.5-0.2)2 (1.8-2.2)4.3 (4.1-4.5)Gliddon0.1 (0-0.1)0.3 (0.2-0.5)2.4 (2.3-2.6)4.6 (4.4-4.7)Blefuscu5.2 (3.7-7)-3.6 (-4.8-2.6)-1.2 (-2.5-0.2)1.2 (-1.2-2.2)Lilliput1.3 (1-1.8)-1.2 (-1.6-0.9)1.2 (0.8-1.6)3.8 (3.3-4.1)Olive18.6 (13.5-25.1)-5.2 (-7-3.8)-2.7 (-4.6-1.3)-0.4 (-2.3-1.1)N Baudin8.7 (6.3-11.7)-5.2 (-7-3.8)-2.7 (-4.6-1.3)-0.4 (-2.3-1.1)N Baudin8.7 (6.3-11.7)-5.2 (-7-3.8)-2.7 (-4.6-1.3)-0.4 (-2.3-1.1)N Baudin8.7 (6.3-1.6)-1.5 (-3.8-0.3)Jones1.8 (1.3-2.4)-6.8 (-9.4-4.9)-4.6 (-7.2-2.7)-2.5 (-5.1-0.5)Dorothee0.1 (0.1-0.2)-3.1 (-4.4-2.2)-1.7 (-3.4-0.5)-0.5 (-2.5-1.1)Pearson4.6 (3.4-6.3)
NR W $0.4 (0.3 \cdot 0.5)$ $-1.2 (-1.9 - 0.6)$ $0.9 (0.2 \cdot 1.4)$ $3.3 (2.5 \cdot 3.8)$ NR E $0.1 (0.1 \cdot 0.1)$ $-0.4 (-0.8 - 0.2)$ $1.7 (1.3 \cdot 2)$ $3.8 (3.3 \cdot 4.2)$ Pt Fowler $0 (0 - 0)$ $-0.5 (-0.8 - 0.2)$ $1.6 (1.2 \cdot 2)$ $3.7 (3.1 \cdot 4.1)$ Purdie $5.4 (3.9 \cdot 7.3)$ $-2.4 (-3.2 \cdot -1.7)$ $0.1 (0.8 \cdot 0.7)$ $2.5 (1.6 \cdot 3.2)$ West $2.7 (2 \cdot 3.7)$ $-2.9 (-3.9 \cdot -2.1)$ $-0.5 (-1.5 \cdot 0.3)$ $2 (0.9 \cdot 2.8)$ Fenelon $2.1 (1.5 \cdot 2.8)$ $-3.1 (-4.1 \cdot -2.3)$ $-0.7 (-1.8 \cdot 0.1)$ $1.7 (0.6 \cdot 2.6)$ Lounds $0.5 (0.4 \cdot 0.7)$ $-1 (-1.4 \cdot -0.8)$ $1.4 (1.1 \cdot 1.7)$ $3.9 (3.5 \cdot 4.1)$ B'water $0.2 (0.1 \cdot 0.2)$ $-0.3 (-0.5 \cdot -0.2)$ $2 (1.8 \cdot 2.2)$ $4.3 (4.1 \cdot 4.5)$ Gliddon $0.1 (0 \cdot 0.1)$ $0.3 (0.2 \cdot 0.5)$ $2.4 (2.3 \cdot 2.6)$ $4.6 (4.4 \cdot 4.7)$ Blefuscu $5.2 (3.7 \cdot 7)$ $-3.6 (-4.8 \cdot -2.6)$ $-1.2 (-2.5 \cdot -0.2)$ $1.2 (-0.1 \cdot -2.2)$ Lilliput $1.3 (1 \cdot 1.8)$ $-1.2 (-1.6 \cdot 0.9)$ $1.2 (0.8 \cdot 1.6)$ $3.8 (3.3 \cdot 4.1)$ Olive $18.6 (13.5 \cdot 25.1)$ $-5.2 (-7 \cdot -3.8)$ $-2.8 (-4.7 - 1.4)$ $-0.4 (-2.3 \cdot 1.1)$ N Baudin $8.7 (6.3 \cdot 11.7)$ $-5.2 (-7 \cdot -3.8)$ $-2.8 (-4.7 - 1.4)$ $-0.4 (-2.3 \cdot 1.1)$ Pt Labatt $0.7 (0.5 \cdot 0.9)$ $-4.9 (-6.7 \cdot -3.6)$ $-3.4 (-5.6 - 1.6)$ $-1.5 (-3.8 \cdot 0.3)$ Jones $1.8 (1.3 \cdot 2.4)$ $-6.8 (-9.4 \cdot -4.9)$ $-4.6 (-7.2 \cdot -2.7)$ $-2.5 (-5.1 \cdot 1.0.5)$ Dorothee $0.1 (0.1 \cdot 0.2)$ $-3.1 (-4.4 \cdot -2.$
NR E $0.1 (0.1-0.1)$ $-0.4 (-0.8-0.2)$ $1.7 (1.3-2)$ $3.8 (3.3-4.2)$ Pt Fowler $0 (0-0)$ $-0.5 (-0.8-0.2)$ $1.6 (1.2-2)$ $3.7 (3.1-4.1)$ Purdie $5.4 (3.9-7.3)$ $-2.4 (-3.2-1.7)$ $0.1 (-0.8-0.7)$ $2.5 (1.6-3.2)$ West $2.7 (2-3.7)$ $-2.9 (-3.9-2.1)$ $-0.5 (-1.5-0.3)$ $2 (0.9-2.8)$ Fenelon $2.1 (1.5-2.8)$ $-3.1 (-4.1-2.3)$ $-0.7 (-1.8-0.1)$ $1.7 (0.6-2.6)$ Lounds $0.5 (0.4-0.7)$ $-1 (-1.4-0.8)$ $1.4 (1.1-1.7)$ $3.9 (3.5-4.1)$ B'water $0.2 (0.1-0.2)$ $-0.3 (-0.5-0.2)$ $2 (1.8-2.2)$ $4.3 (4.1-4.5)$ Gliddon $0.1 (0-0.1)$ $0.3 (0.2-0.5)$ $2.4 (2.3-2.6)$ $4.6 (4.4-4.7)$ Blefuscu $5.2 (3.7-7)$ $-3.6 (-4.82.6)$ $-1.2 (-2.50.2)$ $1.2 (-0.1-2.2)$ Lilliput $1.3 (1-1.8)$ $-1.2 (-1.6-0.9)$ $1.2 (0.8-1.6)$ $3.8 (3.3-4.1)$ Olive $18.6 (13.5-25.1)$ $-5.2 (-73.8)$ $-2.7 (-4.61.3)$ $-0.4 (-2.3-1.1)$ N Baudin $8.7 (6.3-11.7)$ $-5.2 (-73.8)$ $-2.7 (-4.61.6)$ $-1.5 (-3.8-0.3)$ Jones $1.8 (1.3-2.4)$ $-6.8 (-9.4-4.9)$ $-4.6 (-7.22.7)$ $-2.5 (-5.1-0.5)$ Dorothee $0.1 (0.1-0.2)$ $-3.1 (-4.4-2.2)$ $-1.7 (-3.4-0.5)$ $-0.5 (-2.5-1.1)$ Pearson $4.6 (3.4-6.3)$ $-7.8 (-10.65.7)$ $-5.6 (-8.43.4)$ $-3.3 (-6.11.1)$ Ward $6.8 (5-9.2)$ $-8.8 (-11.9-6.5)$ $-5.2 (-7.93.1)$ $-2.9 (-5.7-0.8)$ Four Hummocks $2.5 (1.8-3.4)$ $-11.9 $
Pt Fowler0 (0-0) -0.5 (-0.8- 0.2)1.6 (1.2-2)3.7 (3.1-4.1)Purdie5.4 (3.9-7.3) -2.4 (-3.2- -1.7)0.1 (-0.8- 0.7)2.5 (1.6-3.2)West2.7 (2-3.7) -2.9 (-3.9- -2.1) -0.5 (-1.5- 0.3)2 (0.9- 2.8)Fenelon2.1 (1.5- 2.8) -3.1 (-4.1- -2.3) -0.7 (-1.8- 0.1)1.7 (0.6- 2.6)Lounds0.5 (0.4- 0.7) -1 (-1.4- -0.8)1.4 (1.1- 1.7)3.9 (3.5- 4.1)B'water0.2 (0.1- 0.2) -0.3 (-0.5- 0.2)2 (1.82- 2.2)4.3 (4.1- 4.5)Gliddon0.1 (0-0.1)0.3 (0.2- 0.5)2.4 (2.3- 2.6)4.6 (4.4- 4.7)Blefuscu5.2 (3.7-7) -3.6 (-4.8- -2.6) -1.2 ($-2.5-0.2$)1.2 ($-0.1-2.2$)Lilliput1.3 (1-1.8) -1.2 (-1.6- 0.9)1.2 (0.8-1.6)3.8 (3.3- 4.1)Olive18.6 (13.5- 25.1) -5.2 ($-7-3.8$) -2.8 ($-4.7-1.4$) -0.4 ($-2.4-1$)N Baudin8.7 (6.3-11.7) -5.2 ($-7-3.8$) -2.7 ($-4.6-1.3$) -0.4 ($-2.4-1$)N Baudin8.7 (6.3-11.7) -5.2 ($-7-3.8$) -2.7 ($-4.6-1.3$) -0.4 ($-2.4-1$)N Baudin8.7 (6.3-11.7) -5.2 ($-7-3.8$) -2.7 ($-4.6-1.3$) -0.4 ($-2.4-1$)N Baudin8.7 (6.3-1.17) -5.2 ($-7-3.8$) -2.7 ($-4.6-1.3$) -0.4 ($-2.4-1$)N Baudin8.7 (6.3-1.17) -5.2 ($-7-3.8$) -2.7 ($-4.6-1.3$) -0.4 ($-2.4-1$)N Baudin8.7 (6.3-1.6) -1.5 ($-5.2-6.7$) -5.6 ($-8.43.4$) -3.3 ($-6.11.1$)Vard 6.8 (59
Purdie 5.4 ($3.9-7.3$) -2.4 ($-3.2-1.7$) 0.1 ($-0.8-0.7$) 2.5 ($1.6-3.2$)West 2.7 ($2-3.7$) -2.9 ($-3.9-2.1$) -0.5 ($-1.5-0.3$) 2 ($0.9-2.8$)Fenelon 2.1 ($1.5-2.8$) -3.1 ($-4.1-2.3$) -0.7 ($-1.8-0.1$) 1.7 ($0.6-2.6$)Lounds 0.5 ($0.4-0.7$) -1 ($-1.4-0.8$) 1.4 ($1.1-1.7$) 3.9 ($3.5-4.1$)B'water 0.2 ($0.1-0.2$) -0.3 ($-0.5-0.2$) 2 ($1.8-2.2$) 4.3 ($4.1-4.5$)Gliddon 0.1 ($0-0.1$) 0.3 ($0.2-0.5$) 2.4 ($2.3-2.6$) 4.6 ($4.4-7$)Blefuscu 5.2 ($3.7-7$) -3.6 ($-4.8-2.6$) -1.2 ($-2.5-0.2$) 1.2 ($-0.1-2.2$)Lilliput 1.3 ($1.1.8$) -1.2 ($-1.6-0.9$) 1.2 ($0.8-1.6$) 3.8 ($3.3-4.1$)Olive 18.6 ($13.5-25.1$) -5.2 ($-7-3.8$) -2.7 ($-4.6-1.3$) -0.4 ($-2.4-1$)N Baudin 8.7 ($6.3-11.7$) -5.2 ($-7-3.8$) -2.7 ($-4.6-1.3$) -0.4 ($-2.4-1$)N Baudin 8.7 ($6.3-11.7$) -5.2 ($-7-3.8$) -2.7 ($-4.6-1.3$) -0.4 ($-2.4-1$)N Baudin 8.7 ($6.3-11.7$) -5.2 ($-7-3.8$) -2.7 ($-4.6-1.3$) -0.4 ($-2.4-1$)N Baudin 8.7 ($6.3-11.7$) -5.2 ($-7-3.8$) -2.7 ($-4.6-1.3$) -0.4 ($-2.4-1$)N Baudin 8.7 ($6.3-11.7$) -5.2 ($-7-3.8$) -2.7 ($-4.6-1.3$) -0.4 ($-2.4-1$)N Baudin 8.7 ($6.3-11.7$) -5.2 ($-7-3.8$) -2.7 ($-4.6-1.3$) -0.4 ($-2.4-1$)N Baudin 8.7 ($6.3-11.7$) -5.2 ($-7-3.8$)
West $2.7 (2-3.7)$ $-2.9 (-3.9-2.1)$ $-0.5 (-1.5-0.3)$ $2 (0.9-2.8)$ Fenelon $2.1 (1.5-2.8)$ $-3.1 (-4.1-2.3)$ $-0.7 (-1.8-0.1)$ $1.7 (0.6-2.6)$ Lounds $0.5 (0.4-0.7)$ $-1 (-1.4-0.8)$ $1.4 (1.1-1.7)$ $3.9 (3.5-4.1)$ B'water $0.2 (0.1-0.2)$ $-0.3 (-0.5-0.2)$ $2 (1.8-2.2)$ $4.3 (4.1-4.5)$ Gliddon $0.1 (0-0.1)$ $0.3 (0.2-0.5)$ $2.4 (2.3-2.6)$ $4.6 (4.4-4.7)$ Blefuscu $5.2 (3.7-7)$ $-3.6 (-4.82.6)$ $-1.2 (-2.5-0.2)$ $1.2 (-0.1-2.2)$ Lilliput $1.3 (1-1.8)$ $-1.2 (-1.6-0.9)$ $1.2 (0.8+1.6)$ $3.8 (3.3-4.1)$ Olive $18.6 (13.5-25.1)$ $-5.2 (-73.8)$ $-2.8 (-4.71.4)$ $-0.4 (-2.4-1)$ N Baudin $8.7 (6.3-11.7)$ $-5.2 (-73.8)$ $-2.8 (-4.71.4)$ $-0.4 (-2.3-1.1)$ Pt Labatt $0.7 (0.5-0.9)$ $-4.9 (-6.73.6)$ $-3.4 (-5.61.6)$ $-1.5 (-3.8-0.3)$ Jones $1.8 (1.3-2.4)$ $-6.8 (-9.44.9)$ $-4.6 (-7.22.7)$ $-2.5 (-5.1-0.5)$ Dorothee $0.1 (0.1-0.2)$ $-3.1 (-4.42.2)$ $-1.7 (-3.40.5)$ $-0.5 (-2.5-1.1)$ Pearson $4.6 (3.4-6.3)$ $-7.8 (-10.6-5.7)$ $-5.6 (-8.43.4)$ $-3.3 (-6.11.1)$ Ward $6.8 (5-9.2)$ $-8.8 (-11.9-6.5)$ $-6.5 (-9.74.2)$ $-4.3 (-7.61.9)$ Waldegrave $20.4 (14.9-27.6)$ $-7.5 (-10.1-5.5)$ $-5.2 (-7.93.1)$ $-2.9 (-5.70.8)$ Four Hummocks $2.5 (1.8-3.4)$ $-11.9 (-16.48.5)$ $-10.1 (-14.56.5)$ $-7.9 (-12.64.3)$ Roc
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Lounds $0.5 (0.4-0.7)$ $-1 (-1.4-0.8)$ $1.4 (1.1-1.7)$ $3.9 (3.5-4.1)$ B'water $0.2 (0.1-0.2)$ $-0.3 (-0.5-0.2)$ $2 (1.8-2.2)$ $4.3 (4.1-4.5)$ Gliddon $0.1 (0-0.1)$ $0.3 (0.2-0.5)$ $2.4 (2.3-2.6)$ $4.6 (4.4-4.7)$ Blefuscu $5.2 (3.7-7)$ $-3.6 (-4.8-2.6)$ $-1.2 (-2.5-0.2)$ $1.2 (-0.1-2.2)$ Lilliput $1.3 (1-1.8)$ $-1.2 (-1.6-0.9)$ $1.2 (0.8-1.6)$ $3.8 (3.3-4.1)$ Olive $18.6 (13.5-25.1)$ $-5.2 (-7-3.8)$ $-2.8 (-4.7-1.4)$ $-0.4 (-2.4-1)$ N Baudin $8.7 (6.3-11.7)$ $-5.2 (-7-3.8)$ $-2.8 (-4.7-1.4)$ $-0.4 (-2.3-1.1)$ Pt Labatt $0.7 (0.5-0.9)$ $-4.9 (-6.7-3.6)$ $-3.4 (-5.61.6)$ $-1.5 (-3.8-0.3)$ Jones $1.8 (1.3-2.4)$ $-6.8 (-9.4-4.9)$ $-4.6 (-7.2-2.7)$ $-2.5 (-5.1-0.5)$ Dorothee $0.1 (0.1-0.2)$ $-3.1 (-4.4-2.2)$ $-1.7 (-3.4-0.5)$ $-0.5 (-2.5-1.1)$ Pearson $4.6 (3.4-6.3)$ $-7.8 (-10.6-5.7)$ $-5.6 (-8.43.4)$ $-3.3 (-6.11.1)$ Ward $6.8 (5-9.2)$ $-8.8 (-11.9-6.5)$ $-6.5 (-9.7-4.2)$ $-4.3 (-7.61.9)$ Waldegrave $20.4 (14.9-27.6)$ $-7.5 (-10.1-5.5)$ $-5.2 (-7.9-3.1)$ $-2.9 (-5.7-0.8)$ Four Hummocks $2.5 (1.8-3.4)$ $-11.9 (-16.4-8.5)$ $-10 (-14.5-6.5)$ $-7.9 (-12.6-4.3)$ Rocky North $1.8 (1.3-2.4)$ $-6.1 (-8.44.4)$ $-4.1 (-6.5-2.3)$ $-1.9 (-4.3-0.1)$ Price $5.2 (3.8-7.1)$ $-12.2 (-16.58.8)$ $-10.1 (-14.6-6.6)$ $-7.8 (-12.34.3)$
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Black Point $0.1 (0.1-0.2) = -3.4 (-4.82.3) = -2.1 (-3.90.7) = -1.(-3.1-0.8)$
Seal Slide 23 (17-31) -82 (-11 2-58) -63 (-0.4-38) -41 (-7.2-16)
SPage 32.2 (1.7.0.1) 5.2 (1.7.2-5.0) -0.3 (-5.2-1.6) -1.1 (-7.3-1.0)
NPage $244(176-331) -54(-73-30) -29(-48-14) -07(-27-00)$
Mean $197 (142-266) -34 (-4.7-24) -12 (-2.6-0.1) 0.0 (-0.5-2.1)$
% of subpops. 96 (90-96) 50 (46-56) 42 (21-46)

Table 7.20. Summary of the estimated impacts of bycatch mortality on ASL populations in South Australia using three measures of population viability: Terminal Extinction Rate (TER), Quasi Extinction Time (QET), and the estimated population growth rates over the next 20 breeding cycles (~29 years). Comparisons are made between a 'No bycatch' mortality and a 'With bycatch' mortality based on the current distribution of fishing effort (2006-2009) in the sector GHAT fishery off SA.

Intrinsic rate of growth scenario	% of subpopulations TER greater than 10% (±95% CL)		% of subpopulations with QET <3 generations (±95% CL)		% of subpopulations declining (±95% CL)	
	No bycatch	With bycatch	No bycatch	With bycatch	No bycatch	With bycatch
0% (stable)	50	77 (73-81)	65	81 (73-83)	0	96 (90-96)
2.5% (medium)	0	40 (31-48)	60	69 (65-73)	0	50 (46-56)
5% (high)	0	31 (19-38)	58	63 (60-65)	0	42 (21-46)



Figure 7.1. Schematic representation of the various components of data used, and the steps undertaken to develop foraging and bycatch estimation models.



Figure 7.2. Schematic diagram of a demersal shark gill-net being hauled, depicting the lay of the net on the benthos and its ascent through and out of the water, and over the net roller (illustration by D. Hamer).



Figure 7.3. Distribution of raw satellite positions from 157 tracked adult female ASL from 17 subpopulations (A.), their derived foraging tracks after filtering (B.) and distribution of foraging effort following time-in-area analyses (C.) (red to light blue scale indicates higher to lower areas of use). Green dots represent the location of ASL subpopulations.



Figure 7.4. Distribution of raw satellite positions from 31 tracked adult male ASL from nine subpopulations (A.), their derived foraging tracks after filtering (B.) and distribution of foraging effort following time-in-area analyses (C.) (red to light blue scale indicates higher to lower areas of use). Green dots represent the location of ASL subpopulations.



Figure 7.5. Distribution of raw satellite positions from 22 tracked juveniles ASL from 4 subpopulations (A.), their derived foraging tracks after filtering (B.) and distribution of foraging effort following time-inarea analyses (C.) (red to light blue scale indicates higher to lower areas of use). Green dots represent the location of ASL subpopulations.

A. All adult females







Figure 7.6. Examples of density plots of the time spent at distance and depth for all tracked adult female ASL (A.), and the Dangerous Reef (B.) and Lilliput Is (C.) subpopulations. Time spent at distance and depth for all tracked juvenile ASL (D.) is also presented. The red vertical line indicates the mean of the data, and the fit of normal and gamma probability distributions are given by green and blue lines, respectively.

A. Adult males 'West'



B. Adult males 'Gulf'

C. Adult males 'KI'



Figure 7.7. Examples of density plots of the time spent at distance and depth for tracked adult male ASL western Eyre Peninsula subpopulations (WEST,A.), in southern Spencer Gulf and Gulf Saint Vincent (Gulf, B.) and off the south coast of Kangaroo Island (KI, C.) The red vertical line indicates the mean of the data, and the fit of normal and gamma probability distributions are given by green and blue lines, respectively.



Figure 7.8. Scatterplots of the proportion of dive bottom time as a function of dive depth for 27,079 female dives (from nine ASL, above)) and 113,816 male dives (from four ASL, below)). Generalised linear mixed-effects models (GLMMs) of complementary log-log transformed data (proportion bottom time) are presented.



Figure 7.9. Modelled distribution of bottom-time foraging effort for adult female ASL in the South Australian population. The gradient from red to light blue colours indicates areas from highest to lowest foraging effort. Green dots indicate the location of the 48 SA subpopulations. Bathymetry lines are indicated from light to dark blue (100, 200, 500, 1000, 2000m).





Figure 7.10. Modelled contour distribution of core foraging areas of adult female Australian sea lions in the South Australian population. The smallest area that contains the highest 10% of all foraging effort from each subpopulations is indicated in red, progressing in 10% contours out to the minimum area that contains 100% of the foraging effort (dark blue)(see method section "Core foraging areas" for further explanation). Green dots indicate the location of the 48 SA subpopulations. Bathymetry lines are indicated from light to dark blue (100, 200, 500, 1000, 2000m)



Figure 7.11. Modelled distribution of bottom-time foraging effort for adult males ASL in the South Australian population. The gradient from red to light blue colours indicates areas from highest to lowest foraging effort. Green dots indicate the location of the 48 SA subpopulations. Bathymetry lines are indicated from light to dark blue (100, 200, 500, 1000, 2000m).



Figure 7.12. Modelled contour distribution of core foraging areas of adult male Australian sea lions in the South Australian population. The smallest area that contains the highest 10% of all foraging effort from each subpopulation is indicated in red, progressing in 10% contours out to the minimum area that contains 100% of the foraging effort (dark blue)(see method section "Core foraging areas" for further explanation). Green dots indicate the location of the 48 SA subpopulations. Bathymetry lines are indicated from light to dark blue (100, 200, 500, 1000, 2000m).



Figure 7.13. Modelled distribution of bottom-time foraging effort for juvenile ASL in the South Australian population. The gradient from red to light blue colours indicates areas from highest to lowest foraging effort. Green dots indicate the location of the 48 SA subpopulations. Bathymetry lines are indicated from light to dark blue (100, 200, 500, 1000, 2000m).





Figure 7.14. Modelled contour distribution of core foraging areas of juvenile Australian sea lions in the South Australian population. The smallest area that contains the highest 10% of all foraging effort from each subpopulation is indicated in red, progressing in 10% contours out to the minimum area that contains 100% of the foraging effort (dark blue) (see method section "Core foraging areas" for further explanation). Green dots indicate the location of the 48 SA subpopulations. Bathymetry lines are indicated from light to dark blue (100, 200, 500, 1000, 2000m).



Figure 7.15. Overall model of the distribution of bottom-time foraging effort of the in South Australian population of Australian sea lions including adult females, males and juveniles. The gradient from red to light blue colours indicates areas from highest to lowest foraging effort. Green dots indicate the location of the 48 SA subpopulations. Bathymetry lines are indicated from light to dark blue (100, 200, 500, 1000, 2000m).



Figure 7.16. Contour plot of the minimum distance from Australian sea lion subpopulations in South Australia in 20km increments. Green dots indicate the location of the 48 SA subpopulations. Bathymetry lines are indicated from light to dark blue (100, 200, 500, 1000, 2000m).



Figure 7.17. Frequency histograms (from left to right) of net-set length (km), soak-time (hrs) and netlength x soak-time (km.hrs), in the gillnet sector of the GHAT fishery off South Australia between 1 January 2006 and 25 July 2009 (total of 17,676 net-sets, soak-time data available for 17,637 netsets). Data are based on fishery logbook data provided by AFMA.



Figure 7.18. Spatial distribution of fishing effort (net-set km) (A), CPUE (kg/km) (B) and core CPUE (kg/km) (C) for 2006-2009. Effort and CPUE data smoothed using Inverse Distance Weighting (red high, blue low). Core CPUE is presented as a gradient (0-100%), in 10% contours (highest core CPUE 0-10% (red), lowest core CPUE 90-100% deep blue).



Figure 7.19. Spatial distribution of fishing effort (net-set km-hrs) (A), CPUE (kg/km.hr) (B) and core CPUE (kg/km.hr) (C) for 2006-2009. Effort and CPUE data smoothed using Inverse Distance Weighting (red high, blue low). Core CPUE is presented as gradient (0-100%), in 10% contours (highest CPUE 0-10% (red), lowest CPUE 90-100% deep blue).



Figure 7.20. Comparison of the distribution of fishing effort in the gillnet sector of the GHAT fishery off South Australia (1 January 2006 to 25 July 2009) and adult female, adult male and juvenile ASL foraging effort relative to depth (m) (A-C) and minimum distance from ASL subpopulation sites (km) (D-F). Fishing effort data (km.hr) east of 139° longitude have been excluded.



Figure 7.21. Proportion, cumulative fishing effort and CPUE of gummy shark occurring within 10 percentiles of core foraging areas of adult female ASL in the gillnet sector GHAT fishery off South Australia (1 January 2006 to 25 July 2009). Effort and CPUE are presented in km and kg/km (A-C) and km.hr and kg/km.hr (D-F). Data east of 139° longitude have been excluded. The figures illustrate that most of the fishing effort and regions of high CPUE in the fishery occur well within the core foraging areas of ASL females





Figure 7.22. Distribution of observed net-sets in the gillnet sector of the GHAT fishery off South Australia relative to the modelled distribution of foraging effort for the SA population of ASL. Net-sets where ASL bycatch mortalities were observed (pink dots) and were not observed (white dots) are indicated. The gradient from red to blues indicates areas from highest to lowest foraging effort (seal days/yr). Green dots indicate the location of the 48 SA subpopulations. Bathymetry lines are indicated from light blue to dark blue (100, 200, 500, 1000, 2000m).



Figure 7.23. Comparison of the linear models of mean foraging effort (bottom time) and bycatch rate expressed as Seals/km for 3 to 8 bin models (A-F).



Figure 7.24. Comparison of the linear models of mean foraging effort (bottom time) and bycatch rate expressed as Seals/km.hr for 3 to 8 bin models (A-F).



Figure 7.25. Trade-off 6-bin model of mean foraging effort (bottom time) and bycatch rate expressed as seals/km.hr (A), and a box-plot to illustrate the sample size and range differences between bins (B). A histogram of the distribution of male and female ASL bycatch mortalities relative to the foraging effort distribution illustrates that most mortalities occur within the 0-20 seal days/year range (C). Figure D-F are the same as figures A-C, except that the 6th bin in the model has been removed, and the bycatch distribution has been recalculated for comparison.



Figure 7.26. Estimated number of ASL females, and the relative percentage within each subpopulations taken as bycatch mortality each breeding cycle (17.5 months) in the gillnet of the GHAT fishery off SA, based on the distribution of fishing effort between 2006-2009. The ranges (±95% CL) are given for each estimate.



Females taken as bycatch mortality /breeding cycle (%)

Figure 7.27. Histogram of the estimated number of ASL females (>1.5 years) in South Australian subpopulations taken as bycatch mortality each breeding cycle (17.5 months) in the gillnet GHAT fishery off South Australia.



Figure 7.28. Estimated Terminal Extinction Risk (TER) of subpopulations of ASL in South Australia based on estimated bycatch mortalities resulting from the current distribution of fishing effort in the gillnet GHAT fishery off SA (2006-2009). TER is the probability that a subpopulation will become extinct within 100 breeding cycles (~145.8 years), and is given for three intrinsic growth-rate scenarios stable (0%), medium (2.5%) and high (5%) with ±95% CL.







Figure 7.29. The estimated contribution to the Terminal Extinction Risk of ASL subpopulations in South Australia attributable to their size and to estimated bycatch mortality, for three scenarios of intrinsic growth rate: stable (A. 0%), medium (B. 2.5%) and high (C 5%), based on estimated bycatch mortalities resulting from the distribution of fishing effort in the gillnet GHAT fishery off SA from 2006 to 2009.



Figure 7.30. Estimates of the Quasi-Extinction Time (QET – the number of years for the median [half, 250] of the simulated population trajectory replicates to fall below a per breeding cycle pup production of 5 pups). QETs (±95% CL) are given for three intrinsic growth rates scenarios (stable, 0%), medium (2.5%) and high (5%) based on the estimated bycatch mortalities resulting from the distribution of fishing effort in the gillnet GHAT fishery off SA from 2006 to 2009. QETs beyond the range of the PVA simulations (100 breeding cycles, 145.8 years) are not presented.



Figure 7.31. Estimated ASL subpopulation growth rates (±95% CL) based on the estimated bycatch mortalities resulting from the distribution of fishing effort in the gillnet GHAT fishery off SA from 2006 to 2009. Subpopulation growth rates are estimated for 20 breeding cycles (~29 years) for three different intrinsic growth-rate scenarios (stable, 0%), medium (2.5%) and high (5%).




Figure 7.32. Estimated bycatch vulnerability of ASL subpopulation in South Australia, based on the current distribution of fishing effort in the gillnet sector of the GHAT fishery. Highly vulnerable (subpopulation growth rates estimated to be negative or close to zero, high terminal extinction risk); medium vulnerable (negative or positive growth rates, depending on intrinsic growth scenario, terminal extinction risk <10%, except under stable growth), and least vulnerable subpopulations (subpopulations that are estimated to foraging within areas closed to the fishery) are indicated by red, orange and green dots, respectively.

8 ASSESSMENT OF SPATIAL MANAGEMENT OPTIONS TO MITIGATE BYCATCH OF AUSTRALIAN SEA LIONS IN THE GILLNET GHAT FISHERY OFF SOUTH AUSTRALIA

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Introduction

The Australian sea lion (ASL) is listed under *the Environment Protection and Biodiversity Conservation* Act 1999 (EPBC Act) as *Threatened* ('vulnerable' category, February 2005), and as *vulnerable* under the South Australian National Parks and Wildlife Act 1972 (February 2008). Recently, the International Union for the Conservation of Nature (IUCN) listed ASL as *Endangered* (October 2008). The ASL is also protected under the South Australian Fisheries Management Act 2007.

The policy and legislative background from a fisheries and threatened species management perspective has been detailed in Section 4 (Need). The most pressing of these from a fisheries management perspective is Condition 8 of the Southern and Eastern, Scalefish and Shark Fishery (SESSF) WTO (December 2008), which requires that: "*AFMA, after considering advice from relevant experts, to develop and implement management measures, including fishery closures, that take account of site-specific issues and which seek to minimise the risks of interactions between fisheries regulated by <i>AFMA and sea lions by 21 December 2009*." This condition was extended in a variation to the declaration of an approved WTO (Gazetted 19 February 2010), which now states under Conditions 6b "*by June 2010, taking into account current information and in consultation with marine mammal*

experts, AFMA to implement long-term management measures, including formal fishery closures and other actions, that will lead to a significant reduction of the impact of the fishery on Australian sea lions. These measures will be clearly directed towards enabling recovery of the species, including all subpopulations."

This section of the report, aims to provide a range of potential spatial management closure options in the gillnet sector GHAT fishery off South Australia, and an assessment of their expected benefit in terms of reduction in ASL bycatch mortality to assist fisheries and threatened species managers in mitigating ASL bycatch in the gillnet sector GHAT fishery.

Methods

Spatial management scenarios

Spatial management scenarios were tested using methods developed in the preceding chapter. Fishing effort data from 2007 to July 2009 were used as a measure of the expected fishery effort into the future, based on advice from AFMA regarding changes in the fishery post 2006, as part of the Australian Government's "Securing our Fishing Future", structural adjustment package.

The distribution of fishing effort for the period January 2006 to July 2009 was used to distribute the mean 2007-2009 effort (set initially at 100,000 km.hrs, for comparative purposes) across the present distribution of the fishery. Changes to the distribution of fishing effort were modelled by extracting values for proportion of fishing effort (across 2006-2009), female core foraging area, depth and minimum distance from an ASL subpopulation for each 1 x 1 km node in the array. Depending on the management scenarios being examined and the values for the node parameters, a subset of nodes that satisfied the management scenarios was selected, with fishing effort apportioned proportionally across the selected nodes. The bycatch rate estimation equation was then applied to the ASL foraging effort and fishing effort values for the subset of nodes, and the sum of these gave estimates of ASL bycatch mortality which could then be apportioned to subpopulations by number of individuals and sex as detailed in Chapter 7.

The bycatch rate estimation equation for ASL bycatch as a function of net-set km.hrs is: $seals/km.hr = 0.000511 \times btfe \times FE_{km.hr}$ The 95% confidence limits are:

seals/km.hr (-95% CL) =
$$0.000379 \times btfe \times FE_{km.hr}$$

seals/km.hr (+95% CL) = $0.000692 \times btfe \times FE_{km.kr}$

Where *btfe* is sea lion bottom-time foraging effort (seal days/yr) and $FE_{km,hr}$ is fishing effort in terms of km.hrs net-set.

Population viability analyses (PVAs) were run on all subpopulations based upon the percentage of females removed as bycatch mortality over the course of one breeding cycle (17.5 months). PVAs were undertaken using the approach detailed in Chapter 7.

Assessment of different spatial management scenarios

Management scenarios were examined using reduction to fishing areas based on four factors considered separately: closures of SA state waters; female core foraging areas, minimum depth range of the fishery and minimum distance from subpopulations. For each scenario, the estimated changes in overall bycatch mortality (all ASLs, females and males separately, each with ±95% CL) were estimated with fishing effort removed completely, or with fishing effort displaced to the remaining fishing areas. Displaced fishing effort was apportioned across the remaining fishing areas proportional to the proportion of fishing effort in the remaining nodes. The reduction in area available to the fishery and the remaining fishing effort was also calculated.

Estimated changes to bycatch levels of individual subpopulations under these management scenarios were also investigated. Given the objectives used here are to minimise female bycatch mortality, to simplify assessment of management scenarios all population viability analyses (PVAs) were run assuming a stable population (i.e., 0% growth). In this way, the potential impact of any additional bycatch mortality on a subpopulation could be easily assessed, as positive growth rates have the potential to mask the impacts on recovery from a low level of bycatch mortality. Furthermore, given that the majority (58%) of subpopulations are small (produce <30 pups), their recovery potential is unknown, and their recovery time is likely to be long. As such, the stable growth scenario provides the most conservative approach to assessing the potential impacts on subpopulation growth and recovery, as small subpopulations are mixed amongst the larger ones and the foraging distributions of neighbouring subpopulations overlap, it is not possible to partition up foraging areas from high and lower risk subpopulations.

Stable growth models are the easiest to interpret when the aim is to minimise female bycatch mortality, because any additional female bycatch mortality will cause the subpopulation to decline. Although these may not accurately reflect the potential implications of bycatch mortality on subpopulations which are growing, they provide the most conservative PVA scenarios. Furthermore, the assessment criteria used is principally the number of female bycatch mortalities. PVA assessment based on stable subpopulation growth is used to provide a worst-case assessment of the potential impact of certain levels of bycatch on particular subpopulations. PVAs on individual subpopulations were undertaken assuming no displacement of fishing effort from spatial closures (i.e., with fishing effort unaltered for areas remaining in the fishery).

Following this, the main criteria against which different spatial management scenarios are compared are:

- estimated female, male and total ASL bycatch mortality
- the percentage of subpopulations with terminal extinction risk >10%
- the percentage of subpopulations with a quasi-extinction time (QET) <3 generations (i.e., 33.3 years),
- the percentage of subpopulations with declining growth rates (calculated over 20 breeding cycles), and
- the loss of fishery area as a proportion of the current area available to the fishery.

Results

The estimated changes to Australian sea lion (ASL) bycatch mortality that would result from four scenarios of spatial closure to the demersal gillnet fishery are presented in Tables 8.1-8.3. The scenarios involve closure of: South Australian State waters; minimum core foraging areas of ASL females; minimum depth and minimum distance from ASL subpopulations. The areas represented as closures to the fishery in these scenarios are presented in Figures 8.1-8.3. The level of reduction in bycatch mortality of all ASL (females and males), achieved from each management scenario was greatest when fishing effort was removed. For each management scenario displacement of fishing effort into the remaining areas of the fishery reduced the benefits (in terms of ASL bycatch reduction) by increasing numbers of bycatch mortalities in the area remaining to the fishery. Displaced fishing effort also increased the confidence limits of estimated bycatch mortality for both male and female ASL (Tables 8.1-8.4). Comparison of the reductions to ASL bycatch mortality achieved from removed and

displaced fishing effort for minimum female core foraging area, minimum depth and subpopulation distance closures are presented in Figure 8.5.

South Australian State waters comprise 10% of the area currently available to the fishery. Closure of these waters is estimated to achieve a 27.7% reduction in ASL female bycatch mortality if the fishing effort is removed completely or an 18.7% reduction in female bycatch mortality if fishing effort is displaced to remaining areas of the fishery (Table 8.1).

Closure scenarios based upon minimum core foraging areas of ASL females resulted in the greatest bycatch mortality reductions for a given area closed to the fishery, compared to bycatch mortality reductions involving depth and distance approaches (Tables 8.1-8.3, Figure 8.5). With all scenarios, closures nearest to subpopulations provided the greatest reduction in bycatch mortality, relative to closures further away, whether they were based on core foraging area, depth or distance (Figure 8.5). Based on removal of fishing effort, ASL female bycatch mortality could be reduced to zero if 100% of minimum female core foraging areas were to be closed, if the minimum depth range of the fishery were 110m or if the minimum distance from subpopulations fished was 130km (Tables 8.1-8.3).

The relative benefit to cost in terms of female bycatch reduction and area of fishery lost based on core foraging area, depth and distance (including removed or displace fishing effort) is presented in Figure 8.6. The figure demonstrates that management strategies based around core foraging area is most likely to produce the greatest benefit in terms of bycatch reduction with the minimum cost to the fishery. Based on these analyses female bycatch could be reduced by 95% by reducing the fishing area by 50% based on female core foraging areas, 59% based on depth restrictions and 65% based on minimum distance restriction (Figure 8.6). All scenarios based on displaced fishing effort performed poorer with respect to the level of female bycatch reduction achieved.

The area of the fishery closed based on depth and distance closures could be reduced by not applying management arrangements east of 139.5° longitude, which is east of the eastern-most extension of female core foraging areas from of The Pages. The modelling tools developed here could be used to examine the bycatch reduction benefits from any number of potential management arrangements.

Within each of the above management scenarios that involve removal of fishing effort rather than its displacement, the predicted bycatch mortality of ASL females for each subpopulation is presented in Tables 8.4-8.28. These tables include the percentage of females from each subpopulation removed as bycatch mortality, and their terminal extinction risks, quasiextinction times and projected growth rates over the next 20 breeding cycles (based on stable intrinsic growth rates). The tables provide many examples of very low levels of bycatch mortality (<1 female per breeding cycle) increasing the risk of extinction, especially for small subpopulations where there is a high extinction probability even in the absence of bycatch mortality.

Discussion

We have examined a range of potential management closure approaches that could provide protection to ASL subpopulations from bycatch mortality in the gillnet GHAT fishery off South Australia. We have identified the elimination of bycatch mortality of ASL females as the key management objective for any fishery closures, based on: 1) identified risks to ASL subpopulations (Chapter 7), and 2) the need to implement spatial management closures in the gillnet sector GHAT fishery off South Australia that will satisfy conditions of the WTO accreditation for the SESSF, 3) sections relating to threatened species conservation and management under the EPBC Act, and 4) the Australian Governments' proposed objectives for the recovery of the Australian sea lion as detailed in the Draft Recovery Plan.

Goldsworthy and Page (2007) identified that even very low levels of bycatch mortality for small ASL subpopulations can increase their risk of extinction. This has been confirmed through analyses undertaken in this study, although as discussed here and in Chapter 7, the underlying intrinsic population growth rate will determine the extent to which subpopulations can withstand low or moderate levels of bycatch mortality. As discussed, the underlying population growth rates are unknown for most ASL subpopulations, particularly small ones (<30 pups) that make up the majority of ASL subpopulations. We have applied the stable population model (0% growth) to small subpopulations for the following reasons: because there is no data to support their capacity to recover; their recovery times would be very long even under optimal population growth rates and hence they are at greater risk compared to large subpopulations from stochastic events and other threatening processes; and the uncertain role of Allee effects on their recovery. Because of the preponderance of very small and vulnerable subpopulations, management arrangements to minimise the impacts of bycatch mortality will need to take into account the extreme vulnerability of many ASL subpopulations, particularly the uncertainty in the level of protection afforded by different management arrangements.

Analyses indicate that area closures to the fishery would need to be very large to significantly reduce the bycatch impacts on subpopulations. Areas near subpopulations where female foraging density is greatest are in greatest need of protection, although areas near the limits of female foraging are also important, especially where some foraging effort from smaller subpopulations may occur. As identified in Chapter 7, under the present distribution of fishing effort, most female bycatch mortality occurs within areas of lower foraging effort. The risk of not affording these outer areas equal protection is that displaced fishing effort could still impose significant bycatch mortalities on small subpopulations.

We have assumed that displaced fishing effort would be distributed proportionally when added to the remaining areas of the fishery. This assumption is likely to be unrealistic, as effort is more likely to contract to regions which currently have a high CPUE and to regions closer to ports. Therefore, for some regions that remain open to fishing, bycatch mortality rates of ASL would likely increase and the impact on some subpopulations may be even greater than before the introduction of ASL closures. This analysis has clearly identified that the benefit of fishing closures, in terms of reduction to ASL bycatch mortalities, would be significantly reduced if fishing effort were displaced to remaining areas of the fishery. It emphasises a critical point for the management of bycatch mortality in the gillnet GHAT fishery: if closures do not completely protect foraging areas of ASL females, changes in fishing behaviour and displacement of fishing effort could lead to increased extinction risks for some subpopulations. As identified in Chapter 7, the level of fishing effort in areas remaining open to the fishery that overlap with ASL foraging areas would need to be managed carefully.

Closure scenarios based on core foraging areas of ASL females provided the greatest reduction in bycatch while minimising the area that would be closed to the fishery. However, there are some potential problems in using this approach to guide the area of fishery closures. Firstly, for most subpopulations, core foraging areas are based on statistical models and assumptions about their foraging distributions are based on data from other subpopulations. Thus there is some uncertainty in the level of protection that fishery closures based on predicted core foraging areas would provide to these subpopulations. Furthermore, as some of the boundaries based on this approach are highly convoluted, they would be difficult to implement as fishery closures. Using minimum distances from ASL subpopulations as a means to guide fishery closures would potentially lead to greater fishing area reduction than necessary to achieve the management objectives, because some distance measures would result in closures in water beyond the foraging depth range of ASL. Minimum depth restrictions are likely to provide the simplest basis to guide fishery

closures, as irrespective of the distance from subpopulations, ASL females are limited to the depths in which they can forage, and management of closures by depth would be easier to implement in the fishery. Almost all ASL females satellite-tracked foraged in water shallower than 120m (Chapter 7). All fishing vessels have sounders and the outer boundary of the fishery is also presently set by depth (183m). The problem with using minimum depth alone as a guide to fishery closures, is that it may also close areas of the fishery where ASL do not forage. For example, regions east of 139.5° longitude (east of the easternmost ASL subpopulation) are estimated to have very low levels of female foraging effort. As such, depth closures could be applied to certain regions of the fishery that overlap with female core foraging areas. The modelling tools developed here could be used investigate any number of management scenarios, including a combination of factors (female core area,

depth, and minimum distance) and other criteria (SA State waters, additional net closures, marine parks, fishery CPUE etc.).

Conclusion

A range of closure scenarios was examined based upon closure of SA State waters, minimum female core foraging areas, minimum depth range and distance from subpopulations. These analyses indicated that fishery closures would need to be very large if they are to significantly reduce female bycatch mortality in the fishery. Closure scenarios based on core female foraging areas provided the greatest reduction in bycatch while minimising the area closed to the fishery, but would be difficult to implement. Closures based around minimum depth ranges would be more easily implemented. The benefit of fishing closures, in terms of reduction in bycatch mortalities, was greatest when fishing effort was removed, and was significantly reduced when fishing effort was displaced to remaining areas of the fishery. Fisheries and threatened species managers should be aware that if closures do not completely protect female foraging areas, changes in fishing behaviour and displacement of fishing effort could lead to increased levels of bycatch and extinction risks for some subpopulations. Table 8.1. Estimated changes in ASL bycatch mortality resulting from gillnet GHAT fishery closures in core foraging areas of female ASL off South Australia. The proportion of the core area closed to the fishery is indicated, along with the proportion of original fishing area closed and effort (based on current distribution) under each management scenario. Bycatch estimates are given with fishing effort removed and with fishing effort displaced to remaining areas of the fishery. The last scenario (bottom row) refers to the closure of South Australian State waters to the fishery.

Female core Area area closed closed to to fishery fishery		Estimated ASL b	fort removed	Total fishing effort	Female bycatch reduction (%)	Estimated ASL bycatch – fishing effort displaced			Total fishing effort	Female bycatch reduction (%)	
(%)	(%)	Total	Female	Male	(km.hrs)		Total	Female	Male	(km.hrs)	()
0	0.0	344 (257-470)	179 (134-245)	165 (123-225)	100,000	0.0	344 (257-470)	179 (134-245)	165 (123-225)	100,000	0.0
5	2.4	316 (237-433)	163 (122-224)	153 (115-209)	96,499	8.8	327 (245-448)	169 (127-232)	158 (119-217)	100,000	5.5
10	4.8	285 (214-391)	146 (110-200)	139 (104-191)	92,340	18.3	309 (232-423)	158 (119-217)	151 (113-207)	100,000	11.5
15	7.4	259 (194-354)	132 (98-180)	128 (96-174)	88,572	26.4	293 (219-400)	149 (111-203)	144 (108-197)	100,000	16.9
20	10.0	226 (168-308)	114 (85-155)	112 (84-153)	84,255	36.3	268 (200-365)	135 (101-184)	133 (99-181)	100,000	24.4
25	12.9	194 (144-264)	95 (71-129)	99 (74-135)	79,192	46.8	245 (182-333)	120 (89-163)	125 (93-170)	100,000	32.8
30	15.7	167 (124-226)	79 (59-108)	88 (65-119)	73,893	55.7	226 (168-306)	107 (80-146)	119 (88-161)	100,000	40.0
35	18.5	142 (106-193)	65 (48-88)	77 (57-105)	69,120	63.6	206 (153-279)	94 (70-128)	112 (83-152)	100,000	47.4
40	21.2	125 (92-169)	55 (41-74)	70 (52-95)	65,563	69.5	190 (141-257)	83 (62-113)	107 (79-145)	100,000	53.4
45	24.0	110 (81-149)	46 (34-63)	63 (47-86)	62,019	74.1	177 (131-240)	75 (55-101)	102 (76-139)	100,000	58.3
50	27.1	98 (73-133)	40 (30-54)	58 (43-78)	58,460	77.6	168 (124-227)	68 (51-93)	99 (73-134)	100,000	61.7
55	30.4	87 (64-117)	34 (25-46)	53 (39-71)	54,929	80.9	158 (117-214)	62 (46-84)	96 (71-130)	100,000	65.2
60	33.4	78 (58-105)	29 (22-40)	48 (36-65)	51,928	83.5	149 (111-202)	57 (42-77)	93 (69-126)	100,000	68.3
65	36.4	69 (51-94)	25 (19-34)	44 (33-60)	49,083	86.0	141 (104-191)	51 (38-69)	90 (67-122)	100,000	71.5
70	39.3	60 (44-81)	20 (15-28)	39 (29-53)	45,463	88.6	131 (97-177)	45 (33-61)	86 (64-117)	100,000	75.0
75	42.8	51 (38-69)	16 (12-22)	35 (26-47)	42,013	91.0	121 (89-163)	38 (29-52)	82 (61-111)	100,000	78.5
80	46.1	42 (31-57)	13 (9-17)	30 (22-40)	39,022	93.0	109 (81-147)	32 (24-44)	77 (57-104)	100,000	82.0
85	50.1	34 (25-46)	9 (7-12)	25 (18-34)	35,389	95.0	95 (71-129)	25 (19-34)	70 (52-95)	100,000	86.0
90	55.9	24 (17-32)	5 (3-6)	19 (14-26)	29,856	97.4	79 (59-107)	16 (12-21)	63 (47-86)	100,000	91.3
95	64.1	13 (10-18)	2 (1-2)	12 (9-16)	24,030	99.1	95 (71-129)	25 (19-34)	70 (52-95)	100,000	96.2
100	89.2	4 (3-5)	0 (0-0)	4 (3-5)	10,567	100.0	35 (26-47)	0 (0-1)	34 (25-46)	100,000	99.8
SA waters closed	10.0	251 (187-341)	129 (96-175)	122 (91-166)	88,849	27.7	283 (210-384)	145 (108-197)	138 (102-187)	100,000	18.7

Table 8.2. Estimated changes in ASL bycatch resulting from fishery closures based on minimum depth ranges in the gillnet GHAT fishery off South Australia. The minimum depth range of the fishery is indicated, along with the proportion of original fishing area closed and effort (based on current distribution) under each management scenario. Bycatch estimates are given with fishing effort removed and with fishing effort displaced to remaining areas of the fishery.

Minimum depth closed to fishery (m)	Area closed to fishery (%)	Estimated ASL bycatch – fishing effort removed		Total fishing effort (km.hrs)	Female bycatch reduction (%)	Estimated ASL b	vycatch – fishing eff Female	ort displaced Male	Total fishing effort (km.hrs)	Female bycatch reduction (%)	
0	0.0	344 (257-470)	179 (134-245)	165 (123-225)	100,000	0.0	344 (257-470)	179 (134-245)	165 (123-225)	100,000	0.0
-10	0.3	342 (257-469)	178 (134-244)	164 (123-225)	99,837	0.3	343 (257-469)	179 (134-245)	164 (123-225)	100,000	0.1
-20	0.7	339 (254-464)	177 (132-242)	162 (121-222)	99,227	1.2	342 (256-467)	178 (133-244)	163 (122-224)	100,000	0.4
-30	2.0	314 (234-427)	164 (122-223)	150 (112-204)	96,860	8.4	324 (241-441)	169 (126-230)	155 (115-211)	100,000	5.4
-40	5.3	279 (207-378)	146 (108-198)	133 (98-180)	91,231	18.1	306 (227-414)	160 (119-217)	146 (108-197)	100,000	10.3
-50	13.9	228 (169-308)	122 (91-166)	105 (78-143)	77,387	31.6	294 (218-398)	158 (117-214)	136 (101-184)	100,000	11.6
-60	27.8	149 (110-201)	77 (57-105)	72 (53-97)	59,353	56.8	251 (186-339)	130 (96-176)	121 (89-163)	100,000	27.2
-70	43.9	59 (44-80)	25 (18-34)	34 (26-47)	37,274	86.1	159 (118-215)	67 (49-90)	92 (68-125)	100,000	62.8
-80	55.4	34 (25-46)	13 (10-18)	21 (15-28)	26,706	92.5	127 (94-172)	50 (37-68)	77 (57-104)	100,000	71.8
-90	65.0	13 (9-17)	4 (3-5)	9 (7-12)	15,914	97.9	79 (59-107)	24 (18-32)	55 (41-75)	100,000	86.6
-100	75.0	4 (3-6)	1 (1-1)	4 (3-5)	9,138	99.5	47 (35-64)	9 (7-12)	38 (29-52)	100,000	95.0
-110	81.2	1 (1-2)	0 (0-0)	1 (1-2)	5,100	99.9	28 (21-38)	3 (2-4)	25 (19-34)	100,000	98.4
-120	87.3	1 (0-1)	0 (0-0)	1 (0-1)	2,693	100.0	20 (15-27)	1 (1-1)	19 (14-26)	100,000	99.6
-130	92.4	0 (0-0)	0 (0-0)	0 (0-0)	1,252	100.0	14 (11-19)	0 (0-0)	14 (10-19)	100,000	99.9

Table 8.3. Estimated changes in ASL bycatch resulting from fishery closures based on minimum distance to ASL subpopulations in the gillnet GHAT fishery off South Australia. The proportion of the core area closed is indicated, along with the proportion of original fishing area closed and effort (based on current distribution) under each management scenario. Bycatch estimates are given with fishing effort removed and with fishing effort displaced to remaining areas of the fishery.

Minimum distance from ASL subpopulation	Area closed to fishery	Estimated ASL bycatch – fishing effort removed			Total fishing effort (km.hrs)	Female bycatch reduction (%)	Estimated ASL bycatch – fishing effort displaced			Total fishing effort (km.hrs)	Female bycatch reduction (%)
fishery (km)		Total	Female	Male			Total	Female	Male		
0	0.0	344 (257-470)	179 (134-245)	165 (123-225)	100,000	0.0	344 (257-470)	179 (134-245)	165 (123-225)	100,000	0.0
10	2.9	284 (211-385)	147 (109-199)	137 (102-186)	94,618	17.7	300 (223-407)	155 (115-210)	145 (107-196)	100,000	13.1
20	10.6	192 (142-260)	96 (71-130)	95 (71-129)	81,172	46.1	236 (175-320)	119 (88-161)	118 (87-159)	100,000	33.6
30	19.3	129 (96-175)	64 (47-86)	65 (48-88)	66,640	64.3	194 (144-262)	96 (71-130)	98 (73-133)	100,000	46.5
40	28.4	93 (69-126)	46 (34-62)	47 (35-64)	56,179	74.5	165 (123-224)	81 (60-110)	84 (63-114)	100,000	54.7
50	37.6	67 (49-90)	30 (23-41)	36 (27-49)	47,864	83.0	139 (103-189)	63 (47-86)	76 (56-103)	100,000	64.5
60	46.3	49 (36-66)	20 (15-28)	28 (21-38)	41,066	88.6	118 (88-160)	50 (37-67)	69 (51-93)	100,000	72.2
70	53.7	38 (28-51)	15 (11-21)	22 (17-30)	35,374	91.4	107 (79-144)	43 (32-59)	63 (47-85)	100,000	75.7
80	60.0	28 (21-38)	11 (8-15)	17 (13-23)	29,910	94.0	93 (69-126)	36 (27-49)	57 (42-77)	100,000	79.9
90	65.3	23 (17-31)	8 (6-11)	15 (11-20)	27,058	95.3	85 (63-115)	31 (23-42)	54 (40-73)	100,000	82.5
100	70.1	17 (13-23)	5 (4-7)	12 (9-16)	23,617	97.0	73 (54-99)	23 (17-31)	50 (37-68)	100,000	87.2
110	74.7	12 (9-16)	3 (2-3)	9 (7-12)	19,659	98.6	59 (44-80)	13 (10-18)	46 (34-62)	100,000	92.7
120	78.9	8 (6-11)	1 (1-1)	7 (5-9)	16,692	99.4	48 (36-65)	6 (5-8)	42 (31-57)	100,000	96.6
130	82.7	6 (4-8)	0 (0-1)	5 (4-7)	13,840	99.7	41 (30-55)	3 (3-5)	38 (28-51)	100,000	98.1

Table 8.4. Subpopulation estimates of female bycatch, and percentage of females removed as bycatch mortality per breeding cycle. Terminal Extinction Risk (TER), Quasi-extinction Time (QET, and estimated growth rate over the next 20 breeding cycles (% per 17.5 months) are also given assuming an underlying stable intrinsic growth rate. \pm 95 CL are given in parentheses. The current estimated pup production per subpopulation is also shown. The table presents estimates based on the current distribution of the GHAT fishery off South Australia (100,000 km.hrs/yr), with removal of fishing effort within SA State waters (no displaced effort). The % of subpopulations with TERs >0.1, QETs < 3 generations (33.3 yrs) and negative growth rates are given on the last line of the table.

Subpop	Pup prod	Female bycatch	% females/sub	TER	QET	Growth rate
B9	17	0.4 (0.3-0.6)	1.6 (1.2-2.1)	0.13 (0.11-0.16)	2 (2-2)	-1.3 (-1.80.9)
B8	38	1 (0.7-1.3)	1.5 (1.1-2.1)	0.06 (0.03-0.11)	22 (24-18)	-1.6 (-2.11.2)
B7	3	0.1 (0.1-0.1)	1.5 (1.1-2.1)	0.48 (0.48-0.49)	1 (1-1)	-0.2 (-0.5-0)
B6	12	0.3 (0.2-0.4)	1.5 (1.1-2.1)	0.25 (0.23-0.28)	1 (1-1)	-0.7 (-1.20.3)
B5	43	0.9 (0.6-1.2)	1.2 (0.9-1.7)	0.02 (0.02-0.04)	47 (56-37)	-1.3 (-1.71)
B4	2	0 (0-0.1)	1.2 (0.9-1.6)	0.48 (0.48-0.48)	1 (1-1)	-0.1 (-0.3-0.1)
B3	31	0.6 (0.4-0.8)	1.1 (0.8-1.5)	0.04 (0.03-0.06)	10 (11-9)	-3.3 (-3.43.2)
B2	5	0 (0-0.1)	0.5 (0.4-0.7)	0.37 (0.37-0.37)	1 (1-1)	0.2 (0-0.3)
B1	15	0.1 (0.1-0.2)	0.5 (0.3-0.6)	0.13 (0.13-0.14)	1 (1-1)	-0.1 (-0.2-0.1)
NR W	12	0.3 (0.2-0.4)	1.4 (1-1.9)	0.24 (0.23-0.26)	1 (1-1)	-0.5 (-10.2)
NR E	3	0.1 (0-0.1)	1.4 (1-1.8)	0.48 (0.48-0.49)	1 (1-1)	-0.1 (-0.4-0)
Pt Fowler	1	0 (0-0)	1.1 (0.8-1.5)	0.48 (0.48-0.48)	1 (1-1)	0 (-0.2-0.1)
Purdie	132	1.7 (1.3-2.3)	0.8 (0.6-1.1)	0 (0-0)	123 (128-116)	-0.8 (-10.6)
West	56	0.8 (0.6-1.1)	0.9 (0.6-1.2)	0.01 (0.01-0.02)	82 (94-68)	-0.9 (-1.20.7)
Fenelon	40	1.1 (0.8-1.5)	1.7 (1.3-2.3)	0.07 (0.04-0.13)	21 (25-17)	-1.7 (-2.31.3)
Lounds	34	0 (0-0.1)	0.1 (0-0.1)	0.03 (0.03-0.03)	13 (13-13)	-0.2 (-0.20.2)
B'water	17	0 (0-0)	0 (0-0)	0.1 (0.1-0.1)	2 (2-2)	0.2 (0.2-0.3)
Gliddon	7	0 (0-0)	0 (0-0)	0.36 (0.36-0.36)	1 (1-1)	0.8 (0.8-0.8)
Blefuscu	84	1.4 (1.1-2)	1.1 (0.8-1.4)	0 (0-0.01)	98 (108-87)	-1 (-1.40.7)
Lilliput	67	0 (0-0.1)	0 (0-0.1)	0 (0-0)	138 (139-138)	-0.1 (-0.10.1)
Olive	206	3.6 (2.7-4.9)	1.1 (0.8-1.4)	0 (0-0)	130 (136-122)	-1 (-1.40.8)
N Baudin	98	6 (4.5-8.2)	3.8 (2.8-5.1)	0.18 (0.07-0.39)	51 (65-37)	-3.6 (-4.92.7)
Pt Labatt	6	0.5 (0.4-0.6)	4.9 (3.6-6.6)	0.64 (0.52-0.79)	1 (1-1)	-3.6 (-4.82.6)
Jones	15	1.3 (1-1.8)	5.4 (4-7.3)	0.68 (0.5-0.82)	1 (1-1)	-4.9 (-6.83.5)
Dorothee	1	0.1 (0.1-0.1)	6.5 (4.8-8.8)	0.8 (0.66-0.91)	1 (1-1)	-2.5 (-3.61.8)
Pearson	35	3.8 (2.8-5.2)	6.7 (5-9.1)	0.73 (0.53-0.87)	5 (6-4)	-6.5 (-8.74.8)
Ward	45	5.2 (3.9-7.1)	7.1 (5.3-9.7)	0.75 (0.55-0.88)	7 (8-7)	-6.8 (-9.25.1)
Waldegrave	157	14.4 (10.7-19.5)	5.6 (4.2-7.6)	0.43 (0.21-0.68)	52 (67-37)	-5.3 (-7.13.9)
Four Hummocks	12	1.8 (1.4-2.5)	9.4 (7-12.7)	0.93 (0.84-0.97)	1 (1-1)	-8.6 (-126.2)
Rocky North	16	1.3 (1-1.8)	5.1 (3.7-6.8)	0.62 (0.44-0.78)	1 (1-1)	-4.5 (-6.33.3)
Price	25	3.8 (2.8-5.1)	9.2 (6.8-12.5)	0.88 (0.76-0.94)	3 (3-3)	-8.8 (-11.96.5)
Liguanea	43	2.6 (2-3.6)	3.8 (2.8-5.1)	0.3 (0.15-0.51)	14 (21-10)	-3.6 (-4.92.7)
Lewis	131	0 (0-0)	0 (0-0)	0 (0-0)	145 (145-145)	0 (0-0)
East Island	14	0.2 (0.1-0.2)	0.8 (0.6-1.1)	0.15 (0.15-0.16)	1 (1-1)	-0.4 (-0.70.2)
South Neptune	6	0 (0-0.1)	0.4 (0.3-0.5)	0.38 (0.38-0.38)	1 (1-1)	-0.2 (-0.30.2)
Albatross	15	0.1 (0.1-0.2)	0.5 (0.4-0.7)	0.13 (0.13-0.14)	1 (1-1)	-0.1 (-0.3-0)
English	27	0 (0-0)	0 (0-0)	0.03 (0.03-0.03)	5 (5-5)	0.1 (0.1-0.1)
Dangerous	709	0 (0-0)	0 (0-0)	0 (0-0)	145 (145-145)	0 (0-0)
North Islet	28	0 (0-0)	0 (0-0)	0.03 (0.03-0.03)	5 (5-5)	0.1 (0.1-0.1)
Peaked Rocks	24	0 (0-0)	0 (0-0)	0.05 (0.05-0.05)	2 (2-2)	0 (0-0)
N Casuarina	3	0.3 (0.2-0.4)	6 (4.5-8.1)	0.76 (0.63-0.88)	1 (1-1)	-2.3 (-3.31.6)
Cape Bouguer	3	0.3 (0.2-0.3)	5.2 (3.9-7.1)	0.7 (0.58-0.84)	1 (1-1)	-1.9 (-2.81.3)
Cave Point	3	0.3 (0.2-0.4)	5.4 (4-7.3)	0.71 (0.59-0.85)	1 (1-1)	-2 (-2.91.4)
Seal Bay	260	26.2 (19.5-35.7)	6.2 (4.6-8.4)	0.4 (0.15-0.73)	49 (70-32)	-5.7 (-7.84.3)
Black Point	1	0.1 (0.1-0.1)	6.5 (4.8-8.9)	0.8 (0.66-0.91)	1 (1-1)	-2.5 (-3.61.8)
Seal Slide	16	1.8 (1.3-2.4)	6.8 (5.1-9.2)	0.78 (0.62-0.89)	1 (1-1)	-6.2 (-8.54.6)
SPage	331	26.4 (19.7-36)	4.9 (3.6-6.7)	0.21 (0.07-0.49)	71 (85-55)	-4.6 (-6.23.4)
NPage	258	20 (14.9-27.2)	4.7 (3.5-6.5)	0.17 (0.05-0.45)	68 (92-46)	-4.4 (-63.3)
Mean	3107	129 (96-175)	2.8 (2.1-3.8)	0.33 (0.27-0.4)	28 (31-25)	-2.1 (-31.5)
% of subpops.				69 (63-73)	77 (73-75)	85 (75-85)

Table 8.5. Subpopulation estimates of female bycatch, and percentage of females removed as bycatch mortality per breeding cycle. Terminal Extinction Risk (TER), Quasi-extinction Time (QET, and estimated growth rate over the next 20 breeding cycles (% per 17.5 months) are also given assuming an underlying stable intrinsic growth rate. ±95 CL are given in parentheses. The current estimated pup production per subpopulation is also shown. The default bycatch scenario is presented based on the current distribution of fishing effort in the gillnet sector of the GHAT fishery off South Australia (100,000 km.hrs/yr). The % of subpopulations with TERs >0.1, QETs < 3 generations (33.3 vrs) and negative growth rates are given on the last line of the table.

yrs) anu negau	vegiow	li i lales ale give		or the table.		
Subpop.	Pup	Female	%females/sub	TER	QET (years)	Growth rate
B9	17	0.4 (0.3-0.6)	1.6 (1.2-2.1)	0.13 (0.11-	2 (2-2)	-1.3 (-1.80.9)
B8	38	1 (0.7-1.3)	1.5 (1.1-2.1)	0.06 (0.03-	22 (24-18)	-1.6 (-2.11.2)
B7	3	0.1 (0.1-0.1)	1.5 (1.1-2.1)	0.48 (0.48-	1 (1-1)	-0.2 (-0.5-0)
B6	12	0.3 (0.2-0.4)	1.5 (1.1-2.1)	0.25 (0.23-	1 (1-1)	-0.7 (-1.20.3)
B5	43	0.9 (0.6-1.2)	1.2 (0.9-1.7)	0.02 (0.02-	47 (56-37)	-1.3 (-1.71)
B4	2	0 (0-0.1)	1.2 (0.9-1.6)	0.48 (0.48-	1 (1-1)	-0.1 (-0.3-0.1)
B3	31	0.6 (0.4-0.8)	1.1 (0.8-1.5)	0.04 (0.03-	10 (11-9)	-3.3 (-3.43.2)
B2	5	0 (0-0.1)	0.5 (0.4-0.7)	0.37 (0.37-	1 (1-1)	0.2 (0-0.3)
B1	15	0.1 (0.1-0.2)	0.5 (0.3-0.6)	0.13 (0.13-	1 (1-1)	-0.1 (-0.2-0.1)
NR W	12	0.3 (0.3-0.5)	1.8 (1.3-2.4)	0.26 (0.24-0.3)	1 (1-1)	-0.9 (-1.60.5)
NR E	3	0.1 (0.1-0.1)	1.7 (1.3-2.4)	0.48 (0.48-0.5)	1 (1-1)	-0.3 (-0.60.1)
Pt Fowler	1	0 (0-0)	1.6 (1.2-2.2)	0.48 (0.48-	1 (1-1)	-0.3 (-0.50.1)
Purdie	132	4.9 (3.6-6.7)	2.3 (1.7-3.1)	0.03 (0.01-	89 (101-75)	-2.2 (-2.91.6)
West	56	2.6 (2-3.6)	2.8 (2.1-3.9)	0.12 (0.06-	27 (38-17)	-2.8 (-3.82.1)
Fenelon	40	2 (1.5-2.7)	3 (2.2-4.1)	0.23 (0.12-	14 (18-10)	-2.9 (-42.2)
Lounds	34	0.4 (0.3-0.6)	0.7 (0.5-1)	0.03 (0.03-	12 (12-11)	-0.8 (-10.6)
B'water	17	0.1 (0.1-0.1)	0.3 (0.2-0.4)	0.1 (0.1-0.1)	2 (2-2)	0 (-0.1-0.1)
Gliddon	7	0 (0-0)	0.2 (0.2-0.3)	0.36 (0.36-	1 (1-1)	0.6 (0.5-0.6)
Blefuscu	84	4.2 (3.2-5.8)	3.1 (2.3-4.2)	0.13 (0.05-	51 (65-37)	-2.9 (-42.2)
Lilliput	67	0.6 (0.4-0.8)	0.5 (0.4-0.7)	0 (0-0)	110 (117-100)	-0.5 (-0.70.4)
Olive	206	12.8 (10-18.2)	3.8 (3-5.4)	0.13 (0.05-	83 (95-64)	-3.6 (-5.12.8)
N Baudin	98	8.1 (6.1-11.1)	5.1 (3.8-6.9)	0.39 (0.18-	37 (50-25)	-4.9 (-6.63.6)
Pt Labatt	6	0.6 (0.5-0.9)	6.4 (4.8-8.7)	0.78 (0.64-	1 (1-1)	-4.7 (-6.43.5)
Jones	15	1.7 (1.3-2.3)	7.1 (5.2-9.6)	0.81 (0.66-	1 (1-1)	-6.5 (-94.7)
Dorothee	1	0.1 (0.1-0.2)	7.7 (5.7-10.4)	0.86 (0.73-	1 (1-1)	-3.1 (-4.32.1)
Pearson	35	4.6 (3.4-6.2)	8 (5.9-10.8)	0.82 (0.65-	5 (6-4)	-7.7 (-10.45.7)
Ward	45	6.7 (4.9-9)	9 (6.7-12.2)	0.86 (0.71-	7 (7-7)	-8.6 (-11.76.4)
Waldegrave	157	19.6 (14.5-	7.6 (5.6-10.3)	0.69 (0.43-	36 (51-24)	-7.2 (-9.75.3)
Four	12	2.4 (1.8-3.3)	12.4 (9.2-16.8)	0.97 (0.93-	1 (1-1)	-11.6 (-16.1
Rocky North	16	1.7 (1.3-2.3)	6.6 (4.9-8.9)	0.76 (0.6-0.88)	1 (1-1)	-6 (-8.24.4)
Price	25	5.1 (3.8-6.9)	12.5 (9.3-16.9)	0.94 (0.88-	3 (3-2)	-11.9 (-16.1
Liguanea	43	4.2 (3.1-5.6)	5.9 (4.4-8)	0.62 (0.4-0.81)	8 (12-7)	-5.7 (-7.64.2)
Lewis	131	0.2 (0.2-0.3)	0.1 (0.1-0.2)	0 (0-0)	145 (145-141)	-0.1 (-0.20.1)
East Island	14	1.1 (0.8-1.4)	4.6 (3.4-6.3)	0.58 (0.39-	1 (1-1)	-4 (-5.62.9)
South Neptune	6	0.3 (0.2-0.4)	2.9 (2.1-3.9)	0.46 (0.41-	1 (1-1)	-2.1 (-2.91.5)
Albatross	15	0.5 (0.4-0.7)	2.2 (1.6-3)	0.24 (0.18-	1 (1-1)	-1.8 (-2.51.2)
English	27	0 (0-0)	0 (0-0)	0.03 (0.03-	5 (5-5)	0.1 (0.1-0.1)
Dangerous	709	0.1 (0.1-0.1)	0 (0-0)	0 (0-0)	145 (145-145)	0 (0-0)
North Islet	28	0.2 (0.2-0.3)	0.5 (0.4-0.7)	0.03 (0.03-	4 (5-4)	-0.4 (-0.60.3)
Peaked Rocks	24	0.4 (0.3-0.5)	1 (0.7-1.3)	0.06 (0.06-	2 (2-2)	-0.9 (-1.20.6)
N Casuarina	3	0.5 (0.4-0.7)	10.4 (7.7-14.1)	0.94 (0.87-	1 (1-1)	-4.4 (-6.13.1)
Cape Bouguer	3	0.4 (0.3-0.5)	7.7 (5.8-10.5)	0.87 (0.74-	1 (1-1)	-3.1 (-4.42.2)
Cave Point	3	0.4 (0.3-0.5)	7.7 (5.7-10.4)	0.86 (0.74-	1 (1-1)	-3.1 (-4.42.2)
Seal Bay	260	33.8 (25.4-	8 (6-10.9)	0.68 (0.37-0.9)	35 (51-23)	-7.4 (-10.15.5)
Black Point	1	0.1 (0.1-0.2)	8.1 (6-11)	0.88 (0.76-	1 (1-1)	-3.3 (-4.62.3)
Seal Slide	16	2.2 (1.7-3)	8.5 (6.4-11.6)	0.87 (0.75-	1 (1-1)	-7.8 (-10.85.8)
SPage	331	29.8 (22.4-	5.5 (4.1-7.6)	0.3 (0.11-0.63)	64 (79-48)	-5.2 (-7.13.9)
NPage	258	22.5 (16.9-	5.3 (4-7.3)	0.26 (0.09-	59 (81-39)	-4.9 (-6.83.7)
Mean	3107	179 (134-245)	4 (3-5.5)	0.41 (0.34-0.5)	22 (25-19)	-3.1 (-4.32.3)
% of subpops.				77 (69-79)	79 (73-81)	90 (85-92)

Table 8.6. Subpopulation estimates of female bycatch, and percentage of females removed as bycatch mortality per breeding cycle. Terminal Extinction Risk (TER), Quasi-extinction Time (QET, and estimated growth rate over the next 20 breeding cycles (% per 17.5 months) are also given assuming an underlying stable intrinsic growth rate. \pm 95 CL are given in parentheses. The current estimated pup production per subpopulation is also shown. The table presents estimates based on the current distribution of the GHAT fishery off South Australia (100,000 km.hrs/yr), with removal of the top 10% of female core foraging areas (no displaced effort). The % of subpopulations with TERs >0.1, QETs < 3 generations (33.3 yrs) and negative growth rates are given on the last line of the table.

Subpop	Pup prod	Female	% females/sub	TER	QET	Growth rate
B9	17	0.3 (0.3-0.5)	1.2 (0.9-1.7)	0.11 (0.11-0.13)	2 (2-2)	-0.9 (-1.30.6)
B8	38	0.7 (0.5-1)	1.2 (0.9-1.6)	0.04 (0.02-0.06)	24 (27-21)	-1.3 (-1.61)
B7	3	0.1 (0-0.1)	1.2 (0.9-1.6)	0.48 (0.48-0.48)	1 (1-1)	-0.1 (-0.3-0.1)
B6	12	0.2 (0.2-0.3)	1.2 (0.9-1.6)	0.24 (0.23-0.25)	1 (1-1)	-0.3 (-0.7-0)
B5	43	0.7 (0.5-1)	1 (0.8-1.4)	0.02 (0.01-0.03)	52 (61-43)	-1 (-1.40.8)
B4	2	0 (0-0)	1 (0.7-1.3)	0.48 (0.48-0.48)	1 (1-1)	0 (-0.1-0.2)
B3	31	0.5 (0.3-0.6)	0.9 (0.7-1.2)	0.03 (0.03-0.05)	10 (11-10)	-3.2 (-3.33.1)
B2	5	0 (0-0)	0.4 (0.3-0.5)	0.37 (0.37-0.37)	1 (1-1)	0.4 (0.2-0.4)
B1	15	0.1 (0-0.1)	0.2 (0.2-0.3)	0.13 (0.13-0.13)	1 (1-1)	0.2 (0.1-0.3)
NR W	12	0.3 (0.2-0.4)	1.3 (1-1.8)	0.24 (0.23-0.26)	1 (1-1)	-0.5 (-0.90.1)
NR E	3	0.1 (0-0.1)	1.3 (1-1.8)	0.48 (0.48-0.48)	1 (1-1)	-0.1 (-0.3-0)
Pt Fowler	1	0 (0-0)	1.2 (0.9-1.7)	0.48 (0.48-0.48)	1 (1-1)	-0.1 (-0.3-0.1)
Purdie	132	3.6 (2.7-4.9)	1.7 (1.2-2.3)	0.01 (0-0.03)	102 (111-89)	-1.6 (-2.21.2)
West	56	1.6 (1.2-2.2)	1.7 (1.3-2.4)	0.03 (0.02-0.08)	50 (63-34)	-1.7 (-2.31.3)
Fenelon	40	1.5 (1.1-2.1)	2 3 (1 7-3 2)	0 13 (0 07-0 26)	17 (21-13)	-2.3 (-3.11.7)
Lounds	34	0.3 (0.2-0.4)	0.5(0.4-0.7)	0.03 (0.03-0.03)	12 (13-12)	-0.6 (-0.80.5)
B'water	17	0.0 (0.2 0.4)	0.0(0.40.7) 0.2(0.1-0.2)	0.00 (0.00 0.00)	2 (2-2)	0.0 (0.0 0.0)
Gliddon	7	0 (0 0)	0.2(0.1-0.2)	0.26 (0.26 0.26)	$\frac{2}{1}(\frac{2}{1})$	0.7 (0.6 0.7)
Blofuscu	94	(0,0,0)	0.1(0.1-0.2)	0.30(0.30-0.30)	F (1-1)	0.7(0.0-0.7)
Lilliput	67	3.3(2.4-4.4)	2.4(1.0-3.2)	0.03 (0.02-0.14)	110 (124	-2.2(-3.1-1.7)
	206	0.4 (0.3-0.3)	0.3(0.3-0.3)		04 (105 77)	-0.4(-0.5-0.3)
Olive N Devidir	200	10.3 (7.9-	3.1 (2.3-4.3)	0.00 (0.02-0.16)	94 (105-77)	-2.9 (-4.12.2)
	96	0.5 (4.6-6.6)	4 (3-5.5)	0.22 (0.09-0.45)	47 (62-33)	-3.9 (-5.22.9)
Pt Labatt	6	0.5 (0.4-0.7)	5.1 (3.8-6.9)	0.66 (0.53-0.81)	1 (1-1)	-3.7 (-5.12.7)
Jones	15	1.4 (1-1.9)	5.7 (4.2-7.7)	0.7 (0.52-0.84)	1 (1-1)	-5.2 (-7.13.7)
Dorothee	1	0.1 (0.1-0.1)	6 (4.5-8.2)	0.76 (0.63-0.89)	1 (1-1)	-2.3 (-3.31.6)
Pearson	35	3.5 (2.6-4.7)	6.1 (4.5-8.2)	0.67 (0.46-0.83)	6 (7-4)	-5.9 (-7.94.4)
Ward	45	5.1 (3.8-6.9)	6.9 (5.1-9.3)	0.73 (0.52-0.87)	7 (9-7)	-6.6 (-8.94.9)
Waldegrave	157	17.9 (13.2-	7 (5.2-9.4)	0.61 (0.36-0.82)	41 (56-27)	-6.6 (-8.94.9)
Four Hummocks	12	2.2 (1.6-2.9)	11.1 (8.2-15)	0.96 (0.9-0.98)	1 (1-1)	-10.3 (-14.2
Rocky North	16	1.5 (1.1-2.1)	5.8 (4.3-7.9)	0.7 (0.52-0.84)	1 (1-1)	-5.3 (-7.23.8)
Price	25	3.5 (2.6-4.7)	8.6 (6.4-11.6)	0.86 (0.72-0.93)	3 (3-3)	-8.2 (-11.16)
Liguanea	43	2.5 (1.9-3.4)	3.6 (2.7-4.9)	0.27 (0.14-0.48)	15 (22-10)	-3.5 (-4.72.6)
Lewis	131	0.1 (0.1-0.2)	0.1 (0-0.1)	0 (0-0)	145 (145-	-0.1 (-0.10.1)
East Island	14	0.7 (0.5-0.9)	3 (2.2-4.1)	0.33 (0.23-0.49)	1 (1-1)	-2.5 (-3.51.7)
South Neptune	6	0.2 (0.1-0.2)	1.6 (1.2-2.2)	0.39 (0.38-0.41)	1 (1-1)	-1.1 (-1.60.8)
Albatross	15	0.3 (0.2-0.4)	1.2 (0.9-1.6)	0.15 (0.14-0.18)	1 (1-1)	-0.8 (-1.20.5)
English	27	0 (0-0)	0 (0-0)	0.03 (0.03-0.03)	5 (5-5)	0.1 (0.1-0.1)
Dangerous	709	0 (0-0)	0 (0-0)	0 (0-0)	145 (145-	0 (0-0)
North Islet	28	0.2 (0.1-0.3)	0.4 (0.3-0.5)	0.03 (0.03-0.03)	4 (5-4)	-0.3 (-0.50.2)
Peaked Rocks	24	0.3 (0.2-0.4)	0.8 (0.6-1.1)	0.06 (0.05-0.07)	2 (2-2)	-0.7 (-10.5)
N Casuarina	3	0.4 (0.3-0.5)	8.1 (6-10.9)	0.88 (0.76-0.95)	1 (1-1)	-3.3 (-4.62.3)
Cape Bouguer	3	0.3 (0.2-0.4)	5.5 (4.1-7.5)	0.72 (0.6-0.85)	1 (1-1)	-2 (-31.4)
Cave Point	3	0.3 (0.2-0.4)	5.3 (3.9-7.2)	0.7 (0.59-0.84)	1 (1-1)	-2 (-2.91.3)
Seal Bay	260	23.5 (17.8-	5.5 (4.2-7.6)	0.29 (0.11-0.64)	56 (78-37)	-5.1 (-7.13.9)
Black Point	1	0.1 (0.1-0.1)	5.9 (4.4-8.1)	0.75 (0.63-0.88)	, 1 (1-1)	-2.2 (-3.31.6)
Seal Slide	16	1.3 (1-1.8)	5.1 (3.8-7)	0.62 (0.45-0.79)	1 (1-1)	-4.6 (-6.43.4)
SPage	331	28.4 (21.4-	5.3 (4-7.2)	0.26 (0.1-0.58)	67 (81-50)	-4.9 (-6.73.7)
NPage	258	21.5 (16.2-	5.1 (3.8-7)	0.22 (0.07-0.54)	62 (85-41)	-4.7 (-6.53.5)
Mean	3107	146 (110-200)	3.1 (2.3-4.2)	0.34 (0.28-0.43)	25 (28-21)	-2.4 (-3.31.7)
% of subpops.	-	· /	·/	71 (63-75)	77 (73-75)	85 (79-88)

Table 8.7. Subpopulation estimates of female bycatch, and percentage of females removed as bycatch mortality per breeding cycle. Terminal Extinction Risk (TER), Quasi-extinction Time (QET, and estimated growth rate over the next 20 breeding cycles (% per 17.5 months) are also given assuming an underlying stable intrinsic growth rate. \pm 95 CL are given in parentheses. The current estimated pup production per subpopulation is also shown. The table presents estimates based on the current distribution of the GHAT fishery off South Australia (100,000 km.hrs/yr), with removal of the top 20% of female core foraging areas (no displaced effort). The % of subpopulations with TERs >0.1, QETs < 3 generations (33.3 yrs) and negative growth rates are given on the last line of the table.

Subpop	Pup prod	Female	% females/sub	TER	QET	Growth rate
B9	17	0.3 (0.2-0.4)	1 (0.8-1.4)	0.11 (0.1-0.12)	2 (2-2)	-0.7 (-1.10.5)
B8	38	0.6 (0.5-0.8)	1 (0.7-1.3)	0.03 (0.02-	26 (28-23)	-1.1 (-1.40.8)
B7	3	0 (0-0.1)	1 (0.7-1.3)	0.48 (0.48-	1 (1-1)	0 (-0.1-0.2)
B6	12	0.2 (0.1-0.3)	0.9 (0.7-1.3)	0.23 (0.23-	1 (1-1)	-0.1 (-0.4-0.2)
B5	43	0.6 (0.4-0.7)	0.8 (0.6-1.1)	0.01 (0.01-	60 (67-51)	-0.8 (-1.10.6)
B4	2	0 (0-0)	0.8 (0.6-1)	0.48 (0.48-	1 (1-1)	0.1 (0-0.2)
B3	31	0.4 (0.3-0.5)	0.7 (0.5-1)	0.03 (0.03-	11 (11-10)	-3.1 (-3.23.1)
B2	5	0 (0-0)	0.3 (0.2-0.4)	0.37 (0.37-	1 (1-1)	0.4 (0.3-0.5)
B1	15	0 (0-0.1)	0.2 (0.1-0.2)	0.13 (0.13-	1 (1-1)	0.2 (0.2-0.3)
NR W	12	0.2 (0.1-0.2)	0.8 (0.6-1.1)	0.23 (0.23-	1 (1-1)	0 (-0.2-0.3)
NR E	3	0 (0-0.1)	0.8 (0.6-1.1)	0.48 (0.48-	1 (1-1)	0.1 (0-0.2)
Pt Fowler	1	0 (0-0)	0.8 (0.6-1.1)	0.48 (0.48-	1 (1-1)	0.1 (0-0.2)
Purdie	132	2.1 (1.6-2.9)	1 (0.7-1.3)	0 (0-0)	117 (124-109)	-1 (-1.30.7)
West	56	0.7 (0.5-0.9)	0.7 (0.5-1)	0.01 (0.01-	90 (101-77)	-0.8 (-10.6)
Fenelon	40	1 (0.8-1.4)	1.6 (1.2-2.2)	0.06 (0.03-	22 (26-18)	-1.6 (-2.11.2)
Lounds	34	0.2 (0.1-0.3)	0.3 (0.3-0.5)	0.03 (0.03-	13 (13-12)	-0.4 (-0.50.3)
B'water	17	0 (0-0)	0.1 (0.1-0.1)	0.1 (0.1-0.1)	2 (2-2)	0.2 (0.2-0.2)
Gliddon	7	0 (0-0)	0.1 (0.1-0.1)	0.36 (0.36-	1 (1-1)	0.7 (0.7-0.8)
Blefuscu	84	2.1 (1.6-2.8)	1.5 (1.1-2.1)	0.01 (0-0.03)	84 (96-70)	-1.4 (-21.1)
Lilliput	67	0.2 (0.1-0.3)	0.2 (0.1-0.2)	0 (0-0)	129 (132-125)	-0.2 (-0.30.2)
Olive	206	6.3 (4.6-8.5)	1.9 (1.4-2.5)	0.01 (0-0.03)	114 (124-102)	-1.8 (-2.41.3)
N Baudin	98	4.7 (3.5-6.3)	2.9 (2.2-3.9)	0.08 (0.03-	63 (77-48)	-2.8 (-3.82.1)
Pt Labatt	6	0.4 (0.3-0.5)	3.7 (2.7-5)	0.53 (0.45-	1 (1-1)	-2.7 (-3.72)
Jones	15	1 (0.7-1.4)	4.1 (3-5.6)	0.51 (0.35-	1 (1-1)	-3.6 (-5.12.6)
Dorothee	1	0.1 (0.1-0.1)	4.6 (3.4-6.3)	0.64 (0.55-	1 (1-1)	-1.7 (-2.41.1)
Pearson	35	2.6 (1.9-3.6)	4.6 (3.4-6.2)	0.47 (0.27-	7 (8-5)	-4.5 (-63.3)
Ward	45	3.8 (2.8-5.1)	5.1 (3.8-6.9)	0.53 (0.31-	9 (12-7)	-4.9 (-6.63.7)
Waldegrave	157	14.7 (10.9-	5.7 (4.3-7.8)	0.45 (0.22-0.7)	50 (66-36)	-5.4 (-7.34)
Four Hummocks	12	1.4 (1-1.9)	7.1 (5.3-9.6)	0.84 (0.69-	1 (1-1)	-6.3 (-8.84.4)
Rocky North	16	1.2 (0.9-1.6)	4.6 (3.4-6.2)	0.56 (0.38-	1 (1-1)	-4.1 (-5.73)
Price	25	1.7 (1.3-2.4)	4.2 (3.1-5.7)	0.47 (0.29-	3 (3-3)	-4 (-5.43)
Liguanea	43	1.8 (1.3-2.5)	2.6 (1.9-3.5)	0.12 (0.06-	23 (32-16)	-2.5 (-3.41.9)
Lewis	131	0.1 (0.1-0.2)	0.1 (0-0.1)	0 (0-0)	145 (145-145)	-0.1 (-0.10.1)
East Island	14	0.3 (0.2-0.4)	1.2 (0.9-1.6)	0.16 (0.15-	1 (1-1)	-0.8 (-1.20.5)
South Neptune	6	0.1 (0-0.1)	0.6 (0.4-0.8)	0.38 (0.38-	1 (1-1)	-0.4 (-0.50.3)
Albatross	15	0.1 (0.1-0.2)	0.6 (0.5-0.8)	0.14 (0.13-	1 (1-1)	-0.2 (-0.4-0)
English	27	0 (0-0)	0 (0-0)	0.03 (0.03-	5 (5-5)	0.1 (0.1-0.1)
Dangerous	709	0 (0-0)	0 (0-0)	0 (0-0)	145 (145-145)	0 (0-0)
North Islet	28	0.2 (0.1-0.2)	0.4 (0.3-0.5)	0.03 (0.03-	5 (5-4)	-0.3 (-0.40.2)
Peaked Rocks	24	0.3 (0.2-0.4)	0.8 (0.6-1)	0.06 (0.05-	2 (2-2)	-0.7 (-0.90.5)
N Casuarina	3	0.3 (0.2-0.4)	6 (4.5-8.2)	0.76 (0.63-	1 (1-1)	-2.3 (-3.31.6)
Cape Bouquer	3	0.2 (0.2-0.3)	4.3 (3.2-5.9)	0.62 (0.54-	1 (1-1)	-1.5 (-2.21)
Cave Point	3	0.2 (0.2-0.3)	4.1 (3.1-5.6)	0.6 (0.53-0.73)	1 (1-1)	-1.4 (-2.10.9)
Seal Bay	260	18.9 (14.2-26)	4.5 (3.4-6.1)	0.14 (0.04-	73 (96-49)	-4.1 (-5.73.1)
Black Point	1	0.1 (0.1-0.1)	4.9 (3.7-6.7)	0.67 (0.57-	1 (1-1)	-1.8 (-2.61.2)
Seal Slide	16	1 (0.8-1.4)	4 (3-5.4)	0.47 (0.32-	1 (1-1)	-3.5 (-4.92.6)
SPage	331	24.9 (18.5-	4.6 (3.4-6.2)	0.17 (0.05-	74 (88-58)	-4.3 (-5.83.2)
NPage	258	18.8 (14-25.6)	4.5 (3.3-6.1)	0.14 (0.04-	72 (97-50)	-4.1 (-5.63.1)
Mean	3107	114 (85-155)	2.2 (1.6-3)	0.27 (0.22-	29 (32-25)	-1.6 (-2.31.2)
% of subpops.		(3000)	(67 (58-71)	77 (73-73)	77 (75-85)

Table 8.8. Subpopulation estimates of female bycatch, and percentage of females removed as bycatch mortality per breeding cycle. Terminal Extinction Risk (TER), Quasi-extinction Time (QET, and estimated growth rate over the next 20 breeding cycles (% per 17.5 months) are also given assuming an underlying stable intrinsic growth rate. \pm 95 CL are given in parentheses. The current estimated pup production per subpopulation is also shown. The table presents estimates based on the current distribution of the GHAT fishery off South Australia (100,000 km.hrs/yr), with removal of the top 30% of female core foraging areas (no displaced effort). The % of subpopulations with TERs >0.1, QETs < 3 generations (33.3 yrs) and negative growth rates are given on the last line of the table.

Subpop	Pup prod	Female bycatch	% females/sub	TER	QET	Growth rate
B9	17	0.3 (0.2-0.3)	0.9 (0.7-1.2)	0.11 (0.1-0.11)	2 (2-2)	-0.6 (-0.90.4)
B8	38	0.5 (0.4-0.7)	0.9 (0.6-1.2)	0.02 (0.02-0.03)	27 (29-24)	-0.9 (-1.20.7)
B7	3	0 (0-0.1)	0.9 (0.6-1.2)	0.48 (0.48-0.48)	1 (1-1)	0.1 (0-0.2)
B6	12	0.2 (0.1-0.2)	0.8 (0.6-1.1)	0.23 (0.23-0.23)	1 (1-1)	0 (-0.2-0.3)
B5	43	0.5 (0.4-0.7)	0.7 (0.5-0.9)	0.01 (0.01-0.02)	63 (70-55)	-0.7 (-10.6)
B4	2	0 (0-0)	0.7 (0.5-0.9)	0.48 (0.48-0.48)	1 (1-1)	0.2 (0.1-0.3)
B3	31	0.3 (0.2-0.4)	0.6 (0.5-0.8)	0.03 (0.03-0.03)	11 (11-11)	-3.1 (-3.23)
B2	5	0 (0-0)	0.3 (0.2-0.3)	0.37 (0.37-0.37)	1 (1-1)	0.4 (0.4-0.5)
B1	15	0 (0-0.1)	0.2 (0.1-0.2)	0.13 (0.13-0.13)	1 (1-1)	0.2 (0.2-0.3)
NR W	12	0.1 (0.1-0.1)	0.5 (0.4-0.7)	0.23 (0.23-0.23)	1 (1-1)	0.3 (0.1-0.5)
NR E	3	0 (0-0)	0.5 (0.4-0.7)	0.48 (0.48-0.48)	1 (1-1)	0.2 (0.2-0.3)
Pt Fowler	1	0 (0-0)	0.6 (0.4-0.8)	0.48 (0.48-0.48)	1 (1-1)	0.2 (0.1-0.3)
Purdie	132	1.2 (0.9-1.7)	0.6 (0.4-0.8)	0 (0-0)	129 (133-123)	-0.6 (-0.80.4)
West	56	0.3 (0.2-0.4)	0.3 (0.2-0.4)	0.01 (0.01-0.01)	117 (123-109)	-0.4 (-0.50.3)
Fenelon	40	0.7 (0.5-1)	1.1 (0.8-1.5)	0.03 (0.02-0.05)	27 (30-23)	-1.1 (-1.50.9)
Lounds	34	0.1 (0.1-0.1)	0.2 (0.1-0.2)	0.03 (0.03-0.03)	13 (13-13)	-0.3 (-0.30.2)
B'water	17	0 (0-0)	0 (0-0.1)	0.1 (0.1-0.1)	2 (2-2)	0.2 (0.2-0.2)
Gliddon	7	0 (0-0)	0 (0-0.1)	0.36 (0.36-0.36)	1 (1-1)	0.8 (0.8-0.8)
Blefuscu	84	1.3 (1-1.7)	0.9 (0.7-1.3)	0 (0-0)	102 (111-92)	-0.9 (-1.20.7)
Lilliput	67	0.1 (0.1-0.1)	0.1 (0.1-0.1)	0 (0-0)	136 (137-134)	-0.1 (-0.10.1)
Olive	206	3.2 (2.4-4.4)	1 (0.7-1.3)	0 (0-0)	133 (138-125)	-0.9 (-1.30.7)
N Baudin	98	3 (2.2-4)	1.9 (1.4-2.5)	0.02 (0.01-0.05)	84 (96-70)	-1.8 (-2.41.3)
Pt Labatt	6	0.2(0.2-0.3)	2.2 (1.7-3)	0.42 (0.39-0.47)	1 (1-1)	-1.6 (-2.21.2)
Jones	15	0.6(0.4-0.8)	2.4 (1.8-3.3)	0.26 (0.19-0.38)	1 (1-1)	-2 (-2.81.4)
Dorothee	1	0 (0-0.1)	2.8 (2-3.7)	0.51 (0.49-0.57)	1 (1-1)	-0.8 (-1.20.5)
Pearson	35	16(12-21)	27 (2-37)	0.17 (0.09-0.32)	10 (11-8)	-2 7 (-3 62)
Ward	45	2.2 (1.6-2.9)	2.9 (2.2-4)	0.18(0.08-0.34)	17 (26-11)	-2.9 (-3.82.1)
Waldegrave	157	8.6 (6.4-11.7)	3.4 (2.5-4.6)	0.11 (0.04-0.26)	78 (92-62)	-3.2 (-4.32.4)
Four Hummocks	12	07(05-09)	3 4 (2 5-4 6)	0.42 (0.31-0.6)	1 (1-1)	-2.5 (-3.71.7)
Rocky North	16	07(05-09)	26 (19-35)	0.27 (0.19-0.4)	1 (1-1)	-2.2 (-3.11.6)
Price	25	07(05-09)	17(12-23)	0.1 (0.07-0.16)	3 (3-3)	-1.5 (-2.11.1)
Liquanea	43	1.2 (0.9-1.6)	1.7 (1.3-2.3)	0.05 (0.03-0.1)	36 (45-26)	-1.7 (-2.31.3)
Lewis	131	0.1 (0.1-0.1)	0 (0-0)	0 (0-0)	145 (145-145)	-0.1 (-0.10.1)
East Island	14	0.2 (0.1-0.2)	0.8 (0.6-1)	0 15 (0 15-0 16)	1 (1-1)	-0.3 (-0.60.1)
South Nentune	6	0 (0-0)	03(02-04)	0.38 (0.38-0.38)	1 (1-1)	-0.2 (-0.30.1)
Albatross	15	0 1 (0 1-0 1)	0.4 (0.3-0.6)	0.13 (0.13-0.14)	1 (1-1)	0 (-0 1-0 1)
Fnalish	27	0.1 (0.1 0.1)	0.0-0)	0.03 (0.03-0.03)	5 (5-5)	0 1 (0 1-0 1)
Dangerous	709	0 (0-0)	0 (0-0)	0.00 (0.00 0.00)	145 (145-145)	0.1 (0.1 0.1)
North Islet	28	0 1 (0 1-0 2)	0 2 (0 2-0 3)	0.03 (0.03-0.03)	5 (5-5)	-0.2 (-0.30.1)
Peaked Rocks	20	0.7 (0.7 0.2)	0.6 (0.4-0.8)	0.05 (0.05-0.06)	2 (2-2)	-0.5 (-0.70.3)
N Casuarina	27	0.2 (0.2-0.3)	4 1 (3 1-5 6)	0.65 (0.53-0.73)	2 (2-2) 1 (1-1)	-0.3 (-0.70.3)
Cape Bouquer	3	0.2 (0.1-0.3)	3 3 (2 5-4 5)	0.54 (0.5-0.63)	1 (1-1)	-1.1 (-1.60.7)
Cave Point	3	0.2 (0.1-0.2)	3.1(2.3-4.3)	0.53 (0.5-0.61)	1 (1-1)	-1.1 (-1.50.6)
Seal Bay	260	0.2 (0.1-0.2) 14 4 (10 8-10 7)	3.1(2.5-4.5)	0.03(0.0-0.01)	95 (119-70)	-3 1 (-1 32 3)
Black Point	1	0.1 (0.0.1)	3.8 (2.0-5.2)	0.04(0.01-0.10) 0.58(0.52-0.7)	1 (1-1)	-1.3 (-1.90.8)
Seal Slide	16	0.8 (0.6-1.1)	3 (2 2.3-3.2)	0.32 (0.32-0.7)	1 (1-1)	-2 6 (-3 61 0)
SPane	321	19 6 (1/ 5-26 6)	36(27-4.1)	0.02 (0.22 - 0.49) 0 07 (0 02 0 21)	86 (00-70)	-2.0 (-0.01.9)
NPage	258	14 8 (11-20.1)	35 (26.4 8)	0.07 (0.02 - 0.21) 0.05 (0.01 - 0.17)	92 (117-68)	-3.2 (-4.42.4)
Mean	2107	70 (50-102)	1 5 (1 1-2)	$\frac{0.00(0.01-0.17)}{0.2(0.18-0.24)}$	33 (36-30)	-1 (-1 1-0 7)
% of subnons	5107	10 (00-100)	1.5 (1.1-2)	56 (50-65)	73 (71-73)	75 (73-79)
				23 (00 00)	(

Table 7.9. Subpopulation estimates of female bycatch, and percentage of females removed as bycatch mortality per breeding cycle. Terminal Extinction Risk (TER), Quasi-extinction Time (QET, and estimated growth rate over the next 20 breeding cycles (% per 17.5 months) are also given assuming an underlying stable intrinsic growth rate. \pm 95 CL are given in parentheses. The current estimated pup production per subpopulation is also shown. The table presents estimates based on the current distribution of the GHAT fishery off South Australia (100,000 km.hrs/yr), with removal of the top 40% of female core foraging areas (no displaced effort). The % of subpopulations with TERs >0.1, QETs < 3 generations (33.3 yrs) and negative growth rates are given on the last line of the table.

Subpop	Pup prod	Female bycatch	% females/sub	TER	QET	Growth rate
B9	17	0.2 (0.2-0.3)	0.8 (0.6-1.1)	0.1 (0.1-0.11)	2 (2-2)	-0.5 (-0.80.3)
B8	38	0.5 (0.3-0.6)	0.7 (0.5-1)	0.02 (0.01-0.03)	28 (30-26)	-0.8 (-1.10.6)
B7	3	0 (0-0)	0.7 (0.5-1)	0.48 (0.48-0.48)	1 (1-1)	0.2 (0-0.2)
B6	12	0.1 (0.1-0.2)	0.6 (0.5-0.9)	0.23 (0.23-0.23)	1 (1-1)	0.2 (0-0.4)
B5	43	0.4 (0.3-0.5)	0.5 (0.4-0.7)	0.01 (0.01-0.01)	69 (75-62)	-0.6 (-0.80.5)
B4	2	0 (0-0)	0.5 (0.4-0.7)	0.48 (0.48-0.48)	1 (1-1)	0.3 (0.2-0.3)
B3	31	0.2 (0.2-0.3)	0.5 (0.4-0.6)	0.03 (0.02-0.03)	11 (12-11)	-3 (-3.13)
B2	5	0 (0-0)	0.2 (0.1-0.3)	0.37 (0.37-0.37)	1 (1-1)	0.5 (0.4-0.5)
B1	15	0 (0-0)	0.1 (0.1-0.2)	0.13 (0.13-0.13)	1 (1-1)	0.3 (0.2-0.3)
NR W	12	0.1 (0.1-0.1)	0.4 (0.3-0.5)	0.23 (0.23-0.23)	1 (1-1)	0.5 (0.3-0.6)
NR E	3	0 (0-0)	0.4 (0.3-0.6)	0.48 (0.48-0.48)	1 (1-1)	0.3 (0.2-0.4)
Pt Fowler	1	0 (0-0)	0.4 (0.3-0.6)	0.48 (0.48-0.48)	1 (1-1)	0.3 (0.2-0.3)
Purdie	132	0.5 (0.4-0.7)	0.2 (0.2-0.3)	0 (0-0)	139 (141-136)	-0.3 (-0.30.2)
West	56	0.1 (0.1-0.2)	0.1 (0.1-0.2)	0.01 (0.01-0.01)	129 (132-125)	-0.2 (-0.30.2)
Fenelon	40	0.5 (0.4-0.7)	0.8 (0.6-1)	0.02 (0.02-0.03)	30 (33-27)	-0.8 (-1.10.6)
Lounds	34	0.1 (0-0.1)	0.1 (0.1-0.1)	0.03 (0.03-0.03)	13 (13-13)	-0.2 (-0.20.2)
B'water	17	0 (0-0)	0 (0-0)	0.1 (0.1-0.1)	2 (2-2)	0.3 (0.3-0.3)
Gliddon	7	0 (0-0)	0 (0-0)	0.36 (0.36-0.36)	1 (1-1)	0.8 (0.8-0.8)
Blefuscu	84	0.7 (0.5-1)	0.5 (0.4-0.7)	0 (0-0)	118 (123-110)	-0.5 (-0.70.4)
Lilliput	67	0 (0-0)	0 (0-0)	0 (0-0)	139 (139-138)	-0.1 (-0.10.1)
Olive	206	1.6 (1.2-2.1)	0.5 (0.3-0.6)	0 (0-0)	145 (145-140)	-0.5 (-0.60.4)
N Baudin	98	1.6 (1.2-2.2)	1 (0.7-1.4)	0 (0-0.01)	106 (115-96)	-1 (-1.30.7)
Pt Labatt	6	0.1(0.1-0.1)	1 (0.8-1.4)	0.38 (0.38-0.39)	1 (1-1)	-0.7 (-10.5)
Jones	15	0.2 (0.2-0.3)	0.9 (0.7-1.3)	0.14 (0.14-0.16)	1 (1-1)	-0.5 (-0.90.3)
Dorothee	1	0 (0-0)	16(12-22)	0 48 (0 48-0 49)	1 (1-1)	-0.2 (-0.50.1)
Pearson	35	0.9 (0.6-1.2)	1.5 (1.1-2.1)	0.05 (0.03-0.09)	12 (13-11)	-1 5 (-21 1)
Ward	45	1 (0 7-1 3)	1.3 (1-1.8)	0.02 (0.01-0.05)	46 (59-33)	-1.3 (-1.81)
Waldegrave	157	2 7 (2-3 7)	1 1 (0 8-1 4)	0 (0-0 01)	121 (128-112)	-1 1 (-1 40 8)
Four Hummocks	12	0.3(0.2-0.4)	1.6 (1.2-2.2)	0 25 (0 24-0 28)	1 (1-1)	-0.8 (-1.30.3)
Rocky North	16	0.4 (0.3-0.5)	1.6 (1.1-2.1)	0.16 (0.13-0.21)	1 (1-1)	-1 2 (-1 70 8)
Price	25	0.3 (0.2-0.4)	0.8 (0.6-1)	0.05 (0.05-0.06)	3 (3-3)	-0.7 (-0.90.5)
Liquanea	43	0.9 (0.6-1.2)	1 2 (0 9-1 7)	0.02 (0.02-0.04)	46 (55-37)	-1.3 (-1.71)
Lewis	131	0 (0-0)	0 (0-0)	0 (0-0)	145 (145-145)	-0.1 (-0.1-0)
East Island	14	0 1 (0 1-0 2)	0.5 (0.4-0.7)	0 15 (0 15-0 15)	1 (1-1)	-0.1 (-0.3-0)
South Neptune	6	0 (0-0)	0.2(0.2-0.3)	0.38 (0.38-0.38)	1 (1-1)	-0.1 (-0.20.1)
Albatross	15	0 1 (0 1-0 1)	0.2 (0.2 0.0)	0.13 (0.13-0.13)	1 (1-1)	0.1 (0-0.2)
English	27	0.1 (0.1-0.1)	0.0 (0.2 0.4)	0.13 (0.13-0.13)	5 (5-5)	0.1 (0.1.0.1)
Dangerous	709	0 (0-0)	0 (0-0)	0.03 (0.03-0.03)	145 (145-145)	0.1 (0.1-0.1)
North Islet	28	0 (0-0 1)	0 (0 0)	0 03 (0 03-0 03)	5 (5-5)	0 (-0 1-0)
Peaked Rocks	20	0 (0 0.1)	0.1 (0.1 - 0.1) 0.3 (0.2-0.4)	0.05 (0.05-0.05)	2(2-2)	-0.3 (-0.40.2)
N Casuarina	27	0.1 (0.1 - 0.2)	27(2-37)	0.03 (0.03 - 0.03) 0.51 (0.49-0.57)	2 (2 2) 1 (1-1)	-0.8 (-1.20.4)
Cape Bouquer	3	0.1 (0.1-0.2)	25(18-34)	0.5 (0.49-0.54)	1 (1-1)	-0.7 (-1 10.4)
Cave Point	3	0.1 (0.1 - 0.2)	2.3(1.0.3.4) 2.3(1.7.3.1)	0.5(0.43-0.54) 0.5(0.48-0.53)	1 (1-1)	-0.7 (-1.1-0.4)
Seal Bay	260	10.9(8.1-14.8)	2.5 (1.7-3.1)	0.0 (0.40-0.00)	118 (1/5-03)	-2.4 (-3.21.8)
Black Point	200	0 (0-0 1)	2.0(1.9-3.3)	0.52 (0.49-0.6)	1 (1-1)	-2.4 (-3.21.0)
Spal Slide	16	0 (0-0.1)	0 (∠.∠-+.1) 2 3 (1 7-3 2)	0.32 (0.43-0.0)	1 (1-1) 1 (1_1)	-0.0 (-1.40.0) -2 (-2 81 4)
SPana	221	16 3 (12 1-22 1)	2.0(1.7-0.2) 3(2.2-11)	0.23(0.17-0.03)	(۱-۱) (۱۸۵-۵۵) ۵۷	-28(-2824)
NPage	258	12 3 (0 1-16 6)	2 (2.2-4.1) 2 9 (2 2-3 0)	0.02 (0.01-0.11)	108 (132-82)	-2.0 (-3.02.1) _2 7 (_3 72)
Mean	200	55 (11-71)	$\frac{2.3 (2.2-3.9)}{0.9 (0.7-1.3)}$	0.02 (0.01-0.00)	38 (10-25)	-2.1 (-3.12)
% of subnons	5107	55 (41-74)	0.0 (0.7-1.3)	50 (50-52)	71 (69-69)	73 (73-75)
, 5 51 500p0p0.				UUUUL)	(00 00)	(

Table 8.10. Subpopulation estimates of female bycatch, and percentage of females removed as bycatch mortality per breeding cycle. Terminal Extinction Risk (TER), Quasi-extinction Time (QET, and estimated growth rate over the next 20 breeding cycles (% per 17.5 months) are also given assuming an underlying stable intrinsic growth rate. \pm 95 CL are given in parentheses. The current estimated pup production per subpopulation is also shown. The table presents estimates based on the current distribution of the GHAT fishery off South Australia (100,000 km.hrs/yr), with removal of the top 50% of female core foraging areas (no displaced effort). The % of subpopulations with TERs >0.1, QETs < 3 generations (33.3 yrs) and negative growth rates are given on the last line of the table.

Subpop	Pup prod	Female bycatch	% females/sub	TER	QET	Growth rate
B9	17	0.2 (0.1-0.3)	0.7 (0.5-0.9)	0.1 (0.1-0.11)	2 (2-2)	-0.4 (-0.60.2)
B8	38	0.4 (0.3-0.5)	0.6 (0.5-0.9)	0.02 (0.01-0.02)	29 (30-27)	-0.7 (-0.90.6)
B7	3	0 (0-0)	0.6 (0.4-0.8)	0.48 (0.48-0.48)	1 (1-1)	0.2 (0.1-0.3)
B6	12	0.1 (0.1-0.1)	0.5 (0.4-0.7)	0.23 (0.23-0.23)	1 (1-1)	0.4 (0.2-0.5)
B5	43	0.3 (0.2-0.4)	0.4 (0.3-0.5)	0.01 (0.01-0.01)	75 (79-69)	-0.5 (-0.60.4)
B4	2	0 (0-0)	0.4 (0.3-0.5)	0.48 (0.48-0.48)	1 (1-1)	0.3 (0.3-0.4)
B3	31	0.2 (0.1-0.2)	0.3 (0.2-0.5)	0.02 (0.02-0.03)	12 (12-11)	-3 (-32.9)
B2	5	0 (0-0)	0.2 (0.1-0.2)	0.37 (0.37-0.37)	1 (1-1)	0.5 (0.5-0.6)
B1	15	0 (0-0)	0.1 (0.1-0.2)	0.13 (0.13-0.13)	1 (1-1)	0.3 (0.2-0.3)
NR W	12	0.1 (0-0.1)	0.3 (0.2-0.4)	0.23 (0.23-0.23)	1 (1-1)	0.5 (0.4-0.6)
NR E	3	0 (0-0)	0.3 (0.2-0.5)	0.48 (0.48-0.48)	1 (1-1)	0.3 (0.3-0.4)
Pt Fowler	1	0 (0-0)	0.3 (0.2-0.5)	0.48 (0.48-0.48)	1 (1-1)	0.3 (0.3-0.4)
Purdie	132	0.2 (0.2-0.3)	0.1 (0.1-0.1)	0 (0-0)	145 (145-142)	-0.1 (-0.20.1)
West	56	0.1 (0.1-0.1)	0.1 (0.1-0.1)	0.01 (0.01-0.01)	135 (137-133)	-0.2 (-0.20.1)
Fenelon	40	0.3 (0.3-0.5)	0.5 (0.4-0.7)	0.02 (0.02-0.02)	34 (35-31)	-0.6 (-0.80.5)
Lounds	34	0 (0-0.1)	0.1 (0.1-0.1)	0.03 (0.03-0.03)	13 (13-13)	-0.2 (-0.20.2)
B'water	17	0 (0-0)	0 (0-0)	0.1 (0.1-0.1)	2 (2-2)	0.3 (0.3-0.3)
Gliddon	7	0 (0-0)	0 (0-0)	0.36 (0.36-0.36)	1 (1-1)	0.8 (0.8-0.8)
Blefuscu	84	0.3 (0.2-0.4)	0.2 (0.2-0.3)	0 (0-0)	130 (133-127)	-0.2 (-0.30.2)
Lilliput	67	0 (0-0)	0 (0-0)	0 (0-0)	141 (141-141)	0 (0-0)
Olive	206	0.3 (0.2-0.4)	0.1 (0.1-0.1)	0 (0-0)	145 (145-145)	-0.1 (-0.20.1)
N Baudin	98	1 (0.7-1.4)	0.6 (0.5-0.8)	0 (0-0)	119 (124-111)	-0.6 (-0.80.5)
Pt Labatt	6	0.1 (0-0.1)	0.6 (0.5-0.9)	0.38 (0.38-0.38)	1 (1-1)	-0.4 (-0.60.3)
Jones	15	0.1 (0.1-0.2)	0.6 (0.4-0.8)	0.14 (0.13-0.14)	1 (1-1)	-0.2 (-0.4-0)
Dorothee	1	0 (0-0)	0.9 (0.7-1.3)	0.48 (0.48-0.48)	1 (1-1)	0.1 (-0.1-0.2)
Pearson	35	0.5 (0.4-0.7)	0.9 (0.7-1.2)	0.03 (0.02-0.03)	14 (15-13)	-0.9 (-1.20.7)
Ward	45	0.6 (0.4-0.8)	0.8 (0.6-1.1)	0.01 (0-0.01)	68 (80-55)	-0.8 (-1.10.6)
Waldegrave	157	1.1 (0.8-1.5)	0.4 (0.3-0.6)	0 (0-0)	137 (140-133)	-0.5 (-0.60.4)
Four Hummocks	12	0.1 (0.1-0.2)	0.7 (0.5-0.9)	0.23 (0.23-0.23)	1 (1-1)	0.2 (-0.1-0.3)
Rocky North	16	0.2 (0.1-0.2)	0.6 (0.4-0.8)	0.12 (0.12-0.12)	1 (1-1)	-0.3 (-0.50.1)
Price	25	0.1 (0.1-0.2)	0.3 (0.2-0.4)	0.05 (0.05-0.05)	3 (3-3)	-0.2 (-0.30.1)
Liguanea	43	0.6 (0.4-0.8)	0.8 (0.6-1.1)	0.01 (0.01-0.02)	58 (66-49)	-0.9 (-1.20.7)
Lewis	131	0 (0-0)	0 (0-0)	0 (0-0)	145 (145-145)	0 (0-0)
East Island	14	0.1 (0-0.1)	0.2 (0.2-0.3)	0.15 (0.15-0.15)	1 (1-1)	0.2 (0.1-0.2)
South Neptune	6	0 (0-0)	0.1 (0.1-0.1)	0.38 (0.38-0.38)	1 (1-1)	0 (0-0)
Albatross	15	0 (0-0)	0.1 (0.1-0.2)	0.13 (0.13-0.13)	1 (1-1)	0.3 (0.2-0.3)
English	27	0 (0-0)	0 (0-0)	0.03 (0.03-0.03)	5 (5-5)	0.1 (0.1-0.1)
Dangerous	709	0 (0-0)	0 (0-0)	0 (0-0)	145 (145-145)	0 (0-0)
North Islet	28	0 (0-0)	0 (0-0.1)	0.03 (0.03-0.03)	5 (5-5)	0 (0-0)
Peaked Rocks	24	0.1 (0.1-0.1)	0.2 (0.2-0.3)	0.05 (0.05-0.05)	2 (2-2)	-0.2 (-0.20.1)
N Casuarina	3	0.1 (0.1-0.1)	1.7 (1.3-2.3)	0.48 (0.48-0.5)	1 (1-1)	-0.3 (-0.60.1)
Cape Bouguer	3	0.1 (0.1-0.1)	1.9 (1.4-2.5)	0.49 (0.48-0.5)	1 (1-1)	-0.4 (-0.70.1)
Cave Point	3	0.1 (0.1-0.1)	1.7 (1.3-2.3)	0.48 (0.48-0.5)	1 (1-1)	-0.3 (-0.60.1)
Seal Bay	260	8.2 (6.1-11.1)	1.9 (1.4-2.6)	0 (0-0.01)	145 (145-117)	-1.8 (-2.41.3)
Black Point	1	0 (0-0.1)	2.3 (1.7-3.2)	0.5 (0.48-0.53)	`	-0.6 (-10.3)
Seal Slide	16	0.5 (0.3-0.6)	1.8 (1.3-2.4)	0.18 (0.14-0.24)	1 (1-1)	-1.4 (-21)
SPage	331	13.6 (10.1-18.4)	2.5 (1.9-3.4)	0.01 (0-0.05)	102 (113-89)	-2.4 (-3.21.8)
NPage	258	10.2 (7.6-13.8)	2.4 (1.8-3.3)	0.01 (0-0.04)	123 (145-98)	-2.2 (-31.7)
Mean	3107	40 (30-54)	0.6 (0.5-0.9)	0.16 (0.16-0.17)	41 (42-38)	-0.3 (-0.50.2)
% of subpops.		. ,	. ,	50 (50-50)	69 (67-69)	65 (65-69)

Table 8.11. Subpopulation estimates of female bycatch, and percentage of females removed as bycatch mortality per breeding cycle. Terminal Extinction Risk (TER), Quasi-extinction Time (QET, and estimated growth rate over the next 20 breeding cycles (% per 17.5 months) are also given assuming an underlying stable intrinsic growth rate. \pm 95 CL are given in parentheses. The current estimated pup production per subpopulation is also shown. The table presents estimates based on the current distribution of the GHAT fishery off South Australia (100,000 km.hrs/yr), with removal of the top 60% of female core foraging areas (no displaced effort). The % of subpopulations with TERs >0.1, QETs < 3 generations (33.3 yrs) and negative growth rates are given on the last line of the table.

Subpop	Pup prod	Female bycatch	% females/sub	TER	QET	Growth rate
B9	17	0.2 (0.1-0.2)	0.6 (0.4-0.8)	0.1 (0.1-0.1)	2 (2-2)	-0.3 (-0.50.1)
B8	38	0.3 (0.2-0.4)	0.5 (0.4-0.7)	0.01 (0.01-0.02)	30 (31-28)	-0.6 (-0.80.5)
B7	3	0 (0-0)	0.5 (0.3-0.6)	0.48 (0.48-0.48)	1 (1-1)	0.3 (0.2-0.3)
B6	12	0.1 (0.1-0.1)	0.4 (0.3-0.5)	0.23 (0.23-0.23)	1 (1-1)	0.5 (0.4-0.6)
B5	43	0.2 (0.1-0.2)	0.2 (0.2-0.3)	0.01 (0.01-0.01)	82 (85-78)	-0.3 (-0.40.3)
B4	2	0 (0-0)	0.2 (0.2-0.3)	0.48 (0.48-0.48)	1 (1-1)	0.4 (0.4-0.4)
B3	31	0.1 (0.1-0.1)	0.2 (0.2-0.3)	0.02 (0.02-0.02)	12 (12-12)	-2.9 (-32.9)
B2	5	0 (0-0)	0.1 (0.1-0.2)	0.37 (0.37-0.37)	1 (1-1)	0.5 (0.5-0.6)
B1	15	0 (0-0)	0.1 (0.1-0.1)	0.13 (0.13-0.13)	1 (1-1)	0.3 (0.3-0.3)
NR W	12	0 (0-0.1)	0.2 (0.2-0.3)	0.23 (0.23-0.23)	1 (1-1)	0.6 (0.5-0.7)
NR E	3	0 (0-0)	0.2 (0.2-0.3)	0.48 (0.48-0.48)	1 (1-1)	0.4 (0.3-0.4)
Pt Fowler	1	0 (0-0)	0.2 (0.2-0.3)	0.48 (0.48-0.48)	1 (1-1)	0.4 (0.3-0.4)
Purdie	132	0.1 (0.1-0.2)	0.1 (0-0.1)	0 (0-0)	145 (145-145)	-0.1 (-0.10.1)
West	56	0 (0-0.1)	0 (0-0.1)	0.01 (0.01-0.01)	138 (139-136)	-0.1 (-0.10.1)
Fenelon	40	0.2 (0.2-0.3)	0.4 (0.3-0.5)	0.02 (0.02-0.02)	36 (37-34)	-0.4 (-0.50.3)
Lounds	34	0 (0-0)	0.1 (0-0.1)	0.03 (0.03-0.03)	13 (13-13)	-0.2 (-0.20.1)
B'water	17	0 (0-0)	0 (0-0)	0.1 (0.1-0.1)	2 (2-2)	0.3 (0.3-0.3)
Gliddon	7	0 (0-0)	0 (0-0)	0.36 (0.36-0.36)	1 (1-1)	0.8 (0.8-0.8)
Blefuscu	84	0.2 (0.1-0.3)	0.1 (0.1-0.2)	0 (0-0)	134 (136-132)	-0.1 (-0.20.1)
Lilliput	67	0 (0-0)	0 (0-0)	0 (0-0)	141 (141-141)	0 (0-0)
Olive	206	0.2 (0.1-0.2)	0 (0-0.1)	0 (0-0)	145 (145-145)	-0.1 (-0.10.1)
N Baudin	98	0.5 (0.4-0.7)	0.3 (0.2-0.5)	0 (0-0)	129 (132-125)	-0.3 (-0.40.3)
Pt Labatt	6	0 (0-0)	0.3 (0.2-0.4)	0.38 (0.38-0.38)	1 (1-1)	-0.2 (-0.30.1)
Jones	15	0.1 (0.1-0.1)	0.3 (0.2-0.4)	0.13 (0.13-0.13)	1 (1-1)	0.1 (0-0.2)
Dorothee	1	0 (0-0)	0.4 (0.3-0.6)	0.48 (0.48-0.48)	1 (1-1)	0.3 (0.2-0.4)
Pearson	35	0.2 (0.2-0.3)	0.4 (0.3-0.5)	0.02 (0.02-0.02)	16 (17-16)	-0.4 (-0.60.3)
Ward	45	0.3 (0.2-0.4)	0.4 (0.3-0.5)	0 (0-0)	96 (103-87)	-0.4 (-0.50.3)
Waldegrave	157	0.1 (0.1-0.2)	0.1 (0-0.1)	0 (0-0)	145 (145-145)	-0.1 (-0.10.1)
Four Hummocks	12	0 (0-0.1)	0.3 (0.2-0.3)	0.23 (0.23-0.23)	1 (1-1)	0.6 (0.5-0.7)
Rocky North	16	0 (0-0)	0.1 (0.1-0.2)	0.12 (0.12-0.12)	1 (1-1)	0.2 (0.1-0.2)
Price	25	0 (0-0.1)	0.1 (0.1-0.1)	0.04 (0.04-0.04)	3 (3-3)	0 (-0.1-0)
Liquanea	43	0.4 (0.3-0.5)	0.6 (0.4-0.8)	0.01 (0.01-0.01)	67 (73-60)	-0.6 (-0.80.5)
Lewis	131	0 (0-0)	0 (0-0)	0 (0-0)	145 (145-145)	0 (0-0)
East Island	14	0 (0-0)	0.1 (0.1-0.1)	0.15 (0.15-0.15)	1 (1-1)	0.3 (0.3-0.3)
South Neptune	6	0 (0-0)	0 (0-0)	0.38 (0.38-0.38)	1 (1-1)	0 (0-0)
Albatross	15	0 (0-0)	0.1 (0.1-0.1)	0.13 (0.13-0.13)	1 (1-1)	0.3 (0.3-0.3)
English	27	0 (0-0)	0 (0-0)	0.03 (0.03-0.03)	5 (5-5)	0.1 (0.1-0.1)
Dangerous	709	0 (0-0)	0 (0-0)	0 (0-0)	145 (145-145)	0 (0-0)
North Islet	28	0 (0-0)	0 (0-0)	0.03 (0.03-0.03)	5 (5-5)	0 (0-0)
Peaked Rocks	24	0.1 (0.1-0.1)	0.2 (0.1-0.3)	0.05 (0.05-0.05)	2 (2-2)	-0.1 (-0.20.1)
N Casuarina	3	0 (0-0.1)	0.9 (0.6-1.2)	0.48 (0.48-0.48)	1 (1-1)	0.1 (0-0.2)
Cape Bouquer	3	0 (0-0.1)	1 (0.7-1.3)	0.48 (0.48-0.48)	1 (1-1)	0 (-0.1-0.2)
Cave Point	3	0 (0-0.1)	0.9 (0.7-1.2)	0.48 (0.48-0.48)	1 (1-1)	0.1 (-0.1-0.2)
Seal Bay	260	5 2 (3 8-7)	1 2 (0 9-1 6)	0 (0-0)	145 (145-145)	-1 1 (-1 50 8)
Black Point	1	0 (0-0)	1.6 (1.2-2.2)	0.48 (0.48-0.49)	1 (1-1)	-0.3 (-0.50.1)
Seal Slide	16	0.4 (0.3-0.5)	1.4 (1.1-2)	0.15 (0.13-0.19)	1 (1-1)	-1.1 (-1.60.7)
SPage	331	11.5 (8 5-15 5)	2.1 (1.6-2.9)	0.01 (0-0.03)	108 (118-96)	-2 (-2 71 5)
NPage	258	8.6 (6.4-11.6)	2 (1.5-2.8)	0 (0-0.02)	137 (145-112)	-1.9 (-2.61.4)
Mean	3107	29 (22-40)	0.4 (0.3-0.5)	0.16 (0.16-0.16)	43 (44-41)	-0.2 (-0.30.1)
% of subpops.	0.01	_3 (!3)	0.1 (0.0 0.0)	50 (50-50)	69 (67-67)	52 (52-58)

Table 8.12. Subpopulation estimates of female bycatch, and percentage of females removed as bycatch mortality per breeding cycle. Terminal Extinction Risk (TER), Quasi-extinction Time (QET, and estimated growth rate over the next 20 breeding cycles (% per 17.5 months) are also given assuming an underlying stable intrinsic growth rate. \pm 95 CL are given in parentheses. The current estimated pup production per subpopulation is also shown. The table presents estimates based on the current distribution of the GHAT fishery off South Australia (100,000 km.hrs/yr), with removal of the top 70% of female core foraging areas (no displaced effort). The % of subpopulations with TERs >0.1, QETs < 3 generations (33.3 yrs) and negative growth rates are given on the last line of the table.

Subpop	Pup prod	Female bycatch	% females/sub	TER	QET	Growth rate
B9	17	0.1 (0.1-0.1)	0.3 (0.3-0.5)	0.1 (0.1-0.1)	2 (2-2)	-0.1 (-0.2-0)
B8	38	0.2 (0.1-0.3)	0.3 (0.2-0.4)	0.01 (0.01-0.01)	32 (33-31)	-0.4 (-0.50.3)
B7	3	0 (0-0)	0.3 (0.2-0.4)	0.48 (0.48-0.48)	1 (1-1)	0.4 (0.3-0.4)
B6	12	0 (0-0.1)	0.2 (0.2-0.3)	0.23 (0.23-0.23)	1 (1-1)	0.6 (0.5-0.7)
B5	43	0.1 (0.1-0.1)	0.1 (0.1-0.2)	0.01 (0.01-0.01)	87 (89-85)	-0.2 (-0.20.2)
B4	2	0 (0-0)	0.1 (0.1-0.2)	0.48 (0.48-0.48)	1 (1-1)	0.4 (0.4-0.5)
B3	31	0.1 (0-0.1)	0.1 (0.1-0.2)	0.02 (0.02-0.02)	12 (12-12)	-2.9 (-2.92.9)
B2	5	0 (0-0)	0.1 (0.1-0.1)	0.37 (0.37-0.37)	1 (1-1)	0.6 (0.5-0.6)
B1	15	0 (0-0)	0.1 (0.1-0.1)	0.13 (0.13-0.13)	1 (1-1)	0.3 (0.3-0.3)
NR W	12	0 (0-0)	0.1 (0.1-0.2)	0.23 (0.23-0.23)	1 (1-1)	0.7 (0.7-0.8)
NR E	3	0 (0-0)	0.1 (0.1-0.2)	0.48 (0.48-0.48)	1 (1-1)	0.4 (0.4-0.4)
Pt Fowler	1	0 (0-0)	0.1 (0.1-0.2)	0.48 (0.48-0.48)	1 (1-1)	0.4 (0.4-0.5)
Purdie	132	0 (0-0.1)	0 (0-0)	0 (0-0)	145 (145-145)	-0.1 (-0.10.1)
West	56	0 (0-0)	0 (0-0)	0.01 (0.01-0.01)	140 (141-140)	-0.1 (-0.10.1)
Fenelon	40	0.1 (0.1-0.2)	0.2 (0.1-0.3)	0.02 (0.02-0.02)	38 (39-37)	-0.3 (-0.30.2)
Lounds	34	0 (0-0)	0 (0-0)	0.03 (0.03-0.03)	13 (14-13)	-0.1 (-0.10.1)
B'water	17	0 (0-0)	0 (0-0)	0.1 (0.1-0.1)	2 (2-2)	0.3 (0.3-0.3)
Gliddon	7	0 (0-0)	0 (0-0)	0.36 (0.36-0.36)	1 (1-1)	0.8 (0.8-0.8)
Blefuscu	84	0.1 (0.1-0.1)	0.1 (0-0.1)	0 (0-0)	138 (139-137)	-0.1 (-0.1-0)
Lilliput	67	0 (0-0)	0 (0-0)	0 (0-0)	141 (141-141)	0 (0-0)
Olive	206	0.1 (0-0.1)	0 (0-0)	0 (0-0)	145 (145-145)	-0.1 (-0.10.1)
N Baudin	98	0.3 (0.2-0.4)	0 2 (0 1-0 2)	0 (0-0)	135 (137-133)	-0.2 (-0.20.1)
Pt Labatt	6	0 (0-0)	0.2 (0.1-0.2)	0.38 (0.38-0.38)	1 (1-1)	-0.1 (-0.1-0)
Jones	15	0 (0-0)	0.1 (0.1-0.2)	0.13 (0.13-0.13)	1 (1-1)	0.3 (0.2-0.3)
Dorothee	1	0 (0-0)	0.2(0.2-0.3)	0 48 (0 48-0 48)	1 (1-1)	0.4 (0.4 - 0.4)
Pearson	35	0 1 (0 1-0 2)	0.2 (0.2-0.3)	0.02 (0.02-0.02)	17 (17-17)	-0.3 (-0.30.2)
Ward	45	0.1 (0.1-0.2)	0.2 (0.1-0.3)	0.02 (0.02 0.02)	110 (114-104)	-0.2 (-0.30.2)
Waldegrave	157	0.1 (0.1-0.1)	0 (0-0)	0 (0-0)	145 (145-145)	-0.1 (-0.10.1)
Four Hummocks	12	0 (0-0)	0 1 (0 1-0 1)	0 23 (0 23-0 23)	1 (1-1)	0.8 (0.7-0.8)
Rocky North	16	0 (0-0)	0 (0-0 1)	0.12 (0.12-0.12)	1 (1-1)	0.2 (0.2-0.3)
Price	25	0 (0-0)	0 (0-0)	0.02(0.020002) 0.04(0.04-0.04)	3 (3-3)	0.(0-0)
Liquanea	43	0.3 (0.2-0.4)	0 4 (0 3-0 5)	0.01 (0.01-0.01)	74 (79-68)	-0.5 (-0.60.4)
Lewis	131	0 (0-0)	0 (0-0)	0 (0-0)	145 (145-145)	0 (0-0)
East Island	14	0 (0-0)	0 (0-0)	0 15 (0 15-0 15)	1 (1-1)	04(04-04)
South Nentune	6	0 (0-0)	0 (0-0)	0.38 (0.38-0.38)	1 (1-1)	0.0-0)
	15	0 (0-0)	0 (0-0)	0.13 (0.13-0.13)	1 (1-1)	0.4 (0.4 - 0.4)
English	27	0 (0-0)	0 (0-0)	0.13 (0.13-0.13)	5 (5-5)	0.4 (0.4 0.4)
Dangerous	709	0 (0-0)	0 (0-0)	0.03 (0.03-0.03)	145 (145-145)	0.1 (0.1-0.1)
North Islet	28	0 (0-0)	0 (0-0)	0.03 (0.03-0.03)	5 (5-5)	0 1 (0 1-0 1)
Peaked Rocks	20	0 (0-0 1)	0 1 (0 1-0 1)	0.05 (0.05-0.05)	2 (2-2)	0 (-0 1-0)
N Casuarina	27	0 (0-0)	0.4 (0.3-0.5)	0.03 (0.03-0.03)	2 (2 2) 1 (1-1)	0 (-0.1-0) 0 3 (0 2-0 4)
Cape Bouquer	3	0 (0-0)	0.4 (0.3-0.5)	0.48 (0.48-0.48)	1 (1-1)	0.3(0.2 0.4)
Cave Point	3	0 (0-0)	0.4 (0.3-0.5)	0.48 (0.48-0.48)	1 (1-1)	0.3(0.2 0.4)
Seal Bay	260	3 (2 2-4 1)	0.7 (0.3-0.3)	0.+0 ⁻ 0+.0) (0_0) 0	145 (145-145)	-0 6 (-0 90 5)
Black Point	200	0 (0-0)	1 1 (0.8-1.5)	0 (0-0)	1 (1-1)	-0.0 (-0.30.3)
Seal Slide	16	0 (0-0)	1 1 (0.8-1.5)	0.13 (0.12-0.15)	1 (1-1)	-0.8 (-1.10.5)
SPane	321	8 6 (6 <i>1</i> -11 7)	1 6 (1 2-2 2)	0.10 (0.12-0.13) 0 (0_0 01)	117 (125-107)	-0.0 (-1.10.0) -1 5 (-21 1)
NPage	258	6 5 (<u>/</u> 8-8 7)	1.5 (1.2-2.2)	0 (0-0.01)	145 (145-135)	-1.3 (-21.1) -1 4 (-1 01)
Mean	2107	20 (15-22)	0.2 (0.2-0.2)	0.16 (0.16-0.16)	<u> </u>	0 (-0 1.0)
% of subnons	5107	20 (13-20)	0.2 (0.2-0.3)	50 (50-50)	69 (65-67)	50 (46-50)
,5 5, 5aspopo.						(00 0+) 00

Table 8.13. Subpopulation estimates of female bycatch, and percentage of females removed as
bycatch mortality per breeding cycle. Terminal Extinction Risk (TER), Quasi-extinction Time (QET,
and estimated growth rate over the next 20 breeding cycles (% per 17.5 months) are also given
assuming an underlying stable intrinsic growth rate. ±95 CL are given in parentheses. The current
estimated pup production per subpopulation is also shown. The table presents estimates based on
the current distribution of the GHAT fishery off South Australia (100,000 km.hrs/yr), with removal of
the top 80% of female core foraging areas (no displaced effort). The % of subpopulations with TERs
>0.1, QETs < 3 generations (33.3 yrs) and negative growth rates are given on the last line of the
table.

B9 17 0 (0-0.1) 0.2 (0.1-0.2) 0.1 (0.1-0.1) 2 (2.0.3-0.2) B8 38 0.1 (0.1-0.1) 0.1 (0.1-0.2) 0.4 (0.1-0.0) 4 (34-33) 0.0 (-0.3-0.2) B7 3 0 (0-0) 0.1 (0.1-0.2) 0.24 (0.4-0.48) 1 (1-1) 0.4 (0.4-0.49) B6 12 0 (0-0) 0.1 (0.1-0.2) 0.24 (0.2-0.2) 1 (1-1) 0.4 (0.4-0.49) B4 2 0 (0-0) 0.1 (0.1-0.1) 0.02 (0.02-0.2) 1 (2-1) 2.2 (-2.2-2.1) B3 31 0 (0-0) 0.1 (0-1.1) 0.37 (0.37-0.37) 1 (1-1) 0.6 (0.4-0.4) NR E 3 0 (0-0) 0.1 (0-1.1) 0.4 (0.4-0.4) 1 (1-1) 0.5 (0.5-0.5) Pt Fowler 1 0 (0-0) 0.1 (0-1.1) 0.4 (0.4-0.4) 1 (1-1) 0.5 (0.5-0.5) Pt Fowler 1 0 (0-0) 0.0 (0-0) 0.0 (0-0.0) 0.1 (0-1-0.1) 0.1 (0-1-0.1) Vest 56 0 (0-0) 0.0 (0-0) 0.4 (14-12+1) 0.0 (1-0-0.1) Pt Fowler 1	Subpop	Pup prod	Female bycatch	% females/sub	TER	QET	Growth rate
B8 38 0.1 (0.1-0.1) 0.1 (0.1-0.0) 34 (0.43) 0.3 (0.3-0.2) B7 3 0 (0-0) 0.1 (0.1-0.2) 0.48 (0.48-0.48) 1 (1-1) 0.7 (0.7-0.8) B5 4.3 0 (0-0) 0.1 (0.1-0.1) 0.04 (0.4-0.02) 1 (1-1) 0.7 (0.7-0.8) B4 2 0 (0-0) 0.1 (0.1-0.1) 0.04 (0.48-0.48) 1 (1-1) 0.6 (0.6-0.5) B3 31 0 (0-0) 0.1 (0.1-1.1) 0.48 (0.48-0.48) 1 (1-1) 0.48 (0.48-0.48) NR 15 0 (0-0) 0.1 (0.1.1) 0.13 (0.13-0.13) 1 (1-1) 0.48 (0.48-0.48) NR W 12 0 (0-0) 0.1 (0.1.1) 0.48 (0.48-0.48) 1 (1-1) 0.5 (0.5-0.5) Pt Fowler 1 0 (0-0) 0 (0-0) 0.0 (0.0) 144 (142-144) 0.0 (2.0-2.02) Vexts 56 0 (0-0) 0 (0-0) 0.0 (0.0-1) 144 (142-144) 0.0 (2.0-2.02) Uods 34 0 (0-0) 0 (0-0) 0.0 (0.01) 144 (142-144) 0.0 (2.0-2.02) U	B9	17	0 (0-0.1)	0.2 (0.1-0.2)	0.1 (0.1-0.1)	2 (2-2)	0.1 (0.1-0.2)
B7 3 0 (0-0) 0.1 (0.1-2.2) 0.23 (0.23-0.23) 1 (1-1) 0.4 (0.4-0.4) B5 4.3 0 (0-0.1) 0.1 (0-0.1) 0.04 (0.4-0.4) 90 (91-89) -0.2 (-0.2-0.1) B4 2 0 (0-0) 0.1 (0.1.1.0) 0.48 (0.48-0.48) 1 (1-1) 0.5 (0.50-5) B3 31 0 (0-0) 0.1 (0.1.1.0) 0.32 (0.23-0.23) 1 (1-1) 0.6 (0.6-0.6) B1 15 0 (0-0) 0.1 (0-0.1) 0.23 (0.23-0.23) 1 (1-1) 0.5 (0.5-0.5) B1 15 0 (0-0) 0.1 (0-0.1) 0.48 (0.48-0.48) 1 (1-1) 0.5 (0.5-0.5) PrEwire 1 0 (0-0) 0 (0-0) 0 (0-0) 0 (0-0) 0 (0-0) 0 (0-0) Provine 1 0 (0-0) 0 (0-0) 0.02 (0.02-0.02) 44 (40-3) -0.2 (-2.2-0.2) -0.2 (-0.2-0.2) Durdie 32 0 (0-0) 0 (0-0) 0.03 (0.33-0.3) 14 (14-14) 0.1 (-0.1-1) Fewire 17 0 (0-0) 0 (0-0) 0.03 (0.32-0.3) 14 (14-14) 0.0 (-0.0) Durdie 32 0 (0-0) 0 (0-0) <td>B8</td> <td>38</td> <td>0.1 (0.1-0.1)</td> <td>0.1 (0.1-0.2)</td> <td>0.01 (0.01-0.01)</td> <td>34 (34-33)</td> <td>-0.3 (-0.30.2)</td>	B8	38	0.1 (0.1-0.1)	0.1 (0.1-0.2)	0.01 (0.01-0.01)	34 (34-33)	-0.3 (-0.30.2)
B6 12 0 (0-0) 0.1 (0.1-0.1) 0.01 (0.01-0.01) 90 (91-89) -0.2 (-0.2-0.1) B4 2 0 (0-0) 0.1 (0.1-0.1) 0.48 (0.48-0.48) 1 (1-1) 0.5 (0.5-0.5) B3 31 0 (0-0) 0.1 (0.1-0.1) 0.48 (0.48-0.48) 1 (1-1) 0.45 (0.4-0.2) B1 15 0 (0-0) 0 (0-0.1) 0.13 (0.13-0.13) 1 (1-1) 0.48 (0.48-0.48) NR W 12 0 (0-0) 0 (0-0.1) 0.48 (0.48-0.48) 1 (1-1) 0.5 (0.5-0.5) Pt Gwier 1 0 (0-0) 0 (0-0.1) 0.48 (0.48-0.48) 1 (1-1) 0.5 (0.5-0.5) Pt Gwier 1 0 (0-0) 0 (0-0) 0 (0-0.1) 0.48 (0.48-0.48) 1 (1-1) 0.5 (0.5-0.5) Purdie 34 0 (0-0 0 (0-0 0.01 (0.1-0.1) 24 (44-33) -0 (2-0-2-0.2) Lounds 34 0 (0-0 0 (0-0 0.01 (0.1-0.1) 2 (2-2-0.3 (0.3-0.3) Gilddon 7 0 (0-0 0 (0-0) 0 (0-0.1) 0.48 (0.48-0.48) 1 (1-1)	B7	3	0 (0-0)	0.1 (0.1-0.2)	0.48 (0.48-0.48)	1 (1-1)	0.4 (0.4-0.4)
B5 43 0 (0-0.1) 0.1 (0-1.0) 0.4 (0.0-0.0) 99 (91-88) -0.2 (-0.20.1) B4 2 0 (0-0) 0.1 (0.1-0.1) 0.04 (0.40-0.0) 1 (1-1) 0.5 (0.5-0.5) B3 31 0 (0-0) 0.1 (0.1-0.1) 0.02 (0.02-0.02) 12 (13-12) -2.9 (-2.9-2.9) B2 5 0 (0-0) 0.1 (0-0.1) 0.31 (0.3-0.13) 1 (1-1) 0.6 (0.6-0.6) NR 12 0 (0-0) 0.1 (0-0.1) 0.23 (0.23-0.2) 1 (1-1) 0.6 (0.6-0.6) Provier 1 0 (0-0) 0 (0-0) 0.0 (0-0) 145 (145-145) 0 (0-0) Purdie 132 0 (0-0) 0 (0-0) 0.0 (0-0) 141 (142-141) 0.1 (0-1.0-1) Ferein 40 0.1 (0-1.0) 0.0 (0-0) 0.0 (0-0) 141 (142-141) 0.1 (0-1.0) Biddon 7 0 (0-0) 0.0 (0-0) 0.0 (0-0) 140 (140-139) 0.0 (-0) Bidudon 7 0 (0-0) 0 (0-0) 0.0 (0-0) 140 (140-139) 0.0 (-0) <td< td=""><td>B6</td><td>12</td><td>0 (0-0)</td><td>0.1 (0.1-0.2)</td><td>0.23 (0.23-0.23)</td><td>1 (1-1)</td><td>0.7 (0.7-0.8)</td></td<>	B6	12	0 (0-0)	0.1 (0.1-0.2)	0.23 (0.23-0.23)	1 (1-1)	0.7 (0.7-0.8)
B4 2 0 (0-0) 0.1 (0.1-1) 0.48 (0.48-0.48) 1 (1-1) 0.5 (0.5-0.5) B3 31 0 (0-0) 0.1 (0.1-1) 0.37 (0.37-0.37) 1 (1-1) 0.6 (0.6-0.6) B1 15 0 (0-0) 0 (1-0.1) 0.37 (0.37-0.37) 1 (1-1) 0.4 (0.4-0.4) NR W 12 0 (0-0) 0 (1-0.1) 0.23 (0.23-0.23) 1 (1-1) 0.8 (0.8-0.8) NR E 3 0 (0-0) 0 (1-0.1) 0.48 (0.48-0.48) 1 (1-1) 0.5 (0.5-0.5) Purdie 132 0 (0-0) 0 (0-0) 0.01 1.45 (145-145) 0.0-0.0 West 56 0 (0-0) 0 (0-0) 0.02 (0.2-0.22) 2.0 (4.42-33) 0.2 (-2-2.2) Lounds 34 0 (0-0) 0 (0-0) 0.03 (0.03-0.03) 14 (14-14) -0.1 (-0.1-0.1) Bielduscu 84 0 (0-0.1) 0.0 (0-0) 0.00 1.40 (140-39) 0.0 (-0.0) Giiddon 7 0 (0-0) 0 (0-0) 0.40 (140-139) 0.0 (-0.0) Bieluscu 84 <td>B5</td> <td>43</td> <td>0 (0-0.1)</td> <td>0.1 (0-0.1)</td> <td>0.01 (0.01-0.01)</td> <td>90 (91-89)</td> <td>-0.2 (-0.20.1)</td>	B5	43	0 (0-0.1)	0.1 (0-0.1)	0.01 (0.01-0.01)	90 (91-89)	-0.2 (-0.20.1)
B3 31 0 (0-0) 0.1 (0-1.1) 0.02 (0.02-0.02) 12 (13-12) 2-2 (-2-2-2) B2 5 0 (0-0) 0.1 (0-1.1) 0.37 (0.37-0.37) 1 (1-1) 0.6 (0.6-0.6) B1 15 0 (0-0) 0.1 (0-1.1) 0.23 (0.23-0.23) 1 (1-1) 0.8 (0.8-0.6) NR E 3 0 (0-0) 0 (1-0.1) 0.48 (0.48-0.48) 1 (1-1) 0.5 (0.5-0.5) Ptrowler 1 0 (0-0) 0 (0-0) 0 (0-0) 145 (145-145) 0 (0-0) West 56 0 (0-0) 0 (0-0) 0.01 (0.1-0.01) 141 (142-141) -0.1 (-0.1-0.1) Evenien 40 0.1 (0.1-0.1) 0.02 (0.02-0.02) 40 (40-39) -0.2 (-0.2-2.2) Lounds 34 0 (0-0) 0 (0-0) 0.3 (0.30-0.30) 141 (142-141) -0.1 (-0.1-0.1) Betwiser 17 0 (0-0) 0 (0-0) 0.2 (0.2-0.2) 0.3 (0.3-0.3) Giddon 7 0 (0-0) 0 (0-0) 0.4 (141-139) 0 (0-0) Betwiser 17 0 (0-0)	B4	2	0 (0-0)	0.1 (0.1-0.1)	0.48 (0.48-0.48)	1 (1-1)	0.5 (0.5-0.5)
B2 5 0 (0-0) 0.1 (0-1,1) 0.37 (0.37-0.37) 1 (1-1) 0.6 (0.6-0,6) B1 15 0 (0-0) 0 (0-0,1) 0.13 (0.13 0.13 0.13) 1 (1-1) 0.4 (0.4-0.4) NR W 12 0 (0-0) 0.1 (0-1,1) 0.48 (0.48-0.48) 1 (1-1) 0.5 (0.5-0.5) Purdie 132 0 (0-0) 0 (0-0) 0.48 (0.48-0.48) 1 (1-1) 0.5 (0.5-0.5) Purdie 132 0 (0-0) 0 (0-0) 0.48 (0.48-0.48) 1 (1-1) 0.5 (0.5-0.5) Purdie 132 0 (0-0) 0 (0-0) 0.00 (0-0) 1.44 (1.44-1.44) -0.1 (-0.1-0.1) Bvater 17 0 (0-0) 0 (0-0) 0.01 (0.1-0.1) 1.2 (2.2) 0.3 (0.3-3.3) Gliddon 7 0 (0-0) 0 (0-0) 0 (0-0) 1.40 (14-1.4) 0.0 (-0.0) Olive 2.06 0 (0-0) 0 (0-0) 0.45 (145-145) 0 (0-0) Diliput 67 0 (0-0) 0 (0-0) 1.45 (145-145) 0 (0-0) Diliput 67 0 (0-0	B3	31	0 (0-0)	0.1 (0.1-0.1)	0.02 (0.02-0.02)	12 (13-12)	-2.9 (-2.92.9)
B1 15 0 (0-0) 0 (0-1) 0.13 (0.13-0.13) 1 (1-1) 0.4 (0.4-0.4) NR W 12 0 (0-0) 0.1 (0-0.1) 0.23 (0.23-0.23) 1 (1-1) 0.5 (0.5-0.5) Pt Fowler 1 0 (0-0) 0 (0-1) 0.48 (0.48-0.48) 1 (1-1) 0.5 (0.5-0.5) Purdie 132 0 (0-0) 0 (0-0) 145 (145-145) 0 (0-0) West 56 0 (0-0) 0 (0-0) 140 (142-141) -0.1 (-0.1-0.1) Fenelon 40 0.1 (0.1-0.1) 0.02 (0.02-0.2) 40 (40-39) -0.2 (-020.2) Lounds 34 0 (0-0) 0 (0-0) 0.30 (0.3-0.33) 14 (1-14) -0.1 (-0.1-0.1) Biddon 7 0 (0-0) 0 (0-0) 0.46 (0.48-0.48) 1 (1-1) 0.8 (0.8-0.8) Biel/uscu 84 0 (0-0.1) 0 (0-0) 145 (141-141) 0 (0-0) Itiliput 67 0 (0-0) 0 (0-0) 145 (145-145) 0 (0-0) NB audin 98 0.2 (0.1-0.2) 0.1 (0.1-0.1) 0.38 (0.38-0.38) <td>B2</td> <td>5</td> <td>0 (0-0)</td> <td>0.1 (0-0.1)</td> <td>0.37 (0.37-0.37)</td> <td>1 (1-1)</td> <td>0.6 (0.6-0.6)</td>	B2	5	0 (0-0)	0.1 (0-0.1)	0.37 (0.37-0.37)	1 (1-1)	0.6 (0.6-0.6)
NR W 12 0 (0-0) 0.1 (0-0.1) 0.23 (0.23-0.23) 1 (1-1) 0.8 (0.8-0.8) NR E 3 0 (0-0) 0.1 (0-0.1) 0.48 (0.48-0.48) 1 (1-1) 0.5 (0.5-0.5) Purdie 132 0 (0-0) 0 (0-0) 0.48 (0.48-0.48) 1 (1-1) 0.5 (0.5-0.5) West 56 0 (0-0) 0 (0-0) 0.01 (0.01-0.01) 144 (142-144) -0.1 (0.1-0.1) Fenelon 40 0.1 (0.1-0.1) 0.02 (0.02-0.02) 40 (40-39) -0.2 (-0.2-0.2) Londs 34 0 (0-0) 0 (0-0) 0.1 (0.1-0.1) 2 (2.2-0.3) 0.30 (3.3-3) Biddian 7 0 (0-0) 0 (0-0) 0.1 (0.1-0.1) 2 (2.2-0.3) 0.6-0 Diliput 67 0 (0-0) 0 (0-0) 0 (0-0) 141 (141-14) -0.1 (0.1-0.1) Diliput 67 0 (0-0) 0 (0-0) 0 (0-0) 145 (146-143) 0 (0-0) Diliput 67 0 (0-0) 0 (0-0) 0 (0-0) 145 (146-143) 0.01 (0-0.1) Diliput	B1	15	0 (0-0)	0 (0-0.1)	0.13 (0.13-0.13)	1 (1-1)	0.4 (0.4-0.4)
NR E 3 0 (0-0) 0.1 (0-0.1) 0.48 (0.48-0.48) 1 (1-1) 0.5 (0.5-0.5) Pt Fowler 1 0 (0-0) 0 (0-0) 0.0 (0-0) 145 (145-145) 0 (0-0) West 56 0 (0-0) 0 (0-0) 0.0 (0-0) 144 (142-141) -0.1 (0.1-0.1) Fenelon 40 0.1 (0.1-0.1) 0.1 (0.1-0.1) 0.02 (0.02-0.02) 40 (40-39) -0.2 (-0.2-0.2) Lounds 34 0 (0-0) 0 (0-0) 0.3 (0.03-0.03) 14 (14.14) -0.1 (-0.1-0.1) Biduscu 84 0 (0-0.1) 0 (0-0) 0.0 (0-0) 146 (144-141) -0.0 (0-0) Liliput 67 0 (0-0) 0 (0-0) 145 (145-145) 0 (0-0) Olive 206 0 (0-0) 0 (0-0) 138 (139-13) -0.1 (-0.1-0.1) Plabatt 6 0 (0-0) 0.1 (0.1-0.1) 0.38 (0.38-0.38) 1 (1-1) 0.4 (0.4-0.5) Pearson 35 0.1 (0-1.0 0.1 (0.1-0.1) 0.38 (0.38-0.38) 1 (1-1) 0.4 (0.4-0.4) Ward	NR W	12	0 (0-0)	0.1 (0-0.1)	0.23 (0.23-0.23)	1 (1-1)	0.8 (0.8-0.8)
Pt Fowler 1 0 (0-0) 0 (0-0.1) 0.48 (0.48-0.48) 1 (1-1) 0.5 (0.5-0.5) Purdie 132 0 (0-0) 0 (0-0) 0 (0-0) 0 (0-0) 0 (0-0) West 56 0 (0-0) 0 (0-0) 0 (0-0) 0 (10 (1-0.1) 0.2 (0.2-0.2) Lounds 34 0 (0-0) 0 (0-0) 0.03 (0.3-0.3) 14 (14-14) -0.1 (0.1-0.1) Bwater 17 0 (0-0) 0 (0-0) 0.3 (0.3-0.3) 14 (14-13) 0.0 (0-3.0.3) Gilddon 7 0 (0-0) 0 (0-0) 0.3 (0.3-0.3) 1 (1-1) 0.8 (0.8-0.8) Blefuscu 84 0 (0-01) 0 (0-0) 0.40-01 144 (14-14) 0.0-0 Olive 206 0 (0-0) 0 (0-0) 0.0-0 144 (14-14) 0.0-0 Dises 15 0 (0-0) 0 (0-0) 0.0-0 144 (14-14) 0.0 (0-0 Jones 15 0 (0-0) 0.1 (0.1-0.1) 0.38 (0.38-0.38) 1 (1-1) 0.4 (0.4-0.5) Pearson 35 <	NR E	3	0 (0-0)	0.1 (0-0.1)	0.48 (0.48-0.48)	1 (1-1)	0.5 (0.5-0.5)
Purdie 132 0 (0-0) 0 (0-0) 0 (0-0) 145 (145-145) 0 (0-0) West 56 0 (0-0) 0 (0-0) 0.01 (0.01-0.01) 141 (142-141) -0.1 (-0.1-0.1) Fenelon 40 0.1 (0.1-0.1) 0.02 (0.2-0.02) 40 (4-39) -0.2 (-0.2-0.2) Lounds 34 0 (0-0) 0 (0-0) 0.33 (0.3-0.03) 14 (142-144) -0.1 (-0.1-0.1) Bwater 17 0 (0-0) 0 (0-0) 0.36 (0.3-6.36) 1 (1-1) 0.8 (0.8-0.8) Blefuscu 84 0 (0-0.1) 0 (0-0) 0 (0-0) 140 (140-139) 0 (0-0) Olive 206 0 (0-0) 0 (0-0) 0 (0-0) 145 (145-145) 0 (0-0) Olive 206 0 (0-0) 0 (0-0) 145 (145-145) 0 (0-0) Jones 15 0 (0-0) 0 (10.1-0.1) 0.38 (0.38-0.38) 1 (1-1) 0 (0-0) Jones 15 0 (0-0) 0.1 (0.1-0.1) 0.138 (139-137) -0.1 (0.1-0.1) 0.12 (0.2-0.02) 17 (17:17) -0.2 (-0.2-0.1)	Pt Fowler	1	0 (0-0)	0 (0-0.1)	0.48 (0.48-0.48)	1 (1-1)	0.5 (0.5-0.5)
West 56 0 (0-0) 0 (0-0) 0 (0-0) 0 (1 (0.1-0.1) 141 (142-141) -0.1 (-0.1-0.1) Fenelon 40 0.1 (0.1-0.1) 0.1 (0.1-0.1) 0.02 (0.02-0.02) 40 (40-39) -0.2 (-0.2-0.2) Lounds 34 0 (0-0) 0 (0-0) 0.03 (0.30-0.3) 14 (14-14) -0.1 (-0.1-0.1) Biwater 17 0 (0-0) 0 (0-0) 0.36 (0.36-0.36) 1 (1-1) 0.8 (0.8-0.8) Biefuscu 84 0 (0-0.1) 0 (0-0) 0 (0-0) 140 (140-139) 0 (0-0) Lilliput 67 0 (0-0) 0 (0-0) 0 (0-0) 145 (145-145) 0 (0-0) N Baudin 98 0.2 (0.1-0.2) 0.1 (0.1-0.1) 0.38 (0.38-0.38) 1 (1-1) 0.4 (0.4-0.5) Petabatt 6 0 (0-0) 0.1 (0.1-0.1) 0.38 (0.38-0.38) 1 (1-1) 0.4 (0.4-0.5) Pearson 35 0.1 (0-1.0.1) 0.13 (0.12-0.12) 171 (1717) -0.2 (-0.2-0.1) Ward 45 0.1 (0-0.1) 0.1 (0.1-0.0.1) 0.16 (0.0-0) 0 (0-0)	Purdie	132	0 (0-0)	0 (0-0)	0 (0-0)	145 (145-145)	0 (0-0)
Fenelon 40 0.1 (0.1-0.1) 0.1 (0.1-0.1) 0.02 (0.02-0.02) 40 (40-39) -0.2 (-0.2-0.2) Lounds 34 0 (0-0) 0 (0-0) 0.03 (0.03-0.03) 14 (14-14) -0.1 (-0.1-0.1) Bivater 17 0 (0-0) 0 (0-0) 0.03 (0.03-0.03) 14 (14-14) 0.1 (0.1-0.1) Giiddon 7 0 (0-0) 0 (0-0) 0.00 140 (140-139) 0 (0-0) Lilliput 67 0 (0-0) 0 (0-0) 0 (0-0) 141 (14-14) 0 (0-0) Dive 206 0 (0-0) 0 (0-0) 0 (0-0) 145 (145-145) 0 (0-0) N Baudin 98 0.2 (0.1-0.2) 0.1 (0.1-0.1) 0.03 (0.38-0.38) 1 (1-1) 0.4 (0-4.0-1) Jones 15 0 (0-0) 0.1 (0.1-0.1) 0.38 (0.38-0.48) 1 (1-1) 0.4 (0.4-0.3) Pearson 35 0.1 (0-0.1 0.1 (0.1-0.1) 0.2 (0.2-0.01) 117 (1-7) 0.2 (0.2-0.1) Ward 45 0.1 (0.1-0.1) 0.1 (0.1-0.1) 0.2 (0.2-0.2) 11 (1-1) 0.4 (0.4-0	West	56	0 (0-0)	0 (0-0)	0.01 (0.01-0.01)	141 (142-141)	-0.1 (-0.10.1)
	Fenelon	40	0.1 (0.1-0.1)	0.1 (0.1-0.1)	0.02 (0.02-0.02)	40 (40-39)	-0.2 (-0.20.2)
Bwater 17 0 (0-0) 0 (0-0) 0.1 (0.1-0.1) 2 (2-2) 0.3 (0.3-0.3) Gliddon 7 0 (0-0) 0 (0-0) 0.36 (0.3-638) 1 (1-1) 0.8 (0.8-0.8) Blefuscu 84 0 (0-0.1) 0 (0-0) 0 (0-0) 140 (140-139) 0 (0-0) Olive 206 0 (0-0) 0 (0-0) 0 (0-0) 1445 (145-145) 0 (0-0) N Baudin 98 0.2 (0.1-0.2) 0.1 (0.1-0.1) 0.38 (0.38-0.38) 1 (1-1) 0.4 (0.4-0.4) Jones 15 0 (0-0) 0.1 (0.1-0.1) 0.38 (0.38-0.38) 1 (1-1) 0.4 (0.4-0.5) Parson 35 0.1 (0.0-1) 0.13 (0.13-0.13) 1 (1-1) 0.4 (0.4-0.5) Vard 45 0.1 (0.1-0.1) 0.10 (0.20.20.20) 117 (17-17) -0.2 (0.2-0.1) Ward 45 0.1 (0.1-0.1) 0.10 (0.0 118 (120-114) -0.2 (0.2-0.1) Ward 45 0.1 (0.1-0.1) 0.10 (0.1 0.10 (0.1-0.1) 80 (84-76) -0.2 (0.2-0.1) Ward 45 <	Lounds	34	0 (0-0)	0 (0-0)	0.03 (0.03-0.03)	14 (14-14)	-0.1 (-0.10.1)
Gliddon 7 0 (0-0) 0 (0-0) 0 (0-0) 0 (0,36 (0,36 (-),36) 1 (1-1) 0.8 (0,8-0.8) Blefuscu 84 0 (0-0) 0 (0-0) 0 (0-0) 140 (140-139) 0 (0-0) Lilliput 67 0 (0-0) 0 (0-0) 0 (0-0) 145 (145-145) 0 (0-0) N Baudin 98 0.2 (0,1-0.2) 0.1 (0,1-0.1) 0 (0-0) 138 (139-137) -0.1 (-0,1-0-1) Jones 15 0 (0-0) 0.1 (0,1-0.1) 0.38 (0.38-0.38) 1 (1-1) 0.3 (0,3-0.3) Dorothee 1 0 (0-0) 0.1 (0,1-0.1) 0.38 (0.48-0.48) 1 (1-1) 0.2 (0,2-0.01) Ward 45 0.1 (0,1-0.1) 0.1 (0,1-0.1) 0.0 (0-0) 118 (120-114) -0.2 (-0,2-0.1) Ward 45 0.1 (0,1-0.1) 0.1 (0,1-0.1) 0.1 (0,1-0.1) 0.3 (0,3-0.3) Price 157 0 (0-0) 0 (0-0) 0 (0-0) 0.145 (145-145) -0.1 (0,1-0.1) Focky North 16 0 (0-0) 0 (0-0) 0.140 (10,1-0.1) 0.1 (0,1-0.1)	B'water	17	0 (0-0)	0 (0-0)	0.1 (0.1-0.1)	2 (2-2)	0.3 (0.3-0.3)
Blefuscu 84 0 (0-01) 0 (0-0) 0 (0-0) 140 (140-139) 0 (0-0) Lilliput 67 0 (0-0) 0 (0-0) 0 (0-0) 141 (141-141) 0 (0-0) Olive 206 0 (0-0) 0 (0-0) 0 (0-0) 145 (145-145) 0 (0-0) N Baudin 98 0.2 (0.1-0.2) 0.1 (0.1-0.1) 0.38 (0.38-0.38) 18 (139-137) -0.1 (-0.1-0.1) Jones 15 0 (0-0) 0.1 (0.1-0.1) 0.38 (0.48-0.48) 1 (1-1) 0.4 (0-0.5) Dorothee 1 0 (0-0) 0.1 (0.1-0.1) 0.02 (0.02-0.02) 17 (17-17) -0.2 (-0.2-0.1) Ward 45 0.1 (0.1-0.1) 0.1 (0.1-0.1) 0.00-0 145 (145-145) -0.1 (-0.1-0.1) Four Hummocks 12 0 (0-0) 0 (0-0) 0 (0-0) 145 (145-145) -0.1 (0.1-0.1) Liguanea 43 0.2 (0.1-0.3) 0.3 (0.2-0.4) 0.01 (0.01-0.01) 80 (84-76) -0.3 (-0.4-0.3) Lewis 131 0 (0-0) 0 (0-0) 0.4 (0.4-0.4) 3(3-3) 0	Gliddon	7	0 (0-0)	0 (0-0)	0.36 (0.36-0.36)	1 (1-1)	0.8 (0.8-0.8)
Lilliput 67 0 (0-0) 0 (0-0) 0 (0-0) 14 (141-141) 0 (0-0) Olive 206 0 (0-0) 0 (0-0) 0 (0-0) 145 (145-145) 0 (0-0) N Baudin 98 0.2 (0.1-0.2) 0.1 (0.1-0.1) 0.38 (0.38-0.38) 1 (1-1) 0 (0-1) Jones 15 0 (0-0) 0.1 (0.1-0.1) 0.38 (0.38-0.38) 1 (1-1) 0.4 (0.4-0.5) Pearson 35 0.1 (0-0.1) 0.1 (0.1-0.1) 0.02 (0.02-0.02) 17 (17-17) -0.2 (-0.2-0.1) Ward 45 0.1 (0.1-0.1) 0.1 (0.1-0.1) 0 (0-0) 148 (120-114) -0.2 (-0.2-0.1) Ward 45 0.1 (0.1-0.1) 0 (0-0) 0.23 (0.23-0.23) 1 (1-1) 0.8 (0.8-0.9) Rocky North 16 0 (0-0) 0 (0-0) 0.23 (0.23-0.23) 1 (1-1) 0.3 (0.3-0.3) Price 25 0 (0-0) 0 (0-0) 0.44 (0.40.4) 3 (-3) 0.1 (0.1-0.1) Liguanea 43 0.2 (0.1-0.3) 0.3 (0.2-0.4) 0.15 (0.15-0.15) 1 (1-1) 0.4	Blefuscu	84	0 (0-0.1)	0 (0-0)	0 (0-0)	140 (140-139)	0 (0-0)
Olive 206 0 (0-0) 0 (0-0) 0 (0-0) 1 (1-1) 1 (1-1) 0 (0-0) N Baudin 98 0.2 (0.1-0.2) 0.1 (0.1-0.1) 0 (0-0) 138 (139-137) -0.1 (-0.1-0.1) Pt Labatt 6 0 (0-0) 0.1 (0.1-0.1) 0.38 (0.38-0.38) 1 (1-1) 0 (0-1) Jones 15 0 (0-0) 0.1 (0.1-0.1) 0.38 (0.38-0.38) 1 (1-1) 0.4 (0.4-0.5) Pearson 35 0.1 (0-0.1) 0.1 (0.1-0.1) 0.02 (0.02-0.02) 17 (17-17) -0.2 (-0.2-0.1) Ward 45 0.1 (0.1-0.1) 0.1 (0.1-0.1) 0.02 (0.02-0.02) 17 (17-17) -0.2 (-0.2-0.1) Waldegrave 157 0 (0-0) 0 (0-0) 0 (0-0) 145 (145-145) -0.1 (-0.1-0.1) Four Hummocks 12 0 (0-0) 0 (0-0) 0.12 (0.12-0.12) 1 (1-1) 0.8 (0.8-0.9) Rocky North 16 0 (0-0) 0 (0-0) 0.23 (0.23-0.23) 1 (1-1) 0.3 (0.2-04) Liguanea 43 0.2 (0.1-0.3) 0.3 (0.2-04) 0.3 (0.3-0.3)	Lilliput	67	0 (0-0)	0 (0-0)	0 (0-0)	141 (141-141)	0 (0-0)
N Baudin 98 0.2 (0.1-0.2) 0.1 (0.1-0.1) 0 (0-0) 138 (139-137) -0.1 (-0.1-0.1) Pt Labatt 6 0 (0-0) 0.1 (0.1-0.1) 0.38 (0.38-0.38) 1 (1-1) 0 (-0.1-0) Jones 15 0 (0-0) 0.1 (0.1-0.1) 0.38 (0.38-0.38) 1 (1-1) 0.4 (0.4-0.5) Dorothee 1 0 (0-0) 0.1 (0.1-0.2) 0.48 (0.48-0.48) 1 (1-1) 0.4 (0.4-0.5) Pearson 35 0.1 (0-0.1) 0.1 (0.1-0.1) 0.02 (0.2-0.2) 17 (17-17) -0.2 (-0.2-0.1) Ward 45 0.1 (0.1-0.1) 0.1 (0.1-0.1) 0 (0-0) 118 (120-114) -0.2 (-0.2-0.1) Ward 45 0.1 (0.1-0.1) 0.1 (0.1-0.1) 0 (0-0) 118 (120-114) -0.2 (-0.2-0.1) Ward 45 0.1 (0.1-0.1) 0.1 (0.1-0.1) 0 (0-0) 118 (120-114) -0.2 (-0.2-0.1) Ward 45 0.1 (0.1-0.1) 0.1 (0.1-0.1) 118 (145-145) -0.1 (-0.1-0.1) Four Hummocks 12 0 (0-0) 0 (0-0) 0.2 (0.1-2.2) 1 (1-1) </td <td>Olive</td> <td>206</td> <td>0 (0-0)</td> <td>0 (0-0)</td> <td>0 (0-0)</td> <td>145 (145-145)</td> <td>0 (0-0)</td>	Olive	206	0 (0-0)	0 (0-0)	0 (0-0)	145 (145-145)	0 (0-0)
Pt Labatt 6 0 (0-0) 0.1 (0.1-0.1) 0.38 (0.38-0.38) 1 (1-1) 0 (0-0.1-0) Jones 15 0 (0-0) 0.1 (0.1-0.1) 0.13 (0.13-0.13) 1 (1-1) 0.4 (0.4-0.5) Pearson 35 0.1 (0-1.0) 0.1 (0.1-0.1) 0.02 (0.02-0.02) 17 (17-17) -0.2 (-0.2-0.1) Ward 45 0.1 (0.1-0.1) 0.1 (0.1-0.1) 0.02 (0.02-0.02) 17 (17-17) -0.2 (-0.2-0.1) Waldegrave 157 0 (0-0) 0 (0-0) 0 (0-0) 145 (145-145) -0.1 (-0.1-0.1) Focky North 16 0 (0-0) 0 (0-0) 0.23 (0.23-0.23) 1 (1-1) 0.8 (0.80-9) Rocky North 16 0 (0-0) 0 (0-0) 0.23 (0.23-0.23) 1 (1-1) 0.3 (0.3-0.3) Price 25 0 (0-0) 0 (0-0) 0.23 (0.23-0.23) 1 (1-1) 0.3 (0.3-0.3) Lewis 131 0 (0-0) 0 (0-0) 0.4 (0.4-0.4) 3 (3-3) 0 (1 (0.1-0.1) South Neptune 6 0 (0-0) 0 (0-0) 0 (0-0) 145 (145-145)	N Baudin	98	0.2 (0.1-0.2)	0.1 (0.1-0.1)	0 (0-0)	138 (139-137)	-0.1 (-0.10.1)
Jones 15 0 (0-0) 0.1 (0.1-0.1) 0.13 (0.13-0.13) 1 (1-1) 0.3 (0.3-0.3) Dorothee 1 0 (0-0) 0.1 (0.1-0.2) 0.48 (0.48-0.48) 1 (1-1) 0.4 (0.4-0.5) Pearson 35 0.1 (0-0.1) 0.1 (0.1-0.1) 0.02 (0.02-0.02) 17 (17-17) -0.2 (-0.2-0.1) Ward 45 0.1 (0.1-0.1) 0.1 (0.1-0.1) 0.02 (0.02-0.02) 17 (17-17) -0.2 (-0.2-0.1) Waldegrave 157 0 (0-0) 0 (0-0) 0 (0-0) 145 (145-145) -0.1 (-0.1-0.1) Four Hummocks 12 0 (0-0) 0 (0-0) 0 (0-0) 145 (145-145) -0.1 (-0.1-0.1) Iguanea 43 0.2 (0.1-0.3) 0.3 (0.2-0.4) 0.01 (0.01-0.01) 80 (84-76) -0.3 (-0.4-0.3) Lewis 131 0 (0-0) 0 (0-0) 0 (0-0) 0 (0-0) 145 (145-145) 0 (0-0) Albatross 15 0 (0-0) 0 (0-0) 0.3 (0.3-0.3) 5 (5-5) 0.1 (0.1-0.1) Pagerous 709 0 (0-0) 0 (0-0) 0.03 (0.03-0	Pt Labatt	6	0 (0-0)	0.1 (0.1-0.1)	0.38 (0.38-0.38)	1 (1-1)	0 (-0.1-0)
Dorothee 1 0 (0 -0) 0.1 (0.1-0.1) 0.14 (0.10.1 -0.1) 0.14 (0.10.1 -0.1) Ward 45 0.1 (0.1-0.1) 0.1 (0.1-0.1) 0.02 (0.02-0.02) 17 (17-17) -0.2 (-0.2-0.1) Ward 45 0.1 (0.1-0.1) 0.1 (0.1-0.1) 0 (0-0) 118 (120-114) -0.2 (-0.2-0.1) Ward 45 0.1 (0.1-0.1) 0.1 (0.1-0.1) 0 (0-0) 145 (145-145) -0.1 (-0.1-0.1) Four Hummocks 12 0 (0-0) 0 (0-0) 0.23 (0.23-0.23) 1 (1-1) 0.8 (0.8-0.9) Rocky North 16 0 (0-0) 0 (0-0) 0.24 (0.04-0.04) 3 (3-3) 0.1 (0.1-0.1) Liguanea 43 0.2 (0.1-0.3) 0.3 (0.2-0.4) 0.01 (0.01-0.01) 80 (84-76) -0.3 (-0.4-0.3) Lewis 131 0 (0-0) 0 (0-0) 0.15 (0.15-0.15) 1 (1-1) 0.4 (0.4-0.4) South Neptune 6 0 (0-0) 0 (0-0) 0.38 (0.38-0.38) 1 (1-1) 0.4 (0.4-0.4) English 27 0 (0-0) 0 (0-0) 0.03 (0.03-0.03) 5 (5-5)	Jones	15	0 (0-0)	0.1 (0.1-0.1)	0.13 (0.13-0.13)	1 (1-1)	0.3 (0.3-0.3)
Pearson 35 0.1 (0-0.1) 0.0 (0.10.1) 0.02 (0.02-0.02) 17 (17-17) -0.2 (-0.2-0.1) Ward 45 0.1 (0.1-0.1) 0.1 (0.1-0.1) 0.00 (0.00) 145 (145-145) -0.1 (-0.1-0.1) Ward 45 0.1 (0.0) 0 (0-0) 0 (0-0) 145 (145-145) -0.1 (-0.1-0.1) Four Hummocks 12 0 (0-0) 0 (0-0) 0.23 (0.23-0.23) 1 (1-1) 0.8 (0.8-0.9) Rocky North 16 0 (0-0) 0 (0-0) 0.04 (0.04-0.04) 3 (3-3) 0.1 (0.1-0.1) Liguanea 43 0.2 (0.1-0.3) 0.3 (0.2-0.4) 0.01 (0.01-0.01) 80 (84-76) -0.3 (-0.40.3) Lewis 131 0 (0-0) 0 (0-0) 0 (0-0) 145 (145-145) 0 (0-0) Bast Island 14 0 (0-0) 0 (0-0) 0.38 (0.38-0.38) 1 (1-1) 0.4 (0.4-0.4) South Neptune 6 0 (0-0) 0 (0-0) 0.03 (0.03-0.03) 5 (5-5) 0.1 (0.1-0.1) Dangerous 709 0 (0-0) 0 (0-0) 0.03 (0.3-0.03) 5 (5	Dorothee	1	0 (0-0)	0.1 (0.1-0.2)	0.48 (0.48-0.48)	1 (1-1)	0.4 (0.4-0.5)
Ward 45 0.1 (0.1-0.1) 0.1 (0.1-0.1) 0.0 (0.0) 118 (12-114) -0.2 (-0.2-0.1) Waldegrave 157 0 (0-0) 0 (0-0) 0 (0-0) 145 (145-145) -0.1 (-0.1-0.1) Four Hummocks 12 0 (0-0) 0 (0-0) 0.23 (0.23-0.23) 1 (1-1) 0.8 (0.8-0.9) Rocky North 16 0 (0-0) 0 (0-0) 0.12 (0.12-0.12) 1 (1-1) 0.3 (0.3-0.3) Price 25 0 (0-0) 0 (0-0) 0.04 (0.04-0.04) 3 (3-3) 0.1 (0.1-0.1) Liguanea 43 0.2 (0.1-0.3) 0.3 (0.2-0.4) 0.01 (0.1-0.01) 80 (84-76) -0.3 (-0.40.3) Lewis 131 0 (0-0) 0 (0-0) 0 (0-0) 145 (145-145) 0 (0-0) East Island 14 0 (0-0) 0 (0-0) 0.38 (0.38-0.38) 1 (1-1) 0.4 (0.4-0.4) South Neptune 6 0 (0-0) 0 (0-0) 0.33 (0.33-0.03) 5 (5-5) 0.1 (0.1-0.1) Dangerous 709 0 (0-0) 0 (0-0) 0.00 0 0 (0-0) N (Pearson	35	0 1 (0-0 1)	0.1 (0.1-0.1)	0.02 (0.02-0.02)	17 (17-17)	-0.2 (-0.20.1)
Waldegrave 157 0 (0-0) 0 (0-0) 0 (0-0) 145 (145-145) -0.1 (-0.1-0.1) Four Hummocks 12 0 (0-0) 0 (0-0) 0 (0-0) 0 (23 (0.23 - 0.23) 1 (1-1) 0.8 (0.8-0.9) Rocky North 16 0 (0-0) 0 (0-0) 0 (0-0) 0.12 (0.12 - 0.12) 1 (1-1) 0.3 (0.3-0.3) Price 25 0 (0-0) 0 (0-0) 0.04 (0.04-0.04) 3 (3-3) 0.1 (0.1-0.1) Liguanea 43 0.2 (0.1-0.3) 0.3 (0.2-0.4) 0.01 (0.01-0.01) 80 (84-76) -0.3 (-0.40.3) Lewis 131 0 (0-0) 0 (0-0) 0 (0-0) 145 (145-145) 0 (0-0) Bast Island 14 0 (0-0) 0 (0-0) 0.15 (0.15-0.15) 1 (1-1) 0.4 (0.4-0.4) South Neptune 6 0 (0-0) 0 (0-0) 0.03 (0.03-0.03) 5 (5-5) 0.1 (0.1-0.1) Dangerous 709 0 (0-0) 0 (0-0) 0.03 (0.03-0.03) 5 (5-5) 0.1 (0.1-0.1) Paked Rocks 24 0 (0-0) 0 (0-0) 0	Ward	45	0 1 (0 1-0 1)	0.1 (0.1-0.1)	0 (0-0)	118 (120-114)	-0.2 (-0.20.1)
Four Hummocks 12 0 (0-0) 0 (0-0) 0.23 (0.23-0.23) 1 (1-1) 0.8 (0.8-0.9) Rocky North 16 0 (0-0) 0 (0-0) 0 (0-0) 0.12 (0.12-0.12) 1 (1-1) 0.3 (0.3-0.3) Price 25 0 (0-0) 0 (0-0) 0.04 (0.04-0.04) 3 (3-3) 0.1 (0.1-0.1) Liguanea 43 0.2 (0.1-0.3) 0.3 (0.2-0.4) 0.01 (0.01-0.01) 80 (84-76) -0.3 (-0.40.3) Lewis 131 0 (0-0) 0 (0-0) 0 (0-0) 145 (145-145) 0 (0-0) Bast Island 14 0 (0-0) 0 (0-0) 0.15 (0.15-0.15) 1 (1-1) 0.4 (0.4-0.4) South Neptune 6 0 (0-0) 0 (0-0) 0.38 (0.38-0.38) 1 (1-1) 0.4 (0.4-0.4) English 27 0 (0-0) 0 (0-0) 0.03 (0.03-0.03) 5 (5-5) 0.1 (0.1-0.1) Dangerous 709 0 (0-0) 0 (0-0) 0.03 (0.03-0.03) 5 (5-5) 0.1 (0.1-0.1) Paked Rocks 24 0 (0-0) 0 (0-0) 0.05 (0.5-0.05) 2	Waldegrave	157	0 (0-0)	0 (0-0)	0 (0-0)	145 (145-145)	-0.1 (-0.10.1)
North 16 0 (0 -0) 0 (0 -0) 0 (12 (0.12 - 0.12) 1 (1 -1) 0.3 (0.3 - 0.3) Price 25 0 (0 -0) 0 (0 -0) 0 (0 -0) 0 (0 -0) 3 (3 - 3) 0 (1 (0 - 1 - 0.3) Liguanea 43 0.2 (0 1 - 0.3) 0.3 (0.2 - 0.4) 0.01 (0 0 - 1 - 0.01) 80 (84 - 76) -0.3 (-0.4 0.3) Lewis 131 0 (0 - 0) 0 (0 - 0) 0 (0 - 0) 145 (145 - 145) 0 (0 - 0) East Island 14 0 (0 - 0) 0 (0 - 0) 0 (0 - 0) 145 (145 - 145) 0 (0 - 0) Autor Neptune 6 0 (0 - 0) 0 (0 - 0) 0.3 (0 .3 - 0.38) 1 (1 - 1) 0.4 (0.4 - 0.4) South Neptune 6 0 (0 - 0) 0 (0 - 0) 0.3 (0 .3 - 0.38) 1 (1 - 1) 0.4 (0.4 - 0.4) English 27 0 (0 - 0) 0 (0 - 0) 0.3 (0 .0 - 0.33) 5 (5 - 5) 0.1 (0 - 1 - 0.1) Dargerous 709 0 (0 - 0) 0 (0 - 0) 0.3 (0 .0 - 0.33) 5 (5 - 5) 0.1 (0 - 0 - 0) North Islet 28 0 (0 - 0)	Four Hummocks	12	0 (0-0)	0 (0-0)	0 23 (0 23-0 23)	1 (1-1)	0.8 (0.8-0.9)
Price 25 0 (0-0) <t< td=""><td>Rocky North</td><td>16</td><td>0 (0-0)</td><td>0 (0-0)</td><td>0.12 (0.12-0.12)</td><td>1 (1-1)</td><td>0.3 (0.3-0.3)</td></t<>	Rocky North	16	0 (0-0)	0 (0-0)	0.12 (0.12-0.12)	1 (1-1)	0.3 (0.3-0.3)
Liguanea 43 0.2 (0.1-0.3) 0.3 (0.2-0.4) 0.01 (0.01-0.01) 80 (84-76) -0.3 (-0.4-0.3) Lewis 131 0 (0-0) 0 (0-0) 0 (0-0) 0 (0-0) 145 (145-145) 0 (0-0) East Island 14 0 (0-0) 0 (0-0) 0.15 (0.15-0.15) 1 (1-1) 0.4 (0.4-0.4) South Neptune 6 0 (0-0) 0 (0-0) 0.38 (0.38-0.38) 1 (1-1) 0.4 (0.4-0.4) English 27 0 (0-0) 0 (0-0) 0.03 (0.03-0.03) 5 (5-5) 0.1 (0.1-0.1) Dangerous 709 0 (0-0) 0 (0-0) 0.03 (0.03-0.03) 5 (5-5) 0.1 (0.1-0.1) Peaked Rocks 24 0 (0-0) 0 (0-0) 0.05 (0.05-0.05) 2 (2-2) 0 (0-0) N Casuarina 3 0 (0-0) 0.1 (0.1-0.2) 0.48 (0.48-0.48) 1 (1-1) 0.4 (0.4-0.4) Cave Point 3 0 (0-0) 0.1 (0.1-0.2) 0.48 (0.48-0.48) 1 (1-1) 0.4 (0.4-0.4) Seal Bay 260 1.6 (1.2-2.2) 0.4 (0.3-0.5) 0 (0-0) 145 (145-145) -0.3 (-0.50.2) Black Point 1 <t< td=""><td>Price</td><td>25</td><td>0 (0-0)</td><td>0 (0-0)</td><td>0.02(0.020002) 0.04(0.04-0.04)</td><td>3 (3-3)</td><td>0.1 (0.1-0.1)</td></t<>	Price	25	0 (0-0)	0 (0-0)	0.02(0.020002) 0.04(0.04-0.04)	3 (3-3)	0.1 (0.1-0.1)
Lewis 131 0 (0-0) 0 (0-0) 0 (0-0) 145 (145-145) 0 (0-0) East Island 14 0 (0-0) 0 (0-0) 0 (15 (0.15-0.15) 1 (1-1) 0.4 (0.4-0.4) South Neptune 6 0 (0-0) 0 (0-0) 0.38 (0.38-0.38) 1 (1-1) 0.4 (0.4-0.4) Albatross 15 0 (0-0) 0 (0-0) 0.33 (0.33-0.13) 1 (1-1) 0.4 (0.4-0.4) English 27 0 (0-0) 0 (0-0) 0.33 (0.33-0.03) 5 (5-5) 0.1 (0.1-0.1) Dangerous 709 0 (0-0) 0 (0-0) 0.03 (0.03-0.03) 5 (5-5) 0.1 (0.1-0.1) Peaked Rocks 24 0 (0-0) 0 (0-0) 0.03 (0.03-0.03) 5 (5-5) 0.1 (0.1-0.1) Peaked Rocks 24 0 (0-0) 0 (0-0) 0.05 (0.05-0.05) 2 (2-2) 0 (0-0) N Casuarina 3 0 (0-0) 0.1 (0.1-0.2) 0.48 (0.48-0.48) 1 (1-1) 0.4 (0.4-0.4) Cave Point 3 0 (0-0) 0.1 (0.1-0.2) 0.48 (0.48-0.48) 1 (1-1) 0.4 (0.	Liquanea	43	0.2 (0.1-0.3)	0.3(0.2-0.4)	0.01 (0.01-0.01)	80 (84-76)	-0.3 (-0.40.3)
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South Neptune 6 0 (0-0) 0 (0-0) 0.38 (0.38-0.38) 1 (1-1) 0 (0-0) Albatross 15 0 (0-0) 0 (0-0) 0.13 (0.13-0.13) 1 (1-1) 0.4 (0.4-0.4) English 27 0 (0-0) 0 (0-0) 0.03 (0.03-0.03) 5 (5-5) 0.1 (0.1-0.1) Dangerous 709 0 (0-0) 0 (0-0) 0.03 (0.03-0.03) 5 (5-5) 0.1 (0.1-0.1) Peaked Rocks 24 0 (0-0) 0 (0-0) 0.03 (0.03-0.03) 5 (5-5) 0.1 (0.1-0.1) Peaked Rocks 24 0 (0-0) 0 (0-0) 0.05 (0.05-0.05) 2 (2-2) 0 (0-0) N Casuarina 3 0 (0-0) 0.1 (0.1-0.2) 0.48 (0.48-0.48) 1 (1-1) 0.4 (0.4-0.4) Cave Point 3 0 (0-0) 0.1 (0.1-0.2) 0.48 (0.48-0.48) 1 (1-1) 0.4 (0.4-0.4) Seal Bay 260 1.6 (1.2-2.2) 0.4 (0.3-0.5) 0 (0-0) 145 (145-145) -0.3 (-0.5-0.2) Black Point 1 0 (0-0) 0.6 (0.5-0.9) 0.48 (0.48-0.48) 1 (1-1) 0.2 (0.1-0.3) Seal Bay 260 1.6 (1.2-2.2)	East Island	14	0 (0-0)	0 (0-0)	0 15 (0 15-0 15)	1 (1-1)	04(04-04)
Albatross 15 0 (0-0) 0 (0-0) 0.13 (0.13-0.13) 1 (1-1) 0.4 (0.4-0.4) English 27 0 (0-0) 0 (0-0) 0.03 (0.03-0.03) 5 (5-5) 0.1 (0.1-0.1) Dangerous 709 0 (0-0) 0 (0-0) 0 (0-0) 145 (145-145) 0 (0-0) North Islet 28 0 (0-0) 0 (0-0) 0.03 (0.03-0.03) 5 (5-5) 0.1 (0.1-0.1) Peaked Rocks 24 0 (0-0) 0 (0-0) 0.05 (0.05-0.05) 2 (2-2) 0 (0-0) N Casuarina 3 0 (0-0) 0.1 (0.1-0.2) 0.48 (0.48-0.48) 1 (1-1) 0.4 (0.4-0.4) Cave Point 3 0 (0-0) 0.1 (0.1-0.2) 0.48 (0.48-0.48) 1 (1-1) 0.4 (0.4-0.4) Seal Bay 260 1.6 (1.2-2.2) 0.4 (0.3-0.5) 0 (0-0) 145 (145-145) -0.3 (-0.5-0.2) Black Point 1 0 (0-0) 0.6 (0.4-0.8) 0.12 (0.12-0.12) 1 (1-1) 0.2 (0.1-0.3) Seal Slide 16 0.2 (0.1-0.2) 0.6 (0.4-0.8) 0.12 (0.12-0.12) 1 (1-1) -0.3 (-0.50.1) SPage 331 5.6 (4.1-7.6)	South Neptune	6	0 (0-0)	0 (0-0)	0.38 (0.38-0.38)	1 (1-1)	0 (0-0)
Instructs 13 0 (0 0) 0 (0 0) 0 (0 0) 0 (0 0) 0 (0 0) 1 (1 1) 0 (1 (1 1) 0 (1 (0 (1 - 0 (15	0 (0-0)	0 (0-0)	0.13 (0.13-0.13)	1 (1-1)	0.4(0.4-0.4)
Lingson Li 0 (0 0) 0 (0 0) 0 (0 0) 0 (0 0) 0 (0 0) 0 (0 0) 0 (0 0) Dangerous 709 0 (0 0) 0 (0 0) 0 (0 0) 0 (0 0) 145 (145-145) 0 (0 0) North Islet 28 0 (0 0) 0 (0 0) 0 (0 0) 0.03 (0.03-0.03) 5 (5-5) 0.1 (0.1-0.1) Peaked Rocks 24 0 (0 0) 0 (0 0) 0.05 (0.05-0.05) 2 (2-2) 0 (0 0) N Casuarina 3 0 (0 0) 0.1 (0.1-0.2) 0.48 (0.48-0.48) 1 (1-1) 0.4 (0.4-0.4) Cave Point 3 0 (0 0) 0.1 (0.1-0.2) 0.48 (0.48-0.48) 1 (1-1) 0.4 (0.4-0.4) Seal Bay 260 1.6 (1.2-2.2) 0.4 (0.3-0.5) 0 (0-0) 145 (145-145) -0.3 (-0.50.2) Black Point 1 0 (0-0) 0.6 (0.5-0.9) 0.48 (0.48-0.48) 1 (1-1) 0.2 (0.1-0.3) Seal Slide 16 0.2 (0.1-0.2) 0.6 (0.4-0.8) 0.12 (0.12-0.12) 1 (1-1) -0.3 (-0.50.1) SPage 331 5.6 (4.1-7.6) 1 (0.8-1.4) 0 (0-0) 128 (134-121) -1 (-1.30.7) <	English	27	0 (0-0)	0 (0-0)	0.13 (0.13-0.13)	5 (5-5)	0.4 (0.4-0.4)
Dangerous 105 0 (0 0) 0 (0 0) 0 (0 0) 0 (0 0) 145 (145 (145)) 0 (0 0) North Islet 28 0 (0-0) 0 (0-0) 0.03 (0.03-0.03) 5 (5-5) 0.1 (0.1-0.1) Peaked Rocks 24 0 (0-0) 0 (0-0) 0.05 (0.05-0.05) 2 (2-2) 0 (0-0) N Casuarina 3 0 (0-0) 0.1 (0.1-0.2) 0.48 (0.48-0.48) 1 (1-1) 0.4 (0.4-0.5) Cape Bouguer 3 0 (0-0) 0.1 (0.1-0.2) 0.48 (0.48-0.48) 1 (1-1) 0.4 (0.4-0.4) Cave Point 3 0 (0-0) 0.1 (0.1-0.2) 0.48 (0.48-0.48) 1 (1-1) 0.4 (0.4-0.4) Seal Bay 260 1.6 (1.2-2.2) 0.4 (0.3-0.5) 0 (0-0) 145 (145-145) -0.3 (-0.50.2) Black Point 1 0 (0-0) 0.6 (0.5-0.9) 0.48 (0.48-0.48) 1 (1-1) 0.2 (0.1-0.3) Seal Slide 16 0.2 (0.1-0.2) 0.6 (0.4-0.8) 0.12 (0.12-0.12) 1 (1-1) -0.3 (-0.50.1) SPage 331 5.6 (4.1-7.6) 1 (0.8-1.4) 0 (0-0) 128 (134-121) -1 (-1.30.7) NPage <	Dangerous	709	0 (0-0)	0 (0-0)	0.00 (0.00 0.00)	145 (145-145)	0.1 (0.1 0.1)
Norm fact 26 6 (6 0) 6 (0 - 0) 6 (0 - 0) 6 (0 - 0) 6 (0 - 0) 6 (0 - 0) 0 (0 - 0) <t< td=""><td>North Islet</td><td>28</td><td>0 (0-0)</td><td>0 (0-0)</td><td>0.03 (0.03-0.03)</td><td>5 (5-5)</td><td>0 1 (0 1-0 1)</td></t<>	North Islet	28	0 (0-0)	0 (0-0)	0.03 (0.03-0.03)	5 (5-5)	0 1 (0 1-0 1)
N Casuarina 3 0 (0-0) 0.1 (0.1-0.2) 0.48 (0.48-0.48) 1 (1-1) 0.4 (0.4-0.5) Cape Bouguer 3 0 (0-0) 0.1 (0.1-0.2) 0.48 (0.48-0.48) 1 (1-1) 0.4 (0.4-0.4) Cave Point 3 0 (0-0) 0.1 (0.1-0.2) 0.48 (0.48-0.48) 1 (1-1) 0.4 (0.4-0.4) Seal Bay 260 1.6 (1.2-2.2) 0.4 (0.3-0.5) 0 (0-0) 145 (145-145) -0.3 (-0.50.2) Black Point 1 0 (0-0) 0.6 (0.4-0.8) 0.12 (0.12-0.12) 1 (1-1) 0.2 (0.1-0.3) Seal Slide 16 0.2 (0.1-0.2) 0.6 (0.4-0.8) 0.12 (0.12-0.12) 1 (1-1) -0.3 (-0.50.1) SPage 331 5.6 (4.1-7.6) 1 (0.8-1.4) 0 (0-0) 128 (134-121) -1 (-1.3-0.7) NPage 258 4.2 (3.1-5.6) 1 (0.7-1.3) 0 (0-0) 145 (145-145) -0.9 (-1.2-0.7) Mean 3107 13 (9-17) 0.1 (0.1-0.2) 0.16 (0.16-0.16) 45 (45-45) 0.1 (0-0.1) % of subpops. 50 (50-50) 67 (65-65) 44 (44-44)	Peaked Rocks	20	0 (0-0)	0 (0-0)	0.05 (0.05-0.05)	2 (2-2)	0.1 (0.1 0.1)
Cape Bouguer 3 0 (0 - 0) 0.1 (0.1 - 0.2) 0.48 (0.48 - 0.48) 1 (1 - 1) 0.4 (0.4 - 0.4) Cave Point 3 0 (0 - 0) 0.1 (0.1 - 0.2) 0.48 (0.48 - 0.48) 1 (1 - 1) 0.4 (0.4 - 0.4) Seal Bay 260 1.6 (1.2 - 2.2) 0.4 (0.3 - 0.5) 0 (0 - 0) 145 (145 - 145) -0.3 (-0.5 - 0.2) Black Point 1 0 (0 - 0) 0.6 (0.5 - 0.9) 0.48 (0.48 - 0.48) 1 (1 - 1) 0.2 (0.1 - 0.2) Black Point 1 0 (0 - 0) 0.6 (0.5 - 0.9) 0.48 (0.48 - 0.48) 1 (1 - 1) 0.2 (0.1 - 0.2) Black Point 1 0 (0 - 0) 0.6 (0.4 - 0.8) 0.12 (0.12 - 0.12) 1 (1 - 1) -0.3 (-0.50.1) SPage 331 5.6 (4.1 - 7.6) 1 (0.8 - 1.4) 0 (0 - 0) 128 (134 - 121) -1 (-1.3 - 0.7) NPage 258 4.2 (3.1 - 5.6) 1 (0.7 - 1.3) 0 (0 - 0) 145 (145 - 145) -0.9 (-1.2 - 0.7) Mean 3107 13 (9 - 17) 0.1 (0.1 - 0.2) 0.16 (0.16 - 0.16) 45 (45 - 45) 0.1 (0 - 0.1) % of subpops. 50 (50 - 50) 67 (65 - 65) 44 (44 - 44)	N Casuarina	27	0 (0-0)	0 (0 0)	0.03 (0.03-0.03)	2 (2 2) 1 (1-1)	0.4(0.4-0.5)
Cave Point 3 0 (0-0) 0.1 (0.1 - 0.2) 0.48 (0.48 - 0.48) 1 (1-1) 0.4 (0.4 - 0.4) Seal Bay 260 1.6 (1.2 - 2.2) 0.4 (0.3 - 0.5) 0 (0-0) 145 (145 - 145) -0.3 (-0.5 - 0.2) Black Point 1 0 (0-0) 0.6 (0.5 - 0.9) 0.48 (0.48 - 0.48) 1 (1-1) 0.2 (0.1 - 0.2) Black Point 1 0 (0-0) 0.6 (0.5 - 0.9) 0.48 (0.48 - 0.48) 1 (1-1) 0.2 (0.1 - 0.2) Black Point 1 0 (0-0) 0.6 (0.4 - 0.8) 0.12 (0.12 - 0.12) 1 (1-1) -0.3 (-0.50.1) Seal Slide 16 0.2 (0.1 - 0.2) 0.6 (0.4 - 0.8) 0.12 (0.12 - 0.12) 1 (1-1) -0.3 (-0.50.1) SPage 331 5.6 (4.1 - 7.6) 1 (0.8 - 1.4) 0 (0-0) 128 (134 - 121) -1 (-1.3 - 0.7) NPage 258 4.2 (3.1 - 5.6) 1 (0.7 - 1.3) 0 (0-0) 145 (145 - 145) -0.9 (-1.2 - 0.7) Mean 3107 13 (9-17) 0.1 (0.1 - 0.2) 0.16 (0.16 - 0.16) 45 (45 - 45) 0.1 (0-0.1) % of subpops. 50 (50 - 50) 67 (65 - 65) 44 (44 - 44)	Cape Bouquer	3	0 (0-0)	0.1 (0.1 - 0.2) 0.1 (0.1-0.2)	0.48 (0.48-0.48)	1 (1-1)	0.4 (0.4 - 0.3)
Seal Bay 260 1.6 (1.2-2.2) 0.4 (0.3-0.5) 0 (0-0) 145 (145-145) -0.3 (-0.50.2) Black Point 1 0 (0-0) 0.6 (0.5-0.9) 0.48 (0.48-0.48) 1 (1-1) 0.2 (0.1-0.3) Seal Slide 16 0.2 (0.1-0.2) 0.6 (0.4-0.8) 0.12 (0.12-0.12) 1 (1-1) -0.3 (-0.50.1) SPage 331 5.6 (4.1-7.6) 1 (0.8-1.4) 0 (0-0) 128 (134-121) -1 (-1.3-0.7) NPage 258 4.2 (3.1-5.6) 1 (0.7-1.3) 0 (0-0) 145 (145-145) -0.9 (-1.2-0.7) Mean 3107 13 (9-17) 0.1 (0.1-0.2) 0.16 (0.16-0.16) 45 (45-45) 0.1 (0-0.1) % of subpops. 50 (50-50) 67 (65-65) 44 (44-44)	Cave Point	3	0 (0-0)	0.1 (0.1 - 0.2)	0.48 (0.48-0.48)	1 (1-1)	0.4 (0.4 - 0.4)
Black Point 1 0 (0-0) 0.6 (0.5-0.9) 0.48 (0.48-0.48) 1 (1-1) 0.2 (0.1-0.3) Seal Slide 16 0.2 (0.1-0.2) 0.6 (0.4-0.8) 0.12 (0.12-0.12) 1 (1-1) -0.3 (-0.50.1) SPage 331 5.6 (4.1-7.6) 1 (0.8-1.4) 0 (0-0) 128 (134-121) -1 (-1.30.7) NPage 258 4.2 (3.1-5.6) 1 (0.7-1.3) 0 (0-0) 145 (145-145) -0.9 (-1.20.7) Mean 3107 13 (9-17) 0.1 (0.1-0.2) 0.16 (0.16-0.16) 45 (45-45) 0.1 (0-0.1) % of subpops. 50 (50-50) 67 (65-65) 44 (44-44)	Seal Bay	260	0 (0-0) 1 6 (1 2-2 2)	0.1 (0.1-0.2)	0.40 (0.40-0.40)	145 (145-145)	-0.3 (-0.50.2)
Seal Slide 16 0.2 (0.1-0.2) 0.6 (0.4-0.8) 0.12 (0.12-0.12) 1 (1-1) -0.3 (-0.50.1) SPage 331 5.6 (4.1-7.6) 1 (0.8-1.4) 0 (0-0) 128 (134-121) -1 (-1.30.7) NPage 258 4.2 (3.1-5.6) 1 (0.1-0.2) 0.16 (0.16-0.16) 45 (45-45) -0.9 (-1.20.7) Mean 3107 13 (9-17) 0.1 (0.1-0.2) 0.16 (0.16-0.16) 45 (45-45) 0.1 (0-0.1) % of subpops. 50 (50-50) 67 (65-65) 44 (44-44)	Black Point	200	0 (0-0)	0.4 (0.5-0.3)	0 (0-0)	1 (1-1)	0.2 (0.1-0.3)
SPage 331 5.6 (4.1-7.6) 1 (0.8-1.4) 0 (0-0) 128 (134-121) -1 (-1.3-0.7) NPage 258 4.2 (3.1-5.6) 1 (0.7-1.3) 0 (0-0) 145 (145-145) -0.9 (-1.2-0.7) Mean 3107 13 (9-17) 0.1 (0.1-0.2) 0.16 (0.16-0.16) 45 (45-45) 0.1 (0-0.1) % of subpops. 50 (50-50) 67 (65-65) 44 (44-44)	Seal Slide	16	0 (0-0)	0.6 (0.3-0.9)	0.12 (0.12-0.40)	1 (1-1)	-0.3 (-0.50.1)
NPage 258 4.2 (3.1-5.6) 1 (0.7-1.3) 0 (0-0) 145 (145-145) -0.9 (-1.2-0.7) Mean 3107 13 (9-17) 0.1 (0.1-0.2) 0.16 (0.16-0.16) 45 (45-45) 0.1 (0-0.1) % of subpops. 50 (50-50) 67 (65-65) 44 (44-44)	SPane	321	5 6 (1 1-7 6)	1 (0 8-1 4)	0.12 (0.12 ⁻ 0.12) 0 (0_0)	128 (137-121)	-0.0 (-0.00.1) -1 (-1 30 7)
Mean 3107 13 (9-17) 0.1 (0.1-0.2) 0.16 (0.16-0.16) 45 (45-45) 0.1 (0-0.1) % of subpops. 50 (50-50) 67 (65-65) 44 (44-44)	NPage	258	<u> </u>	1 (0.0-1.4)	0 (0-0)	145 (145-145)	-0.9 (-1.30.7)
% of subpops. 50 (50-50) 67 (65-65) 44 (44-44)	Mean	2107	12 (0.1-0.0)	0.1.(0.1-0.2)		45 (145-145)	0.0 (-1.20.7)
	% of subpops	5107	13 (3-17)	0.1 (0.1-0.2)	50 (50-50)	67 (65-65)	44 (44-44)

Table 8.14. Subpopulation estimates of female bycatch, and percentage of females removed as bycatch mortality per breeding cycle. Terminal Extinction Risk (TER), Quasi-extinction Time (QET, and estimated growth rate over the next 20 breeding cycles (% per 17.5 months) are also given assuming an underlying stable intrinsic growth rate. \pm 95 CL are given in parentheses. The current estimated pup production per subpopulation is also shown. The table presents estimates based on the current distribution of the GHAT fishery off South Australia (100,000 km.hrs/yr), with removal of the top 90% of female core foraging areas (no displaced effort). The % of subpopulations with TERs >0.1, QETs < 3 generations (33.3 yrs) and negative growth rates are given on the last line of the table.

B9 17 0 (0-0) 0 (0-0.1) 0.1 (0.1-0.1) 2 (2-2) 0.2 (0.2) B8 38 0 (0-0) 0 (0-0.1) 0.01 (0.01-0.01) 35 (35-35) -0.2 (-0.2) B7 2 0 (0.0) 0 (0-0.1) 0.10 (0.01-0.01) 35 (35-35) -0.2 (-0.2)	2-0.2)
B8 38 0 (0-0) 0 (0-0.1) 0.01 (0.01-0.01) 35 (35-35) -0.2 (-0.2 D7 0 (0.0) 0 (0.01)<	0 0)
	0.2)
B7 3 $U(U-U)$ $U(U-U,1)$ $U(48(0.48-0.48)$ $1(1-1)$ $0.5(0.5)$	5-0.5)
B6 12 0 (0-0) 0 (0-0.1) 0.23 (0.23-0.23) 1 (1-1) 0.8 (0.4	8-0.8)
B5 43 0 (0-0) 0 (0-0) 0.01 (0.01-0.01) 92 (93-92) -0.1 (-0.1	0.1)
B4 2 0 (0-0) 0 (0-0) 0.48 (0.48-0.48) 1 (1-1) 0.5 (0.43)	5-0.5)
B3 31 0 (0-0) 0 (0-0) 0.02 (0.02-0.02) 13 (13-13) -2.9 (-2.9	2.9)
B2 5 0 (0-0) 0 (0-0) 0.37 (0.37-0.37) 1 (1-1) 0.6 (0.4	6-0.6)
B1 15 0 (0-0) 0 (0-0) 0.13 (0.13-0.13) 1 (1-1) 0.4 (0.4	I-0.4)
NR W 12 0 (0-0) 0 (0-0) 0.23 (0.23-0.23) 1 (1-1) 0.8 (0.4	8-0.8)
NR E 3 0 (0-0) 0 (0-0) 0.48 (0.48-0.48) 1 (1-1) 0.5 (0.43)	5-0.5)
Pt Fowler 1 0 (0-0) 0 (0-0) 0.48 (0.48-0.48) 1 (1-1) 0.5 (0.4	5-0.5)
Purdie 132 0 (0-0) 0 (0-0) 0 (0-0) 145 (145-145) 0	(0-0)
West 56 0 (0-0) 0 (0-0) 0.01 (0.01-0.01) 142 (142-142) -0.1 (-0.1	0.1)
Fenelon 40 0 (0-0) 0 (0-0) 0.02 (0.02-0.02) 41 (41-41) -0.1 (-0.1	0.1)
Lounds 34 0 (0-0) 0 (0-0) 0.03 (0.03-0.03) 14 (14-14) -0.1 (-0.1	0.1)
B'water 17 0 (0-0) 0 (0-0) 0.1 (0.1-0.1) 2 (2-2) 0.3 (0.1	, 3-0.3)
Gliddon 7 0 (0-0) 0 (0-0) 0.36 (0.36-0.36) 1 (1-1) 0.8 (0.4	, 3-0.8)
Blefuscu 84 0 (0-0) 0 (0-0) 0 (0-0) 141 (141-141) 0	(0-0)
Lilliput 67 0 (0-0) 0 (0-0) 0 (0-0) 141 (141-141) 0	(0-0)
Olive 206 0 (0-0) 0 (0-0) 0 (0-0) 145 (145-145) 0	(0-0)
N Baudin 98 0 (0-0) 0 (0-0) 0 (0-0) 141 (141-141) 0	(0-0)
Pt Labatt 6 0 (0-0) 0 (0-0) 0.38 (0.38-0.38) 1 (1-1) 0	(0-0)
Jones 15 0 (0-0) 0 (0-0) 0.13 (0.13-0.13) 1 (1-1) 0.4 (0.4	-0.4)
Dorothee 1 0 (0-0) 0 (0-0) 0.48 (0.48-0.48) 1 (1-1) 0.5 (0.4	5-0.5)
Pearson 35 0 (0-0) 0 (0-0) 0.02 (0.02-0.02) 18 (18-18) -0.1 (-0.1	0.1)
Ward 45 0 (0-0) 0 (0-0) 0 (0-0) 125 (126-125) -0.1 (-0.1	0.1)
Waldegrave 157 0 (0-0) 0 (0-0) 0 (0-0) 145 (145-145) -0.1 (-0.1	0.1)
Four Hummocks 12 0 (0-0) 0 (0-0) 0.23 (0.23-0.23) 1 (1-1) 0.9 (0.1)-0.9)
Rocky North 16 0 (0-0) 0 (0-0) 0.12 (0.12-0.12) 1 (1-1) 0.3 (0.1	3-0.3)
Price 25 0 (0-0) 0 (0-0) 0.04 (0.04-0.04) 3 (3-3) 0.1 (0.1	-0.1)
Liguanea 43 0.1 (0.1-0.1) 0.1 (0.1-0.2) 0.01 (0.01-0.01) 87 (89-85) -0.2 (-0.3	0.2)
Lewis 131 0 (0-0) 0 (0-0) 0 (0-0) 145 (145-145) 0	(0-0)
East Island 14 0 (0-0) 0 (0-0) 0.15 (0.15-0.15) 1 (1-1) 0.4 (0.4	(-0.4)
South Neptune 6 0 (0-0) 0 (0-0) 0.38 (0.38-0.38) 1 (1-1) 0	(0-0)
Albatross 15 $0(0-0)$ $0(0-0)$ $0.13(0.13-0.13)$ $1(1-1)$ $0.4(0.4)$	(-0.4)
English 27 $0 (0-0)$ $0 (0-0)$ $0 (0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0$	-0.1)
Dangerous 709 $0(0-0)$ $0(0-0)$ $0(0-0)$ $145(145-145)$ 0	(0-0)
North Islet 28 $0(0-0)$ $0(0-0)$ $0(0-0)$ $0.03(0.03-0.03)$ $5(5-5)$ $0.1(0.03-0.03)$	-0.1)
Peaked Rocks 24 $0 (0-0)$	(0-0)
N Casuarina 3 $0(0-0)$ $0(0-0)$ $0.48 (0.48-0.48)$ $1(1-1)$ $0.5 (0.5)$	(0 0) 5-0 5)
Cape Bouquer 3 $0(0-0)$ $0(0-0)$ $0.48(0.48-0.48)$ $1(1-1)$ $0.5(0.48)$	5-0.5)
Cave Point 3 $0(0-0)$ $0(0-0)$ $0.48(0.48-0.48)$ $1(1-1)$ $0.5(0.48)$	5-0.5)
Seal Bay 260 0.2 (0.1-0.2) 0.(0-0.1) 0.(0-0) 145 (145-145) 0.0	(0-0)
Black Point 1 0 (0-0) 0.1 (0.1-0.1) 0.48 (0.48-0.48) 1 (1-1) 0.5 (0.4	-0.5)
Seal Slide 16 0 (0-0) 0.1 (0.1-0.2) 0.12 (0.12-0.12) 1 (1-1) 0.2 (0.1-0.12)	-0.2)
SPage 331 2.4 (1.8-3.2) 0.4 (0.3-0.6) 0 (0-0) 141 (145-138) -0.4 (-0.6	0.3)
NPage 258 1.8 (1.3-2.4) 0.4 (0.3-0.6) 0 (0-0) 145 (145-145) -0.4 (-0.5	0.3)
Mean 3107 5 (3-6) 0 (0-0.1) 0.16 (0.16-0.16) 46 (46-46) 0.1 (0.16-0.16)	-0.1)
% of subpops. 50 (50-50) 67 (65-65) 40 (4	0-40)

Table 8.15. Subpopulation estimates of female bycatch, and percentage of females removed as bycatch mortality per breeding cycle. Terminal Extinction Risk (TER), Quasi-extinction Time (QET, and estimated growth rate over the next 20 breeding cycles (% per 17.5 months) are also given assuming an underlying stable intrinsic growth rate. \pm 95 CL are given in parentheses. The current estimated pup production per subpopulation is also shown. The table presents estimates based on the current distribution of the GHAT fishery off South Australia (100,000 km.hrs/yr), with removal of 100% of female core foraging areas (no displaced effort). The % of subpopulations with TERs >0.1, QETs < 3 generations (33.3 yrs) and negative growth rates are given on the last line of the table.

Subpop	Pup prod	Female bycatch	% females/sub	TER	QET	Growth rate
B9	17	0 (0-0)	0 (0-0)	0.1 (0.1-0.1)	2 (2-2)	0.3 (0.3-0.3)
B8	38	0 (0-0)	0 (0-0)	0.01 (0.01-0.01)	36 (36-36)	-0.1 (-0.10.1)
B7	3	0 (0-0)	0 (0-0)	0.48 (0.48-0.48)	1 (1-1)	0.5 (0.5-0.5)
B6	12	0 (0-0)	0 (0-0)	0.23 (0.23-0.23)	1 (1-1)	0.9 (0.9-0.9)
B5	43	0 (0-0)	0 (0-0)	0.01 (0.01-0.01)	94 (94-94)	-0.1 (-0.10.1)
B4	2	0 (0-0)	0 (0-0)	0.48 (0.48-0.48)	1 (1-1)	0.5 (0.5-0.5)
B3	31	0 (0-0)	0 (0-0)	0.02 (0.02-0.02)	13 (13-13)	-2.9 (-2.92.9)
B2	5	0 (0-0)	0 (0-0)	0.37 (0.37-0.37)	1 (1-1)	0.7 (0.7-0.7)
B1	15	0 (0-0)	0 (0-0)	0.13 (0.13-0.13)	1 (1-1)	0.4 (0.4-0.4)
NR W	12	0 (0-0)	0 (0-0)	0.23 (0.23-0.23)	1 (1-1)	0.9 (0.9-0.9)
NR E	3	0 (0-0)	0 (0-0)	0.48 (0.48-0.48)	1 (1-1)	0.5 (0.5-0.5)
Pt Fowler	1	0 (0-0)	0 (0-0)	0.48 (0.48-0.48)	1 (1-1)	0.5 (0.5-0.5)
Purdie	132	0 (0-0)	0 (0-0)	0 (0-0)	145 (145-145)	0 (0-0)
West	56	0 (0-0)	0 (0-0)	0.01 (0.01-0.01)	142 (142-142)	-0.1 (-0.10.1)
Fenelon	40	0 (0-0)	0 (0-0)	0.02 (0.02-0.02)	41 (41-41)	-0.1 (-0.10.1)
Lounds	34	0 (0-0)	0 (0-0)	0.03 (0.03-0.03)	14 (14-14)	-0.1 (-0.10.1)
B'water	17	0 (0-0)	0 (0-0)	0.1 (0.1-0.1)	2 (2-2)	0.3 (0.3-0.3)
Gliddon	7	0 (0-0)	0 (0-0)	0.36 (0.36-0.36)	1 (1-1)	0.8 (0.8-0.8)
Blefuscu	84	0 (0-0)	0 (0-0)	0 (0-0)	141 (141-141)	0 (0-0)
Lilliput	67	0 (0-0)	0 (0-0)	0 (0-0)	141 (141-141)	0 (0-0)
Olive	206	0 (0-0)	0 (0-0)	0 (0-0)	145 (145-145)	0 (0-0)
N Baudin	98	0 (0-0)	0 (0-0)	0 (0-0)	145 (145-145)	0 (0-0)
Pt Labatt	6	0 (0-0)	0 (0-0)	0.38 (0.38-0.38)	1 (1-1)	0 (0-0)
Jones	15	0 (0-0)	0 (0-0)	0.13 (0.13-0.13)	1 (1-1)	0.4 (0.4-0.4)
Dorothee	1	0 (0-0)	0 (0-0)	0.48 (0.48-0.48)	1 (1-1)	0.5 (0.5-0.5)
Pearson	35	0 (0-0)	0 (0-0)	0.02 (0.02-0.02)	18 (18-18)	-0.1 (-0.10.1)
Ward	45	0 (0-0)	0 (0-0)	0 (0-0)	128 (128-128)	-0.1 (-0.10.1)
Waldegrave	157	0 (0-0)	0 (0-0)	0 (0-0)	145 (145-145)	-0.1 (-0.10.1)
Four Hummocks	12	0 (0-0)	0 (0-0)	0 23 (0 23-0 23)	1 (1-1)	0.9 (0.9-0.9)
Rocky North	16	0 (0-0)	0 (0-0)	0.12 (0.12-0.12)	1 (1-1)	0.3 (0.3-0.3)
Price	25	0 (0-0)	0 (0-0)	0.04 (0.04 - 0.04)	3 (3-3)	0.1 (0.1-0.1)
Liquanea	43	0 (0-0)	0 (0-0)	0.01 (0.01-0.01)	94 (94-94)	-0.1 (-0.10.1)
Lewis	131	0 (0-0)	0 (0-0)	0 (0-0)	145 (145-145)	0 (0-0)
East Island	14	0 (0-0)	0 (0-0)	0.15 (0.15-0.15)	1 (1-1)	0.4(0.4-0.4)
South Neptune	6	0 (0-0)	0 (0-0)	0.38 (0.38-0.38)	1 (1-1)	0 (0-0)
Albatross	15	0 (0-0)	0 (0-0)	0 13 (0 13-0 13)	1 (1-1)	0 4 (0 4-0 4)
English	27	0 (0-0)	0 (0-0)	0.03 (0.03-0.03)	5 (5-5)	0.1 (0.1-0.1)
Dangerous	709	0 (0-0)	0 (0-0)	0 (0-0)	145 (145-145)	0 (0-0)
North Islet	28	0 (0-0)	0 (0-0)	0.03 (0.03-0.03)	5 (5-5)	0 1 (0 1-0 1)
Peaked Rocks	24	0 (0-0)	0 (0-0)	0.05 (0.05-0.05)	2 (2-2)	0 (0-0)
N Casuarina	27	0 (0-0)	0 (0-0)	0.48 (0.48-0.48)	2 (2 2) 1 (1-1)	05(05)
Cape Bouquer	3	0 (0-0)	0 (0-0)	0.48 (0.48-0.48)	1 (1-1)	0.5 (0.5 0.5)
Cave Point	3	0 (0-0)	0 (0-0)	0.48 (0.48-0.48)	1 (1-1)	0.5 (0.5-0.5)
Seal Bay	260	0 (0-0)	0 (0-0)	0.+0 (0+0) (0-0) 0+.0	145 (145-145)	0.0 (0.0-0.0) 0 (0-0)
Black Point	1	0 (0-0)	0 (0-0)	0 48 (0 48-0 48)	1 (1-1)	0.5 (0.5-0.5)
Seal Slide	16	0 (0-0)	0 (0-0)	0 12 (0 12-0 12)	1 (1-1)	0.3 (0.3-0.3)
SPage	10	0 (0-0)	0 (0-0)	0.12 (0.12 0.12)	· (· · ·)	0.0 (0.0-0.3)
or ugo	331	0 (0-0)	0 (0-0)	0 (0-0)	145 (145-145)	0 (0-0)
NPage	331 258	0 (0-0) 0 (0-0)	0 (0-0)	0 (0-0)	145 (145-145) 145 (145-145)	0 (0-0) 0 (0-0)
NPage Mean	331 258 3107	0 (0-0) 0 (0-0)	0 (0-0) 0 (0-0)	0 (0-0) 0 (0-0) 0 16 (0 16-0 16)	145 (145-145) 145 (145-145) 46 (46-46)	0 (0-0) 0 (0-0) 0.2 (0 2-0 2)

Table 8.16. Subpopulation estimates of female bycatch, and percentage of females removed as bycatch mortality per breeding cycle. Terminal Extinction Risk (TER), Quasi-extinction Time (QET, and estimated growth rate over the next 20 breeding cycles (% per 17.5 months) are also given assuming an underlying stable intrinsic growth rate. \pm 95 CL are given in parentheses. The current estimated pup production per subpopulation is also shown. The table presents estimates based on the current distribution of the GHAT fishery off South Australia (100,000 km.hrs/yr), with removal of 0-20m depth range (no displaced effort). The % of subpopulations with TERs >0.1, QETs < 3 generations (33.3 yrs) and negative growth rates are given on the last line of the table

Subpop	Pup prod	Female bycatch	% females/sub	TER	QET	Growth rate
B9	17	0.4 (0.3-0.6)	1.6 (1.2-2.1)	0.13 (0.11-0.16)	2 (2-2)	-1.3 (-1.80.9)
B8	38	1 (0.7-1.3)	1.5 (1.1-2.1)	0.06 (0.03-0.11)	22 (24-18)	-1.6 (-2.11.2)
B7	3	0.1 (0.1-0.1)	1.5 (1.1-2.1)	0.48 (0.48-0.49)	1 (1-1)	-0.2 (-0.5-0)
B6	12	0.3 (0.2-0.4)	1.5 (1.1-2.1)	0.25 (0.23-0.28)	1 (1-1)	-0.7 (-1.20.3)
B5	43	0.9 (0.6-1.2)	1.2 (0.9-1.7)	0.02 (0.02-0.04)	47 (56-37)	-1.3 (-1.71)
B4	2	0 (0-0.1)	1.2 (0.9-1.6)	0.48 (0.48-0.48)	1 (1-1)	-0.1 (-0.3-0.1)
B3	31	0.6 (0.4-0.8)	1.1 (0.8-1.5)	0.04 (0.03-0.06)	10 (11-9)	-3.3 (-3.43.2)
B2	5	0 (0-0.1)	0.5 (0.4-0.7)	0.37 (0.37-0.37)	1 (1-1)	0.2 (0-0.3)
B1	15	0.1 (0.1-0.2)	0.5 (0.3-0.6)	0.13 (0.13-0.14)	1 (1-1)	-0.1 (-0.2-0.1)
NR W	12	0.3 (0.3-0.5)	1.8 (1.3-2.4)	0.26 (0.24-0.3)	1 (1-1)	-0.9 (-1.50.5)
NR E	3	0.1 (0.1-0.1)	1.7 (1.3-2.3)	0.48 (0.48-0.5)	1 (1-1)	-0.3 (-0.60.1)
Pt Fowler	1	0 (0-0)	1.6 (1.2-2.2)	0.48 (0.48-0.49)	1 (1-1)	-0.3 (-0.50.1)
Purdie	132	4.8 (3.5-6.5)	2.2 (1.6-3)	0.03 (0.01-0.08)	90 (102-77)	-2.1 (-2.91.6)
West	56	2.3 (1.8-3.2)	2.6 (1.9-3.5)	0.09 (0.04-0.21)	31 (44-20)	-2.5 (-3.41.9)
Fenelon	40	1.9 (1.4-2.6)	2.9 (2.2-4)	0.22 (0.11-0.39)	14 (18-10)	-2.9 (-3.92.2)
Lounds	34	0.3 (0.2-0.5)	0.6 (0.4-0.8)	0.03 (0.03-0.03)	12 (12-12)	-0.7 (-0.90.5)
B'water	17	0.1 (0.1-0.1)	0.2 (0.2-0.3)	0.1 (0.1-0.1)	2 (2-2)	0 (-0.1-0.1)
Gliddon	7	0 (0-0)	0.2 (0.2-0.3)	0.36 (0.36-0.36)	1 (1-1)	0.6 (0.5-0.6)
Blefuscu	84	4.2 (3.1-5.7)	3.1 (2.3-4.2)	0.12 (0.05-0.29)	51 (66-37)	-2.9 (-42.2)
Lilliput	67	0.6 (0.4-0.8)	0.5 (0.4-0.7)	0 (0-0)	111 (118-101)	-0.5 (-0.70.4)
Olive	206	12.7 (9.8-18)	3.8 (2.9-5.3)	0.12 (0.05-0.34)	83 (96-65)	-3.6 (-52.8)
N Baudin	98	8.1 (6-10.9)	5 (3.7-6.8)	0.38 (0.18-0.63)	37 (51-25)	-4.8 (-6.53.6)
Pt Labatt	6	0.6 (0.5-0.8)	6.3 (4.7-8.5)	0.77 (0.63-0.89)	1 (1-1)	-4.6 (-6.33.4)
Jones	15	1.7 (1.3-2.3)	7 (5.2-9.4)	0.8 (0.65-0.9)	1 (1-1)	-6.5 (-8.94.7)
Dorothee	1	0.1 (0.1-0.2)	7.6 (5.6-10.3)	0.86 (0.73-0.94)	1 (1-1)	-3.1 (-4.32.1)
Pearson	35	4.5 (3.4-6.1)	7.9 (5.9-10.7)	0.82 (0.65-0.92)	5 (6-4)	-7.7 (-10.35.7)
Ward	45	6.6 (4.9-8.9)	9 (6.6-12.1)	0.85 (0.7-0.93)	7 (7-7)	-8.6 (-11.66.4)
Waldegrave	157	19.4 (14.4-26.3)	7.6 (5.6-10.2)	0.68 (0.43-0.86)	37 (52-24)	-7.1 (-9.65.3)
Four Hummocks	12	2.4 (1.8-3.3)	12.3 (9.1-16.6)	0.97 (0.92-0.99)	1 (1-1)	-11.5 (-15.88.3)
Rocky North	16	1.7 (1.3-2.3)	6.5 (4.8-8.7)	0.76 (0.59-0.88)	1 (1-1)	-5.9 (-8.14.3)
Price	25	5 (3.7-6.8)	12.3 (9.1-16.6)	0.94 (0.88-0.97)	3 (3-3)	-11.7 (-15.98.7)
Liquanea	43	4 (3-5.5)	5.7 (4.3-7.8)	0.6 (0.38-0.79)	8 (12-7)	-5.5 (-7.44.1)
Lewis	131	0.2 (0.2-0.3)	0.1 (0.1-0.1)	0 (0-0)	145 (145-142)	-0.1 (-0.20.1)
East Island	14	1.1 (0.8-1.4)	4.6 (3.4-6.3)	0.57 (0.39-0.76)	1 (1-1)	-4 (-5.62.9)
South Neptune	6	0.3 (0.2-0.4)	2.9 (2.1-3.9)	0.45 (0.41-0.54)	1 (1-1)	-2.1 (-2.81.5)
Albatross	15	0.5 (0.4-0.7)	2.2 (1.6-3)	0.23 (0.18-0.34)	1 (1-1)	-1.7 (-2.51.2)
English	27	0 (0-0)	0 (0-0)	0.03 (0.03-0.03)	5 (5-5)	0.1 (0.1-0.1)
Dangerous	709	0.1 (0.1-0.1)	0 (0-0)	0 (0-0)	145 (145-145)	0 (0-0)
North Islet	28	0.2 (0.2-0.3)	0.5 (0.3-0.6)	0.03 (0.03-0.03)	4 (5-4)	-0.4 (-0.50.3)
Peaked Rocks	24	0.3 (0.3-0.5)	0.9 (0.6-1.2)	0.06 (0.05-0.07)	2 (2-2)	-0.8 (-1.10.6)
N Casuarina	3	0.5 (0.4-0.7)	10.1 (7.5-13.6)	0.94 (0.85-0.98)	1 (1-1)	-4.2 (-5.93)
Cape Bouquer	3	0.4 (0.3-0.5)	7.6 (5.7-10.3)	0.86 (0.73-0.94)	1 (1-1)	-3 (-4.32.1)
Cave Point	3	0.4 (0.3-0.5)	7.5 (5.6-10.3)	0.86 (0.73-0.94)	1 (1-1)	-3 (-4.32.1)
Seal Bay	260	33.4 (25.1-45.8)	7.9 (5.9-10.8)	0.67 (0.36-0.89)	35 (52-23)	-7.3 (-105.5)
Black Point	1	0.1 (0.1-0.2)	8 (6-10.9)	0.88 (0.76-0.95)	1 (1-1)	-3.2 (-4.62.3)
Seal Slide	16	2.2 (1.7-3)	8.5 (6.3-11.6)	0.87 (0.75-0.94)	1 (1-1)	-7.8 (-10.85.8)
SPage	331	29.7 (22.3-40.8)	5.5 (4.1-7.5)	0.3 (0.11-0.62)	65 (79-48)	-5.1 (-73.9)
NPage	258	22.4 (16.8-30.8)	5.3 (4-7.3)	0.26 (0.09-0.59)	59 (81-39)	-4.9 (-6.83.7)
Mean	3107	177 (132-242)	4 (3-5.4)	0.41 (0.33-0.49)	22 (26-19)	-3.1 (-4.32.3)
% of subpops.		· · · · ·	· · · ·	75 (69-79)	79 (73-81)	90 (85-92)

Table 8.17. Subpopulation estimates of female bycatch, and percentage of females removed as bycatch mortality per breeding cycle. Terminal Extinction Risk (TER), Quasi-extinction Time (QET, and estimated growth rate over the next 20 breeding cycles (% per 17.5 months) are also given assuming an underlying stable intrinsic growth rate. \pm 95 CL are given in parentheses. The current estimated pup production per subpopulation is also shown. The table presents estimates based on the current distribution of the GHAT fishery off South Australia (100,000 km.hrs/yr), with removal of 0-40m depth range (no displaced effort). The % of subpopulations with TERs >0.1, QETs < 3 generations (33.3 yrs) and negative growth rates are given on the last line of the table.

$ \begin{array}{c} \text{Descript} & \text{Total Gybor interval} \\ \hline \text{Descript} & \text{Total Gybor interval} \\ \hline \text{Descript} & \text{Descript} \\ \hline \text{Descript} \\ \hline \text{Descript} & \text{Descript} \\ \hline \text{Descript} \\ \hline \text{Descript} & \text{Descript} \\ \hline \text{Descript} & \text{Descript} \\ \hline \text{Descript} & \text{Descript} \\ \hline \text{Descript} \\ \hline \text{Descript} & \text{Descript} \\ \hline \text{Descript} \\ \hline \text{Descript} \\ \hline \text{Descript} \\ $	Subpon	Pup prod	Female bycatch	% females/sub	TFR	OFT	Growth rate
B8380.9 (0.6-1.2)1.1 (1.1.2)0.05 (0.30.00)22 (25.1)1.5 (1.3-1.1)B730.1 (0.1-0.1)1.5 (1.1-2)0.48 (0.48-0.49)1 (1-1) -0.2 (0.4-0)B6120.3 (0.2-0.4)1.5 (1.1-2)0.24 (0.22-0.7)1 (1-1) -0.6 (1.2-0.3)B5430.9 (0.6-1.2)1.2 (0.9-1.7)0.02 (0.02-0.04)47 (56-37) -1.2 (1.6-0.9)B420 (0-0.1)1.2 (0.9-1.6)0.48 (0.48-0.48)1 (1-1) -0.1 (0.3.4-3.2)B250 (0-0.1)0.5 (0.4-0.7)0.37 (0.37-0.37)1 (1-1) -0.6 (1.30.3)B1150.1 (0.1-0.2)0.5 (0.3-0.6)0.13 (0.13-0.14)1 (1-1) -0.2 (0.5-0.1)NR W120.3 (0.2-0.4)1.6 (1.2-2.2)0.48 (0.48-0.49)1 (1-1) -0.3 (0.5-0.1)NR E30.1 (0.1-0.1)1.6 (1.2-2.2)0.48 (0.48-0.49)1 (1-1) -0.3 (0.5-0.1)Pi Fowler10 (0-0)1.4 (1.1.4)0.44 (0.40-0.49)1 (1-1) -0.2 (0.40)Purdie1324.1 (3-5.5)1.9 (1.4-2.6)0.04 (0.02-0.04)97 (108-84) -1.8 (2.4-1.3)West561.7 (1.3-2.3)1.9 (1.4-2.6)0.04 (0.02-0.03)13 (13-12) -0.4 (0.6-0.4)West561.7 (1.3-2.3)0.4 (0.3-0.5)0.03 (0.03-0.03)13 (13-12) -0.4 (0.6-0.4)West561.7 (1.3-2.3)0.4 (0.3-0.5)0.03 (0.03-0.03)13 (13-12) -0.4 (0.6-0.4)Uindus0.40.8 (1.6-2.3)0.0	89	17	0.4 (0.3-0.5)	1 4 (1-1 9)	0 12 (0 11-0 14)	2 (2-2)	-1 1 (-1 60 7)
$ \begin{array}{cccccccccccccccccccccccccccccccccccc$	B8	38	0.9 (0.6-1.2)	1 4 (1-1 9)	0.05 (0.03-0.09)	22 (25-19)	-1.5 (-1.91.1)
$ \begin{array}{cccccccccccccccccccccccccccccccccccc$	B7	3	0.1 (0.1-0.1)	1.5 (1.1-2)	0.48 (0.48-0.49)	1 (1-1)	-0.2 (-0.4-0)
$ \begin{array}{cccccccccccccccccccccccccccccccccccc$	B6	12	0.3 (0.2-0.4)	1.5 (1.1-2)	0.46 (0.46 0.46)	1 (1-1)	-0.6 (-1.20.3)
$ \begin{array}{cccccccccccccccccccccccccccccccccccc$	B5	43	0.9 (0.6-1.2)	1 2 (0 9-1 7)	0.24 (0.20 0.27) 0.02 (0.02-0.04)	47 (56-37)	-1 2 (-1 60 9)
$ \begin{array}{cccccccccccccccccccccccccccccccccccc$	B0	-10 2	0.0 (0.0 1.2)	1.2 (0.9-1.6)	0.02 (0.02 0.04)	1 (1-1)	-0.1 (-0.3-0.1)
$ \begin{array}{cccccccccccccccccccccccccccccccccccc$	B3	2	0 (0-0.1)	1.2 (0.9-1.0)	0.40 (0.40-0.40)	10 (11-0)	-0.1 (-0.3-0.1)
$ \begin{array}{cccccccccccccccccccccccccccccccccccc$	B3	5	0.0 (0.4-0.0)	1.1(0.0-1.3)	0.04(0.03-0.00)	1 (1 1)	-3.3 (-3.43.2)
D1 15 0.1 (0.10.2) 0.3 (0.30.3) 0.1 (0.10.1) 1 (11) 0.0 (0.20.4) NR W 12 0.3 (0.2-0.4) 1.6 (1.2-2.2) 0.25 (0.24-0.28) 1 (1-1) -0.3 (-0.5-0.1) NR E 3 0.1 (0.1-0.1) 1.6 (1.2-2.2) 0.25 (0.24-0.28) 1 (1-1) -0.3 (-0.5-0.1) Purdie 132 4.1 (3-5.5) 1.9 (1.4-2.5) 0.02 (0-0.04) 97 (108-84) -1.8 (-2.4-1.3) West 56 1.7 (1.3-2.3) 1.9 (1.4-2.6) 0.04 (0.02-0.09) 44 (59-31) -1.9 (-2.5-1.4) Fenelon 40 1.8 (1.3-2.4) 2.7 (2-3.7) 0.18 (0.09-0.34) 15 (19-11) -2.7 (-3.6-2) Lounds 34 0.2 (0.1-0.2) 0.16 (0.10-0.1) 2 (0.1 (0.1-0.2) 0.1 (0.1-0.2) 0.1 (0.1-0.2) 0.1 (0.1-0.2) 0.1 (0.1-0.2) 0.1 (0.1-0.2) 0.1 (0.1-0.2) 0.1 (0.1-0.2) 0.1 (0.1-0.2) 0.4 (0.6-0.3) 0.1 (0.1-0.2) 0.2 (0.1-0.2) 0.3 (0.30-0.0) 0.4 (0.6-0.3) 0.1 (0.1-0.2) 0.2 (0.1-0.2) 0.3 (0.30-0.0) 1.0 (1-0.2) 0.4 (0.6-0.3) 0.1 (0.1-0.2) 0.2 (0.1	DZ B1	15	0(0-0.1)	0.5(0.4-0.7)	0.37 (0.37 - 0.37) 0.12 (0.12 0.14)	1 (1-1)	0.2(0-0.3)
$ \begin{array}{c c c c c c c c c c c c c c c c c c c $		10	0.1(0.1-0.2)	0.5(0.3-0.0)	0.13(0.13 - 0.14)	1 (1-1)	-0.1(-0.2-0.1)
$\begin{array}{c c c c c c c c c c c c c c c c c c c $		12	0.3 (0.2-0.4)	1.0 (1.2-2.2)	0.25 (0.24-0.26)	1 (1-1)	-0.8 (-1.30.3)
Purdie 1 0 (0-0) 1.4 (1.1-1.9) 0.48 (0.48-0.49) 1 (1-1) -0.2 (0.4-0.4) Purdie 132 4.1 (3-5.5) 1.9 (1.4-2.5) 0.02 (0-0.04) 97 (108-84) -1.8 (-2.4-1.3) West 56 1.7 (1.3-2.3) 1.9 (1.4-2.5) 0.02 (0.0-0.04) 97 (108-84) -1.8 (-2.4-1.3) Lounds 34 0.2 (0.1-0.3) 0.4 (0.3-0.5) 0.03 (0.03-0.03) 13 (13-12) -0.4 (-0.6-0.4) B'water 17 0 (0-0.1) 0.2 (0.1-0.2) 0.36 (0.36-0.36) 1 (1-1) 0.7 (0.6-0.7) Blefuscu 84 3.8 (2.8-5.1) 2.8 (2-3.7) 0.09 (0.03-0.22) 56 (71-42) -2.6 (-3.5-1.9) Lilliput 67 0.4 (0.3-0.6) 0.44 (0.3-0.6) 0.04 (0.01-0.1) 99 (12-85) -2.6 (-3.5-1.9) Lilliput 67 0.4 (0.3-0.6) 0.44 (0.3-0.6) 0.35 (0.16-0.6) 39 (53-26) -4.6 (-6.3-3.4) Pt Labatt 6 0.6 (0.4-0.8) 6.1 (4.5-8.2) 0.75 (0.61-0.87) 1 (1-1) -4.5 (-6.13.3) Jones 15 1.7 (1.2-2.3)		3	0.1 (0.1-0.1)	1.0 (1.2-2.2)	0.48 (0.48-0.49)	1 (1-1)	-0.3 (-0.50.1)
$ \begin{array}{c c c c c c c c c c c c c c c c c c c $	Pt Fowler Duradia	1	0 (0-0)	1.4 (1.1-1.9)	0.48 (0.48-0.49)	1 (1-1)	-0.2 (-0.4-0)
West561.7 (1.3-2.3)1.9 (1.4-2.6)0.04 (0.02-0.09)44 (59-31)1-1.9 (2.5-1.4)Fenelon401.8 (1.3-2.4)2.7 (2-3.7)0.18 (0.09-0.34)15 (19-11)-2.7 (-3.6-2)Lounds340.2 (0.1-0.3)0.4 (0.3-0.5)0.03 (0.03-0.03)13 (13-12)-0.4 (-0.6-0.4)B'water170 (0-0.1)0.2 (0.1-0.2)0.1 (0.1-0.1)2 (2-2)0.1 (0.1-0.2)Gliddon70 (0-0)0.2 (0.1-0.2)0.36 (0.36-0.36)1 (1-1)0.7 (0.6-0.7)Blefuscu843.8 (2.8-5.1)2.8 (2-3.7)0.09 (0.03-0.22)56 (71-42)-2.6 (-3.5-1.9)N Baudin987.8 (5.7-10.5)4.8 (3.6-6.6)0.35 (0.10-0.1)99 (12-85)-2.6 (-3.5-1.9)N Baudin987.8 (5.7-10.5)4.8 (3.6-6.6)0.35 (0.16-0.6)39 (53-26)-4.6 (-6.3-3.4)Pt Labatt60.6 (0.4-0.8)6.1 (4.5-8.2)0.75 (0.61-0.87)1 (1-1)-4.5 (-6.1-3.3)Jones151.7 (1.2-2.3)6.8 (5-9.2)0.79 (0.63-0.9)1 (1-1)-2.9 (-4.1-2)Pearson354.3 (3.2-5.8)7.5 (5.6-10.2)0.8 (0.61-0.91)5 (6-4)-7.3 (-9.8-5.4)Ward455.9 (4.4-8)8 (5.9-10.8)0.81 (0.63-0.91)7 (8-7)-7.6 (-10.3-5.7)Waldegrave15717.9 (13.3-24.3)7 (5.2-9.4)0.62 (0.36-0.82)41 (56-27)6.6 (8.9-4.9)Four Hummocks122.3 (1.7-3.1)11.6 (8.6-15.7)0.96 (0.91-0.99)1 (1-1)-10.8 (-5.7-8)Four	Purale	132	4.1 (3-5.5)	1.9 (1.4-2.5)	0.02 (0-0.04)	97 (108-84)	-1.8 (-2.41.3)
Fenelon401.8 (1.3-2.4)2.7 (2-3.7)0.18 (0.09-0.34)15 (19-11)-2.7 (-3.6-2)Lounds340.2 (0.1-0.3)0.4 (0.3-0.5)0.03 (0.03-0.03)13 (13-12)-0.4 (-0.6-0.4)Bivater170 (0-01)0.2 (0.1-0.2)0.1 (0.1-0.1)2 (2-2)0.1 (0.1-0.7)Blefuscu843.8 (2.8-5.1)2.8 (2-3.7)0.09 (0.03-0.22)56 (71-42)-2.6 (-3.5-1.9)Lilliput670.4 (0.3-0.6)0.4 (0.3-0.5)0 (0-0)116 (122-108)-0.4 (-0.6-0.3)Olive2069.1 (6.7-12.3)2.7 (2-3.6)0.04 (0.01-0.11)99 (112-85)-2.6 (-3.51.9)N Baudin987.8 (5.7-10.5)4.8 (3.6-6.6)0.35 (0.16-0.6)39 (53-26)-4.6 (-6.33.4)Pt Labatt60.6 (0.4-0.8)6.1 (4.5-8.2)0.75 (0.61-0.87)1 (1-1)-4.5 (-6.13.3)Jones151.7 (1.2-2.3)6.8 (5-9.2)0.79 (0.63-0.9)1 (1-1)-6.3 (-8.6-4.6)Dorothee10.1 (0.1-0.2)7.3 (5.4-9.9)0.85 (0.71-0.93)1 (1-1)-2.9 (-4.1-2)Pearson354.3 (3.2-5.8)7.5 (5.6-10.2)0.8 (0.61-0.91)5 (6.4)-7.3 (-9.8-5.4)Ward455.9 (4.4-8)8 (5.9-10.8)0.81 (0.63-0.91)7 (8-7)-7.6 (-10.3-5.7)Valdegrave15717.9 (13.3-24.3)7 (5.2-9)0.62 (0.36-0.82)41 (56-27)-6.6 (-8.9-4.9)Four Hummocks122.3 (1.7-3.1)11.6 (8.6-15.7)0.96 (0.91-0.99)1 (1-1)-10.8 (-15-7.8)R	West	56	1.7 (1.3-2.3)	1.9 (1.4-2.6)	0.04 (0.02-0.09)	44 (59-31)	-1.9 (-2.51.4)
$ \begin{array}{c c c c c c c c c c c c c c c c c c c $	Fenelon	40	1.8 (1.3-2.4)	2.7 (2-3.7)	0.18 (0.09-0.34)	15 (19-11)	-2.7 (-3.62)
B'water 17 0 (0-0.1) 0.2 (0.1-0.2) 0.1 (0.1-0.1) 2 (2-2) 0.1 (0.1-0.2) Gilddon 7 0 (0-0) 0.2 (0.1-0.2) 0.36 (0.36-0.36) 1 (1-1) 0.7 (0.6-0.7) Blefuscu 84 3.8 (2.8-5.1) 2.8 (2-3.7) 0.09 (0.03-0.22) 56 (71-42) -2.6 (-3.51.9) Lilliput 67 0.4 (0.3-0.6) 0.4 (0.3-0.5) 0 (0-0) 116 (122-108) -0.4 (-0.6-0.3) Olive 206 9.1 (6.7-12.3) 2.7 (2-3.6) 0.04 (0.01-0.11) 99 (112-85) -2.6 (-3.51.9) N Baudin 98 7.8 (5.7-10.5) 4.8 (3.6-6.6) 0.35 (0.16-0.6) 39 (53-26) -4.6 (-6.33.4) Pt Labatt 6 0.6 (0.4-0.8) 6.1 (4.5-8.2) 0.75 (0.61-0.87) 1 (1-1) -4.5 (-6.13.3) Jones 15 1.7 (1.2-2.3) 6.8 (5-9.2) 0.79 (0.63-0.9) 1 (1-1) -6.3 (-8.6-4.6) Dorothee 1 0.1 (0.1-0.2) 7.3 (5.4-9.9) 0.85 (0.71-0.93) 1 (1-1) -7.6 (-10.3-5.7) Ward 45 5.9 (4.4-8) 8	Lounds	34	0.2 (0.1-0.3)	0.4 (0.3-0.5)	0.03 (0.03-0.03)	13 (13-12)	-0.4 (-0.60.4)
Gliddon 7 0 (0-0) 0.2 (0.1-0.2) 0.36 (0.36-0.36) 1 (1-1) 0.7 (0.6-0.7) Blefuscu 84 3.8 (2.8-5.1) 2.8 (2-3.7) 0.09 (0.03-0.22) 56 (71-42) -2.6 (-3.51.9) Lilliput 67 0.4 (0.3-0.6) 0.4 (0.3-0.5) 0 (0-0) 116 (122-108) -0.4 (-0.6-0.3) Olive 206 9.1 (6.7-12.3) 2.7 (2-3.6) 0.04 (0.01-0.11) 99 (112-85) -2.6 (-3.51.9) N Baudin 98 7.8 (5.7-10.5) 4.8 (3.6-6.6) 0.35 (0.16-0.6) 39 (53-26) -4.6 (-6.33.4) Pt Labatt 6 0.6 (0.4-0.8) 6.1 (4.5-8.2) 0.75 (0.61-0.87) 1 (1-1) -4.5 (-6.13.3) Jones 15 1.7 (1.2-2.3) 6.8 (5-9.2) 0.85 (0.71-0.93) 1 (1-1) -2.9 (-4.12) Pearson 35 4.3 (3.2-5.8) 7.5 (5.6-10.2) 0.8 (0.61-0.91) 5 (6-4) -7.3 (-9.8-5.4) Ward 45 5.9 (4.4-8) 8 (5.9-10.8) 0.81 (0.63-0.91) 7 (8-7) -7.6 (-10.3-5.7) Waldegrave 157 17.9 (13.3-24.3) <td>B'water</td> <td>17</td> <td>0 (0-0.1)</td> <td>0.2 (0.1-0.2)</td> <td>0.1 (0.1-0.1)</td> <td>2 (2-2)</td> <td>0.1 (0.1-0.2)</td>	B'water	17	0 (0-0.1)	0.2 (0.1-0.2)	0.1 (0.1-0.1)	2 (2-2)	0.1 (0.1-0.2)
Blefuscu 84 3.8 (2.8-5.1) 2.8 (2-3.7) 0.09 (0.03-0.22) 56 (71-42) -2.6 (-3.5-1.9) Lilliput 67 0.4 (0.3-0.6) 0.4 (0.3-0.5) 0 (0-0) 116 (122-108) -0.4 (-0.60.3) Olive 206 9.1 (6.7-12.3) 2.7 (2-3.6) 0.04 (0.01-0.11) 99 (112-85) -2.6 (-3.51.9) N Baudin 98 7.8 (5.7-10.5) 4.8 (3.6-6.6) 0.35 (0.16-0.6) 39 (53-26) -4.6 (-6.3-3.4) Pt Labatt 6 0.6 (0.4-0.8) 6.1 (4.5-8.2) 0.75 (0.61-0.87) 1 (1-1) -2.9 (-4.1-2) Pearson 35 4.3 (3.2-5.8) 7.5 (5.6-10.2) 0.8 (0.61-0.91) 5 (6-4) -7.3 (-9.8-5.4) Ward 45 5.9 (4.4-8) 8 (5.9-10.8) 0.81 (0.63-0.91) 7 (8-7) -6 (-10.3-5.7) Waldegrave 157 17.9 (13.3-24.3) 7 (5.2-9.4) 0.62 (0.36-0.82) 41 (56-27) -6.6 (-8.9-4.9) Four Hummocks 12 2.3 (1.7-3.1) 11.6 (8.6-15.7) 0.96 (0.91-0.99) 1 (1-1) -5.5 (-7.5-4) Price 25 4.6	Gliddon	7	0 (0-0)	0.2 (0.1-0.2)	0.36 (0.36-0.36)	1 (1-1)	0.7 (0.6-0.7)
	Blefuscu	84	3.8 (2.8-5.1)	2.8 (2-3.7)	0.09 (0.03-0.22)	56 (71-42)	-2.6 (-3.51.9)
$ \begin{array}{c c c c c c c c c c c c c c c c c c c $	Lilliput	67	0.4 (0.3-0.6)	0.4 (0.3-0.5)	0 (0-0)	116 (122-108)	-0.4 (-0.60.3)
N Baudin 98 7.8 (5.7-10.5) 4.8 (3.6-6.6) 0.35 (0.16-0.6) 39 (53-26) -4.6 (-6.33.4) Pt Labatt 6 0.6 (0.4-0.8) 6.1 (4.5-8.2) 0.75 (0.61-0.87) 1 (1-1) -4.5 (-6.13.3) Jones 15 1.7 (1.2-2.3) 6.8 (5-9.2) 0.79 (0.63-0.9) 1 (1-1) -6.3 (-8.64.6) Dorothee 1 0.1 (0.1-0.2) 7.3 (5.4-9.9) 0.85 (0.71-0.93) 1 (1-1) -2.9 (-4.12) Pearson 35 4.3 (3.2-5.8) 7.5 (5.6-10.2) 0.8 (0.61-0.91) 5 (6-4) -7.3 (-9.85.4) Ward 45 5.9 (4.4-8) 8 (5.9-10.8) 0.81 (0.63-0.91) 7 (8-7) -7.6 (-10.35.7) Waldegrave 157 17.9 (13.3-24.3) 7 (5.2-9.4) 0.62 (0.36-0.82) 41 (56-27) -6.6 (-8.94.9) Four Hummocks 12 2.3 (1.7.3.1) 11.6 (8.6-15.7) 0.96 (0.91-0.99) 1 (1-1) -5.5 (-7.54) Price 25 4.6 (3.4-6.3) 11.3 (8.4-15.3) 0.93 (0.85-0.97) 3 (3-3) -10.8 (-14.6-8) Liguanea 43	Olive	206	9.1 (6.7-12.3)	2.7 (2-3.6)	0.04 (0.01-0.11)	99 (112-85)	-2.6 (-3.51.9)
Pt Labatt60.6 (0.4-0.8)6.1 (4.5-8.2)0.75 (0.61-0.87)1 (1-1)-4.5 (-6.13.3)Jones151.7 (1.2-2.3)6.8 (5-9.2)0.79 (0.63-0.9)1 (1-1)-6.3 (-8.64.6)Dorothee10.1 (0.1-0.2)7.3 (5.4-9.9)0.85 (0.71-0.93)1 (1-1)-2.9 (-4.12)Pearson354.3 (3.2-5.8)7.5 (5.6-10.2)0.8 (0.61-0.91)5 (6-4)-7.3 (-9.85.4)Ward455.9 (4.4-8)8 (5.9-10.8)0.81 (0.63-0.91)7 (8-7)-7.6 (-10.35.7)Waldegrave15717.9 (13.3-24.3)7 (5.2-9.4)0.62 (0.36-0.82)41 (56-27)-6.6 (-8.9-4.9)Four Hurmocks122.3 (1.7-3.1)11.6 (8.6-15.7)0.96 (0.91-0.99)1 (1-1)-10.8 (-15-7.8)Rocky North161.6 (1.2-2.1)6 (4.5-8.2)0.72 (0.54-0.85)1 (1-1)-5.5 (-7.5-4)Price254.6 (3.4-6.3)11.3 (8.4-15.3)0.93 (0.85-0.97)3 (3-3)-10.8 (-14.6-8)Liguanea433.7 (2.8-5)5.3 (3.9-7.2)0.54 (0.32-0.75)9 (13-7)-5.1 (-6.83.8)Lewis1310.1 (0-0.1)0 (0-0)0 (0-0)145 (145-145)-0.1 (-0.1-0.1)East Island141 (0.8-1.4)4.6 (3.4-6.2)0.57 (0.38-0.76)1 (1-1)-4 (-5.5-2.8)Albatross150.5 (0.4-0.7)2.1 (1.5-2.8)0.22 (0.17-0.31)1 (1-1)-1.6 (-2.31.1)English270 (0-0)0 (0-0)0 (0-0)0 (0-0)0 (0-0)North Islet28	N Baudin	98	7.8 (5.7-10.5)	4.8 (3.6-6.6)	0.35 (0.16-0.6)	39 (53-26)	-4.6 (-6.33.4)
Jones151.7 (1.2-2.3)6.8 (5-9.2)0.79 (0.63-0.9)1 (1-1)-6.3 (-8.64.6)Dorothee10.1 (0.1-0.2)7.3 (5.4-9.9)0.85 (0.71-0.93)1 (1-1)-2.9 (-4.12)Pearson354.3 (3.2-5.8)7.5 (5.6-10.2)0.8 (0.61-0.91)5 (6-4)-7.3 (-9.85.4)Ward455.9 (4.4-8)8 (5.9-10.8)0.81 (0.63-0.91)7 (8-7)-7.6 (-10.35.7)Waldegrave15717.9 (13.3-24.3)7 (5.2-9.4)0.62 (0.36-0.82)41 (56-27)-6.6 (-8.94.9)Four Hummocks122.3 (1.7-3.1)11.6 (8.6-15.7)0.96 (0.91-0.99)1 (1-1)-10.8 (-157.8)Rocky North161.6 (1.2-2.1)6 (4.5-8.2)0.72 (0.54-0.85)1 (1-1)-5.5 (-7.54)Price254.6 (3.4-6.3)11.3 (8.4-15.3)0.93 (0.85-0.97)3 (3-3)-10.8 (-14.68)Liguanea433.7 (2.8-5)5.3 (3.9-7.2)0.54 (0.32-0.75)9 (13-7)-5.1 (-6.83.8)Lewis1310.1 (0-0.1)0 (0-0)0 (0-0)145 (145-145)-0.1 (-0.1-0.1)East Island141 (0.8-1.4)4.6 (3.4-6.2)0.57 (0.38-0.76)1 (1-1)-2 (-2.81.5)Albatross150.5 (0.4-0.7)2.1 (1.5-2.8)0.22 (0.17-0.31)1 (1-1)-1.6 (-2.31.1)English270 (0-0)0 (0-0)0.03 (0.03-0.03)5 (5-5)0.1 (0.1-0.1)Dangerous7090 (0-0.1)0 (0-0)0 (0-0)145 (145-145)0 (0-0)North Islet28	Pt Labatt	6	0.6 (0.4-0.8)	6.1 (4.5-8.2)	0.75 (0.61-0.87)	1 (1-1)	-4.5 (-6.13.3)
Dorothee10.1 (0.1-0.2)7.3 (5.4-9.9)0.85 (0.71-0.93)1 (1-1)-2.9 (-4.12)Pearson354.3 (3.2-5.8)7.5 (5.6-10.2)0.8 (0.61-0.91)5 (6-4)-7.3 (-9.85.4)Ward455.9 (4.4-8)8 (5.9-10.8)0.81 (0.63-0.91)7 (8-7)-7.6 (-10.35.7)Waldegrave15717.9 (13.3-24.3)7 (5.2-9.4)0.62 (0.36-0.82)41 (56-27)-6.6 (-8.94.9)Four Hummocks122.3 (1.7-3.1)11.6 (8.6-15.7)0.96 (0.91-0.99)1 (1-1)-10.8 (-157.8)Rocky North161.6 (1.2-2.1)6 (4.5-8.2)0.72 (0.54-0.85)1 (1-1)-5.5 (-7.54)Price254.6 (3.4-6.3)11.3 (8.4-15.3)0.93 (0.85-0.97)3 (3-3)-10.8 (-14.68)Liguanea433.7 (2.8-5)5.3 (3.9-7.2)0.54 (0.32-0.75)9 (13-7)-5.1 (-6.83.8)Lewis1310.1 (0-0.1)0 (0-0)0 (0-0)145 (145-145)-0.1 (-0.10.1)East Island141 (0.8-1.4)4.6 (3.4-6.2)0.57 (0.38-0.76)1 (1-1)-2 (-2.81.5)Albatross150.5 (0.4-0.7)2.1 (1.5-2.8)0.22 (0.17-0.31)1 (1-1)-1.6 (-2.31.1)English270 (0-0)0 (0-0)0 (0-0)145 (145-145)0 (0-0)North Islet280.1 (0.1-0.1)0.2 (0.2-0.3)0.03 (0.03-0.03)5 (5-5)-0.2 (-0.20.1)Peaked Rocks240.1 (0.1-0.2)0.4 (0.3-0.5)0.05 (0.05-0.05)2 (2-2)-0.3 (-0.40.2) </td <td>Jones</td> <td>15</td> <td>1.7 (1.2-2.3)</td> <td>6.8 (5-9.2)</td> <td>0.79 (0.63-0.9)</td> <td>1 (1-1)</td> <td>-6.3 (-8.64.6)</td>	Jones	15	1.7 (1.2-2.3)	6.8 (5-9.2)	0.79 (0.63-0.9)	1 (1-1)	-6.3 (-8.64.6)
Pearson354.3 (3.2-5.8)7.5 (5.6-10.2)0.8 (0.61-0.91)5 (6-4)-7.3 (-9.8-5.4)Ward455.9 (4.4-8)8 (5.9-10.8)0.81 (0.63-0.91)7 (8-7)-7.6 (-10.3-5.7)Waldegrave15717.9 (13.3-24.3)7 (5.2-9.4)0.62 (0.36-0.82)41 (56-27)-6.6 (-8.94.9)Four Hummocks122.3 (1.7-3.1)11.6 (8.6-15.7)0.96 (0.91-0.99)1 (1-1)-10.8 (-157.8)Rocky North161.6 (1.2-2.1)6 (4.5-8.2)0.72 (0.54-0.85)1 (1-1)-5.5 (-7.54)Price254.6 (3.4-6.3)11.3 (8.4-15.3)0.93 (0.85-0.97)3 (3-3)-10.8 (-14.68)Liguanea433.7 (2.8-5)5.3 (3.9-7.2)0.54 (0.32-0.75)9 (13-7)-5.1 (-6.83.8)Lewis1310.1 (0-0.1)0 (0-0)0 (0-0)145 (145-145)-0.1 (-0.10.1)East Island141 (0.8-1.4)4.6 (3.4-6.2)0.57 (0.38-0.76)1 (1-1)-2 (-2.81.5)Albatross150.5 (0.4-0.7)2.1 (1.5-2.8)0.22 (0.17-0.31)1 (1-1)-2 (-2.81.5)Albatross150.5 (0.4-0.7)2.1 (1.5-2.8)0.22 (0.17-0.31)1 (1-1)-1.6 (-2.31.1)Dangerous7090 (0-0.1)0 (0-0)0 (0-0)145 (145-145)0 (0-0)North Islet280.1 (0.1-0.1)0.2 (0.2-0.3)0.03 (0.03-0.03)5 (5-5)-0.2 (-0.2-0.1)Peaked Rocks240.1 (0.1-0.2)0.4 (0.3-0.5)0.05 (0.05-0.05)2 (2-2)-0.3 (-0.40.2) <td>Dorothee</td> <td>1</td> <td>0.1 (0.1-0.2)</td> <td>7.3 (5.4-9.9)</td> <td>0.85 (0.71-0.93)</td> <td>1 (1-1)</td> <td>-2.9 (-4.12)</td>	Dorothee	1	0.1 (0.1-0.2)	7.3 (5.4-9.9)	0.85 (0.71-0.93)	1 (1-1)	-2.9 (-4.12)
Ward455.9 (4.4-8)8 (5.9-10.8)0.81 (0.63-0.91)7 (8-7)-7.6 (-10.3-5.7)Waldegrave15717.9 (13.3-24.3)7 (5.2-9.4)0.62 (0.36-0.82)41 (56-27)-6.6 (-8.94.9)Four Hummocks122.3 (1.7-3.1)11.6 (8.6-15.7)0.96 (0.91-0.99)1 (1-1)-10.8 (-157.8)Rocky North161.6 (1.2-2.1)6 (4.5-8.2)0.72 (0.54-0.85)1 (1-1)-5.5 (-7.54)Price254.6 (3.4-6.3)11.3 (8.4-15.3)0.93 (0.85-0.97)3 (3-3)-10.8 (-14.6-8)Liguanea433.7 (2.8-5)5.3 (3.9-7.2)0.54 (0.32-0.75)9 (13-7)-5.1 (-6.83.8)Lewis1310.1 (0-0.1)0 (0-0)0 (0-0)145 (145-145)-0.1 (-0.10.1)East Island141 (0.8-1.4)4.6 (3.4-6.2)0.57 (0.38-0.76)1 (1-1)-2 (-2.81.5)Albatross150.5 (0.4-0.7)2.1 (1.5-2.8)0.22 (0.17-0.31)1 (1-1)-2 (-2.81.5)Albatross150.5 (0.4-0.7)2.1 (1.5-2.8)0.22 (0.17-0.31)1 (1-1)-1.6 (-2.31.1)Dangerous7090 (0-0.1)0 (0-0)0 (0-0)145 (145-145)0 (0-0)North Islet280.1 (0.1-0.1)0.2 (0.2-0.3)0.03 (0.03-0.03)5 (5-5)-0.2 (-0.2-0.1)Peaked Rocks240.1 (0.1-0.2)0.4 (0.3-0.5)0.05 (0.05-0.05)2 (2-2)-0.3 (-0.4-0.2)	Pearson	35	4.3 (3.2-5.8)	7.5 (5.6-10.2)	0.8 (0.61-0.91)	5 (6-4)	-7.3 (-9.85.4)
Waldegrave15717.9 (13.3-24.3)7 (5.2-9.4)0.62 (0.36-0.82)41 (56-27)-6.6 (-8.94.9)Four Hummocks122.3 (1.7-3.1)11.6 (8.6-15.7)0.96 (0.91-0.99)1 (1-1)-10.8 (-15-7.8)Rocky North161.6 (1.2-2.1)6 (4.5-8.2)0.72 (0.54-0.85)1 (1-1)-5.5 (-7.54)Price254.6 (3.4-6.3)11.3 (8.4-15.3)0.93 (0.85-0.97)3 (3-3)-10.8 (-14.68)Liguanea433.7 (2.8-5)5.3 (3.9-7.2)0.54 (0.32-0.75)9 (13-7)-5.1 (-6.83.8)Lewis1310.1 (0-0.1)0 (0-0)0 (0-0)145 (145-145)-0.1 (-0.10.1)East Island141 (0.8-1.4)4.6 (3.4-6.2)0.57 (0.38-0.76)1 (1-1)-4 (-5.52.8)South Neptune60.3 (0.2-0.4)2.8 (2.1-3.8)0.45 (0.41-0.54)1 (1-1)-2 (-2.81.5)Albatross150.5 (0.4-0.7)2.1 (1.5-2.8)0.22 (0.17-0.31)1 (1-1)-1.6 (-2.31.1)English270 (0-0)0 (0-0)0 (0-0)145 (145-145)0 (0-0)North Islet280.1 (0.1-0.1)0.2 (0.2-0.3)0.03 (0.03-0.03)5 (5-5)-0.2 (-0.20.1)Peaked Rocks240.1 (0.1-0.2)0.4 (0.3-0.5)0.05 (0.05-0.05)2 (2-2)-0.3 (-0.40.2)	Ward	45	5.9 (4.4-8)	8 (5.9-10.8)	0.81 (0.63-0.91)	7 (8-7)	-7.6 (-10.35.7)
Four Hummocks122.3 (1.7-3.1)11.6 (8.6-15.7)0.96 (0.91-0.99)1 (1-1)-10.8 (-15-7.8)Rocky North161.6 (1.2-2.1)6 (4.5-8.2)0.72 (0.54-0.85)1 (1-1)-5.5 (-7.54)Price254.6 (3.4-6.3)11.3 (8.4-15.3)0.93 (0.85-0.97)3 (3-3)-10.8 (-14.68)Liguanea433.7 (2.8-5)5.3 (3.9-7.2)0.54 (0.32-0.75)9 (13.7)-5.1 (-6.83.8)Lewis1310.1 (0-0.1)0 (0-0)0 (0-0)145 (145-145)-0.1 (-0.10.1)East Island141 (0.8-1.4)4.6 (3.4-6.2)0.57 (0.38-0.76)1 (1-1)-4 (-5.52.8)South Neptune60.3 (0.2-0.4)2.8 (2.1-3.8)0.45 (0.41-0.54)1 (1-1)-2 (-2.81.5)Albatross150.5 (0.4-0.7)2.1 (1.5-2.8)0.22 (0.17-0.31)1 (1-1)-1.6 (-2.31.1)English270 (0-0)0 (0-0)0 (0-0)145 (145-145)0 (0-0)North Islet280.1 (0.1-0.1)0.2 (0.2-0.3)0.03 (0.03-0.03)5 (5-5)-0.2 (-0.2-0.1)Peaked Rocks240.1 (0.1-0.2)0.4 (0.3-0.5)0.05 (0.05-0.05)2 (2-2)-0.3 (-0.40.2)	Waldegrave	157	17.9 (13.3-24.3)	7 (5.2-9.4)	0.62 (0.36-0.82)	41 (56-27)	-6.6 (-8.94.9)
Rocky North161.6 (1.2-2.1)6 (4.5-8.2)0.72 (0.54-0.85)1 (1-1)-5.5 (-7.5-4)Price254.6 (3.4-6.3)11.3 (8.4-15.3)0.93 (0.85-0.97)3 (3-3)-10.8 (-14.68)Liguanea433.7 (2.8-5)5.3 (3.9-7.2)0.54 (0.32-0.75)9 (13-7)-5.1 (-6.83.8)Lewis1310.1 (0-0.1)0 (0-0)0 (0-0)145 (145-145)-0.1 (-0.10.1)East Island141 (0.8-1.4)4.6 (3.4-6.2)0.57 (0.38-0.76)1 (1-1)-4 (-5.52.8)South Neptune60.3 (0.2-0.4)2.8 (2.1-3.8)0.45 (0.41-0.54)1 (1-1)-2 (-2.81.5)Albatross150.5 (0.4-0.7)2.1 (1.5-2.8)0.22 (0.17-0.31)1 (1-1)-1.6 (-2.31.1)English270 (0-0)0 (0-0)0 (0-0)145 (145-145)0 (0-0)North Islet280.1 (0.1-0.1)0.2 (0.2-0.3)0.03 (0.03-0.03)5 (5-5)-0.2 (-0.20.1)Peaked Rocks240.1 (0.1-0.2)0.4 (0.3-0.5)0.05 (0.05-0.05)2 (2-2)-0.3 (-0.40.2)	Four Hummocks	12	2.3 (1.7-3.1)	11.6 (8.6-15.7)	0.96 (0.91-0.99)	1 (1-1)	-10.8 (-157.8)
Price254.6 (3.4-6.3)11.3 (8.4-15.3)0.93 (0.85-0.97)3 (3-3)-10.8 (-14.68)Liguanea433.7 (2.8-5)5.3 (3.9-7.2)0.54 (0.32-0.75)9 (13-7)-5.1 (-6.83.8)Lewis1310.1 (0-0.1)0 (0-0)0 (0-0)145 (145-145)-0.1 (-0.10.1)East Island141 (0.8-1.4)4.6 (3.4-6.2)0.57 (0.38-0.76)1 (1-1)-4 (-5.52.8)South Neptune60.3 (0.2-0.4)2.8 (2.1-3.8)0.45 (0.41-0.54)1 (1-1)-2 (-2.81.5)Albatross150.5 (0.4-0.7)2.1 (1.5-2.8)0.22 (0.17-0.31)1 (1-1)-1.6 (-2.31.1)English270 (0-0)0 (0-0)0.03 (0.03-0.03)5 (5-5)0.1 (0.1-0.1)Dangerous7090 (0-0.1)0 (0-0)0.03 (0.03-0.03)5 (5-5)-0.2 (-0.20.1)North Islet280.1 (0.1-0.1)0.2 (0.2-0.3)0.03 (0.03-0.03)5 (5-5)-0.2 (-0.20.1)Peaked Rocks240.1 (0.1-0.2)0.4 (0.3-0.5)0.05 (0.05-0.05)2 (2-2)-0.3 (-0.40.2)	Rocky North	16	1.6 (1.2-2.1)	6 (4.5-8.2)	0.72 (0.54-0.85)	1 (1-1)	-5.5 (-7.54)
Liguanea433.7 (2.8-5)5.3 (3.9-7.2)0.54 (0.32-0.75)9 (13-7)-5.1 (-6.83.8)Lewis1310.1 (0-0.1)0 (0-0)0 (0-0)145 (145-145)-0.1 (-0.10.1)East Island141 (0.8-1.4)4.6 (3.4-6.2)0.57 (0.38-0.76)1 (1-1)-4 (-5.52.8)South Neptune60.3 (0.2-0.4)2.8 (2.1-3.8)0.45 (0.41-0.54)1 (1-1)-2 (-2.81.5)Albatross150.5 (0.4-0.7)2.1 (1.5-2.8)0.22 (0.17-0.31)1 (1-1)-1.6 (-2.31.1)English270 (0-0)0 (0-0)0.03 (0.03-0.03)5 (5-5)0.1 (0.1-0.1)Dangerous7090 (0-0.1)0.2 (0.2-0.3)0.03 (0.03-0.03)5 (5-5)-0.2 (-0.2-0.1)North Islet280.1 (0.1-0.1)0.2 (0.2-0.3)0.05 (0.05-0.05)2 (2-2)-0.3 (-0.40.2)Peaked Rocks240.1 (0.1-0.2)0.4 (0.3-0.5)0.05 (0.05-0.05)2 (2-2)-0.3 (-0.40.2)	Price	25	4.6 (3.4-6.3)	11.3 (8.4-15.3)	0.93 (0.85-0.97)	3 (3-3)	-10.8 (-14.68)
Lewis1310.1 (0-0.1)0 (0-0)0 (0-0)145 (145-145)-0.1 (-0.10.1)East Island141 (0.8-1.4)4.6 (3.4-6.2)0.57 (0.38-0.76)1 (1-1)-4 (-5.5-2.8)South Neptune60.3 (0.2-0.4)2.8 (2.1-3.8)0.45 (0.41-0.54)1 (1-1)-2 (-2.81.5)Albatross150.5 (0.4-0.7)2.1 (1.5-2.8)0.22 (0.17-0.31)1 (1-1)-1.6 (-2.31.1)English270 (0-0)0 (0-0)0.03 (0.03-0.03)5 (5-5)0.1 (0.1-0.1)Dangerous7090 (0-0.1)0 (0-0)0 (0-0)145 (145-145)0 (0-0)North Islet280.1 (0.1-0.1)0.2 (0.2-0.3)0.03 (0.03-0.03)5 (5-5)-0.2 (-0.20.1)Peaked Rocks240.1 (0.1-0.2)0.4 (0.3-0.5)0.05 (0.05-0.05)2 (2-2)-0.3 (-0.40.2)	Liguanea	43	3.7 (2.8-5)	5.3 (3.9-7.2)	0.54 (0.32-0.75)	9 (13-7)	-5.1 (-6.83.8)
East Island141 (0.8-1.4)4.6 (3.4-6.2)0.57 (0.38-0.76)1 (1-1)-4 (-5.5-2.8)South Neptune60.3 (0.2-0.4)2.8 (2.1-3.8)0.45 (0.41-0.54)1 (1-1)-2 (-2.8-1.5)Albatross150.5 (0.4-0.7)2.1 (1.5-2.8)0.22 (0.17-0.31)1 (1-1)-1.6 (-2.31.1)English270 (0-0)0 (0-0)0.03 (0.03-0.03)5 (5-5)0.1 (0.1-0.1)Dangerous7090 (0-0.1)0 (0-0)0 (0-0)145 (145-145)0 (0-0)North Islet280.1 (0.1-0.1)0.2 (0.2-0.3)0.03 (0.03-0.03)5 (5-5)-0.2 (-0.20.1)Peaked Rocks240.1 (0.1-0.2)0.4 (0.3-0.5)0.05 (0.05-0.05)2 (2-2)-0.3 (-0.40.2)	Lewis	131	0.1 (0-0.1)	0 (0-0)	0 (0-0)	145 (145-145)	-0.1 (-0.10.1)
South Neptune60.3 (0.2-0.4)2.8 (2.1-3.8)0.45 (0.41-0.54)1 (1-1)-2 (-2.81.5)Albatross150.5 (0.4-0.7)2.1 (1.5-2.8)0.22 (0.17-0.31)1 (1-1)-1.6 (-2.31.1)English270 (0-0)0 (0-0)0.03 (0.03-0.03)5 (5-5)0.1 (0.1-0.1)Dangerous7090 (0-0.1)0 (0-0)0 (0-0)145 (145-145)0 (0-0)North Islet280.1 (0.1-0.1)0.2 (0.2-0.3)0.03 (0.03-0.03)5 (5-5)-0.2 (-0.20.1)Peaked Rocks240.1 (0.1-0.2)0.4 (0.3-0.5)0.05 (0.05-0.05)2 (2-2)-0.3 (-0.40.2)	East Island	14	1 (0.8-1.4)	4.6 (3.4-6.2)	0.57 (0.38-0.76)	1 (1-1)	-4 (-5.52.8)
Albatross150.5 (0.4-0.7)2.1 (1.5-2.8)0.22 (0.17-0.31)1 (1-1)-1.6 (-2.31.1)English270 (0-0)0 (0-0)0.03 (0.03-0.03)5 (5-5)0.1 (0.1-0.1)Dangerous7090 (0-0.1)0 (0-0)0 (0-0)145 (145-145)0 (0-0)North Islet280.1 (0.1-0.1)0.2 (0.2-0.3)0.03 (0.03-0.03)5 (5-5)-0.2 (-0.20.1)Peaked Rocks240.1 (0.1-0.2)0.4 (0.3-0.5)0.05 (0.05-0.05)2 (2-2)-0.3 (-0.40.2)	South Neptune	6	0.3 (0.2-0.4)	2.8 (2.1-3.8)	0.45 (0.41-0.54)	1 (1-1)	-2 (-2.81.5)
English270 (0-0)0 (0-0)0.03 (0.03-0.03)5 (5-5)0.1 (0.1-0.1)Dangerous7090 (0-0.1)0 (0-0)0 (0-0)145 (145-145)0 (0-0)North Islet280.1 (0.1-0.1)0.2 (0.2-0.3)0.03 (0.03-0.03)5 (5-5)-0.2 (-0.2-0.1)Peaked Rocks240.1 (0.1-0.2)0.4 (0.3-0.5)0.05 (0.05-0.05)2 (2-2)-0.3 (-0.40.2)	Albatross	15	0.5 (0.4-0.7)	2.1 (1.5-2.8)	0.22 (0.17-0.31)	1 (1-1)	-1.6 (-2.31.1)
Dangerous 709 0 (0-0.1) 0 (0-0) 0 (0-0) 145 (145-145) 0 (0-0) North Islet 28 0.1 (0.1-0.1) 0.2 (0.2-0.3) 0.03 (0.03-0.03) 5 (5-5) -0.2 (-0.20.1) Peaked Rocks 24 0.1 (0.1-0.2) 0.4 (0.3-0.5) 0.05 (0.05-0.05) 2 (2-2) -0.3 (-0.40.2)	English	27	0 (0-0)	0 (0-0)	0.03 (0.03-0.03)	5 (5-5)	0.1 (0.1-0.1)
North Islet 28 0.1 (0.1-0.1) 0.2 (0.2-0.3) 0.03 (0.03-0.03) 5 (5-5) -0.2 (-0.2-0.1) Peaked Rocks 24 0.1 (0.1-0.2) 0.4 (0.3-0.5) 0.05 (0.05-0.05) 2 (2-2) -0.3 (-0.40.2)	Dangerous	709	0 (0-0.1)	0 (0-0)	0 (0-0)	145 (145-145)	0 (0-0)
Peaked Rocks 24 0.1 (0.1-0.2) 0.4 (0.3-0.5) 0.05 (0.05-0.05) 2 (2-2) -0.3 (-0.40.2)	North Islet	28	0.1 (0.1-0.1)	0.2 (0.2-0.3)	0.03 (0.03-0.03)	5 (5-5)	-0.2 (-0.20.1)
	Peaked Rocks	24	0.1 (0.1-0.2)	0.4 (0.3-0.5)	0.05 (0.05-0.05)	2 (2-2)	-0.3 (-0.40.2)
N Casuarina 3 0.5 (0.3-0.6) 9.3 (6.9-12.6) 0.92 (0.82-0.97) 1 (1-1) -3.8 (-5.42.7)	N Casuarina	3	0.5 (0.3-0.6)	9.3 (6.9-12.6)	0.92 (0.82-0.97)	1 (1-1)	-3.8 (-5.42.7)
Cape Bouquer 3 0.3 (0.2-0.4) 6.7 (4.9-9) 0.81 (0.67-0.91) 1 (1-1) -2.6 (-3.71.8)	Cape Bouquer	3	0.3 (0.2-0.4)	6.7 (4.9-9)	0.81 (0.67-0.91)	1 (1-1)	-2.6 (-3.71.8)
Cave Point 3 0.3 (0.2-0.4) 6.6 (4.9-9) 0.81 (0.67-0.91) 1 (1-1) -2.6 (-3.7-1.8)	Cave Point	3	0.3 (0.2-0.4)	6.6 (4.9-9)	0.81 (0.67-0.91)	1 (1-1)	-2.6 (-3.71.8)
Seal Bay 260 29.2 (21.7-39.5) 6.9 (5.1-9.3) 0.52 (0.22-0.81) 42 (62-28) -6.4 (-8.64.7)	Seal Bay	260	29.2 (21.7-39.5)	6.9 (5.1-9.3)	0.52 (0.22-0.81)	42 (62-28)	-6.4 (-8.64.7)
Black Point 1 0.1 (0.1-0.2) 7.1 (5.3-9.6) 0.83 (0.7-0.93) 1 (1-1) -2.8 (-42)	Black Point		0.1 (0.1-0.2)	7.1 (5.3-9.6)	0.83 (0.7-0.93)	1 (1-1)	-2.8 (-42)
Seal Slide 16 1.9 (1.4-2.6) 7.2 (5.4-9.8) 0.81 (0.65-0.91) 1 (1-1) -6.6 (-9.1-4.8)	Seal Slide	16	1.9 (1 4-2 6)	7.2 (5.4-9.8)	0.81 (0.65-0.91)	1 (1-1)	-6.6 (-9 14 8)
SPage 331 20.9 (15.5-28.3) 3.9 (2.9-5.2) 0.09 (0.03-0.26) 83 (96-67) -3.6 (-4.92.7)	SPage	331	20.9 (15.5-28.3)	3.9 (2.9-5.2)	0.09 (0.03-0.26)	83 (96-67)	-3.6 (-4.92.7)
NPage 258 15.7 (11.7-21.3) 3.7 (2.8-5.1) 0.07 (0.02-0.22) 87 (112-63) -3.5 (-4.7-2.6)	NPage	258	15.7 (11.7-21.3)	3.7 (2.8-5.1)	0.07 (0.02-0.22)	87 (112-63)	-3.5 (-4.72.6)
Mean 3107 146 (108-198) 36 (2 6-4 8) 0.38 (0.31-0.45) 24 (28-21) -2.8 (-3.82)	Mean	3107	146 (108-198)	36 (26-48)	0.38 (0.31-0.45)	24 (28-21)	-2.8 (-3.82)
% of subpops. 67 (65-75) 77 (73-81) 90 (83-90)	% of subpops.	0.01	(100-100)	0.0 (2.0 1.0)	67 (65-75)	77 (73-81)	90 (83-90)

Table 8.18. Subpopulation estimates of female bycatch, and percentage of females removed as bycatch mortality per breeding cycle. Terminal Extinction Risk (TER), Quasi-extinction Time (QET, and estimated growth rate over the next 20 breeding cycles (% per 17.5 months) are also given assuming an underlying stable intrinsic growth rate. \pm 95 CL are given in parentheses. The current estimated pup production per subpopulation is also shown. The table presents estimates based on the current distribution of the GHAT fishery off South Australia (100,000 km.hrs/yr), with removal of 0-60m depth range (no displaced effort). The % of subpopulations with TERs >0.1, QETs < 3 generations (33.3 yrs) and negative growth rates are given on the last line of the table.

Subpop	Pup prod	Female bycatch	% females/sub	TER	QET	Growth rate
B9	17	0 (0-0)	0 (0-0)	0.1 (0.1-0.1)	2 (2-2)	0.3 (0.3-0.3)
B8	38	0 (0-0)	0 (0-0)	0.01 (0.01-0.01)	36 (36-36)	-0.1 (-0.10.1)
B7	3	0 (0-0)	0 (0-0)	0.48 (0.48-0.48)	1 (1-1)	0.5 (0.5-0.5)
B6	12	0 (0-0)	0 (0-0)	0.23 (0.23-0.23)	1 (1-1)	0.8 (0.8-0.9)
B5	43	0 (0-0)	0 (0-0)	0.01 (0.01-0.01)	93 (94-93)	-0.1 (-0.10.1)
B4	2	0 (0-0)	0 (0-0)	0.48 (0.48-0.48)	1 (1-1)	0.5 (0.5-0.5)
B3	31	0 (0-0)	0 (0-0)	0.02 (0.02-0.02)	13 (13-13)	-2.9 (-2.92.9)
B2	5	0 (0-0)	0 (0-0)	0.37 (0.37-0.37)	1 (1-1)	0.6 (0.6-0.6)
B1	15	0 (0-0)	0 (0-0)	0.13 (0.13-0.13)	1 (1-1)	0.4 (0.4-0.4)
NR W	12	0.1 (0.1-0.2)	0.7 (0.5-1)	0.23 (0.23-0.23)	1 (1-1)	0.1 (-0.1-0.3)
NR E	3	0 (0-0)	0.7 (0.6-1)	0.48 (0.48-0.48)	1 (1-1)	0.1 (0-0.2)
Pt Fowler	1	0 (0-0)	0.6 (0.4-0.8)	0.48 (0.48-0.48)	1 (1-1)	0.2 (0.1-0.3)
Purdie	132	1 (0.7-1.4)	0.5 (0.3-0.6)	0 (0-0)	132 (135-127)	-0.5 (-0.60.4)
West	56	0.7 (0.5-1)	0.8 (0.6-1.1)	0.01 (0.01-0.01)	85 (97-71)	-0.8 (-1.10.7)
Fenelon	40	0.9 (0.6-1.2)	1.3 (1-1.8)	0.04 (0.03-0.07)	25 (28-21)	-1.3 (-1.81)
Lounds	34	0 (0-0)	0 (0-0.1)	0.03 (0.03-0.03)	13 (13-13)	-0.1 (-0.20.1)
B'water	17	0 (0-0)	0 (0-0)	0.1 (0.1-0.1)	2 (2-2)	0.3 (0.3-0.3)
Gliddon	7	0 (0-0)	0 (0-0)	0.36 (0.36-0.36)	1 (1-1)	0.8 (0.8-0.8)
Blefuscu	84	0.9 (0.7-1.2)	0.7 (0.5-0.9)	0 (0-0)	112 (119-104)	-0.6 (-0.90.5)
Lilliput	67	0 (0-0)	0 (0-0)	0 (0-0)	140 (140-140)	0 (-0.1-0)
Olive	206	1.7 (1.3-2.3)	0.5 (0.4-0.7)	0 (0-0)	143 (145-139)	-0.5 (-0.70.4)
N Baudin	98	5 (3.7-6.7)	3.1 (2.3-4.2)	0.1 (0.04-0.25)	60 (74-45)	-3 (-42.2)
Pt Labatt	6	0.4 (0.3-0.6)	4.4 (3.3-6)	0.6 (0.49-0.75)	1 (1-1)	-3.2 (-4.42.4)
Jones	15	1.3 (0.9-1.7)	5.1 (3.8-6.9)	0.64 (0.47-0.8)	1 (1-1)	-4.6 (-6.43.3)
Dorothee	1	0.1 (0.1-0.1)	5.8 (4.3-7.9)	0.75 (0.62-0.87)	1 (1-1)	-2.2 (-3.21.5)
Pearson	35	3.4 (2.5-4.6)	5.9 (4.4-8)	0.65 (0.43-0.82)	6 (7-5)	-5.7 (-7.74.2)
Ward	45	4.3 (3.2-5.9)	5.9 (4.4-8)	0.62 (0.41-0.8)	8 (10-7)	-5.6 (-7.64.2)
Waldegrave	157	8.6 (6.3-11.6)	3.3 (2.5-4.5)	0.11 (0.04-0.26)	78 (92-63)	-3.2 (-4.32.4)
Four Hummocks	12	1.7 (1.3-2.3)	8.8 (6.5-11.9)	0.92 (0.81-0.97)	1 (1-1)	-8 (-11,15,7)
Rocky North	16	1 (0.7-1.3)	3.8 (2.8-5.1)	0.44 (0.3-0.63)	1 (1-1)	-3.3 (-4.62.4)
Price	25	2.9 (2.2-4)	7.2 (5.3-9.7)	0.78 (0.61-0.89)	3 (3-3)	-6.8 (-9.25)
Liquanea	43	2.8 (2.1-3.8)	4 (3-5.4)	0.33 (0.17-0.56)	13 (20-9)	-3.8 (-5.22.9)
Lewis	131	0 (0-0)	0 (0-0)	0 (0-0)	145 (145-145)	0 (0-0)
Fast Island	14	1 (0.7-1.3)	4.4 (3.2-5.9)	0.53 (0.36-0.73)	1 (1-1)	-3.7 (-5.22.7)
South Neptune	6	0.2 (0.2-0.3)	2.2 (1.7-3)	0.42 (0.39-0.47)	1 (1-1)	-1.6 (-2.21.2)
Albatross	15	0.4 (0.3 - 0.5)	1.6 (1.2-2.1)	0.17 (0.15-0.22)	1 (1-1)	-1.1 (-1.70.7)
Fnalish	27	0 (0-0)	0 (0-0)	0.03(0.03-0.03)	5 (5-5)	01(01-01)
Dangerous	709	0 (0-0)	0 (0-0)	0 (0-0)	145 (145-145)	0 (0-0)
North Islet	28	0 (0-0)	0 (0-0.1)	0.03 (0.03-0.03)	5 (5-5)	0 (0-0)
Peaked Rocks	24	0 (0-0)	0 1 (0-0 1)	0.05 (0.05-0.05)	2 (2-2)	0 (0-0)
N Casuarina	3	0 4 (0 3-0 5)	7 2 (5 3-9 7)	0.84 (0.7-0.93)	1 (1-1)	-2 8 (-42)
Cape Bouquer	3	0.2 (0.2 - 0.3)	4 6 (3 4-6 2)	0.64 (0.55-0.77)	1 (1-1)	-16 (-2 41 1)
Cave Point	3	0.2 (0.2 - 0.3)	4 5 (3 3-6 1)	0.63 (0.54-0.77)	1 (1-1)	-1 6 (-2 31 1)
Seal Bay	260	17 2 (12 7-23 2)	4 (3-5 5)	0.09 (0.03-0.28)	81 (106-57)	-37 (-5128)
Black Point	1	0.1 (0-0 1)	4 1 (3-5 5)	0.6 (0.53-0.72)	1 (1-1)	-1.4 (-2 10 9)
Seal Slide	16	0.6 (0.4-0.8)	2 2 (1 7-3)	0.22 (0.17-0.33)	1 (1-1)	-1.9 (-2 61 3)
SPage	331	11.4 (8 5-15 5)	2.1 (1.6-2.9)	0.01 (0-0.03)	108 (118-96)	-2 (-2 71 5)
NPage	258	8.6 (6.3-11.6)	2 (1 5-2 7)	0 (0-0 02)	137 (145-113)	-1.9 (-2.51.4)
Mean	3107	77 (57-105)	2.1 (1.6-2.9)	0.29 (0.24-0.34)	34 (36-31)	-1.6 (-2 21 1)
% of subpops.		(01 100)	(63 (58-65)	73 (71-71)	71 (71-75)
				(-)	` '	(-)

Table 8.19. Subpopulation estimates of female bycatch, and percentage of females removed as bycatch mortality per breeding cycle. Terminal Extinction Risk (TER), Quasi-extinction Time (QET, and estimated growth rate over the next 20 breeding cycles (% per 17.5 months) are also given assuming an underlying stable intrinsic growth rate. \pm 95 CL are given in parentheses. The current estimated pup production per subpopulation is also shown. The table presents estimates based on the current distribution of the GHAT fishery off South Australia (100,000 km.hrs/yr), with removal of 0-80m depth range (no displaced effort). The % of subpopulations with TERs >0.1, QETs < 3 generations (33.3 yrs) and negative growth rates are given on the last line of the table.

Subpop	Pup prod	Female bycatch	% females/sub	TER	QET	Growth rate
B9	17	0 (0-0)	0 (0-0)	0.1 (0.1-0.1)	2 (2-2)	0.3 (0.3-0.3)
B8	38	0 (0-0)	0 (0-0)	0.01 (0.01-0.01)	36 (36-36)	-0.1 (-0.10.1)
B7	3	0 (0-0)	0 (0-0)	0.48 (0.48-0.48)	1 (1-1)	0.5 (0.5-0.5)
B6	12	0 (0-0)	0 (0-0)	0.23 (0.23-0.23)	1 (1-1)	0.9 (0.9-0.9)
B5	43	0 (0-0)	0 (0-0)	0.01 (0.01-0.01)	94 (94-94)	-0.1 (-0.10.1)
B4	2	0 (0-0)	0 (0-0)	0.48 (0.48-0.48)	1 (1-1)	0.5 (0.5-0.5)
B3	31	0 (0-0)	0 (0-0)	0.02 (0.02-0.02)	13 (13-13)	-2.9 (-2.92.9)
B2	5	0 (0-0)	0 (0-0)	0.37 (0.37-0.37)	1 (1-1)	0.7 (0.7-0.7)
B1	15	0 (0-0)	0 (0-0)	0.13 (0.13-0.13)	1 (1-1)	0.4 (0.4-0.4)
NR W	12	0 (0-0)	0 (0-0.1)	0.23 (0.23-0.23)	1 (1-1)	0.8 (0.8-0.8)
NR E	3	0 (0-0)	0 (0-0.1)	0.48 (0.48-0.48)	1 (1-1)	0.5 (0.5-0.5)
Pt Fowler	1	0 (0-0)	0 (0-0)	0.48 (0.48-0.48)	1 (1-1)	0.5 (0.5-0.5)
Purdie	132	0 (0-0)	0 (0-0)	0 (0-0)	145 (145-145)	0 (0-0)
West	56	0 (0-0)	0 (0-0)	0.01 (0.01-0.01)	142 (142-142)	-0.1 (-0.10.1)
Fenelon	40	0.1 (0-0.1)	0.1 (0.1-0.1)	0.02 (0.02-0.02)	40 (40-40)	-0.2 (-0.20.1)
Lounds	34	0 (0-0)	0 (0-0)	0.03 (0.03-0.03)	14 (14-14)	-0.1 (-0.10.1)
B'water	17	0 (0-0)	0 (0-0)	0.1 (0.1-0.1)	2 (2-2)	0.3 (0.3-0.3)
Gliddon	7	0 (0-0)	0 (0-0)	0.36 (0.36-0.36)	1 (1-1)	0.8 (0.8-0.8)
Blefuscu	84	0 (0-0)	0 (0-0)	0 (0-0)	140 (140-140)	0 (0-0)
Lilliput	67	0 (0-0)	0 (0-0)	0 (0-0)	141 (141-141)	0 (0-0)
, Olive	206	0 (0-0)	0 (0-0)	0 (0-0)	145 (145-145)	0 (0-0)
N Baudin	98	0.2 (0.2-0.3)	0.1 (0.1-0.2)	0 (0-0)	136 (138-134)	-0.2 (-0.20.1)
Pt Labatt	6	0 (0-0)	0.2 (0.1-0.3)	0.38 (0.38-0.38)	1 (1-1)	-0.1 (-0.20.1)
Jones	15	0 (0-0.1)	0.2 (0.1-0.3)	0.13 (0.13-0.13)	1 (1-1)	0.2 (0.1-0.3)
Dorothee	1	0 (0-0)	1.6 (1.2-2.2)	0.48 (0.48-0.49)	1 (1-1)	-0.3 (-0.50.1)
Pearson	35	0.8 (0.6-1.1)	1.4 (1-1.9)	0.04 (0.03-0.07)	13 (14-11)	-1.4 (-1.81)
Ward	45	0.5 (0.4-0.7)	0.7 (0.5-1)	0.01 (0-0.01)	72 (83-59)	-0.8 (-10.6)
Waldegrave	157	0.3 (0.2-0.4)	0.1 (0.1-0.2)	0 (0-0)	145 (145-145)	-0.2 (-0.20.1)
Four Hummocks	12	0.9 (0.6-1.2)	4.5 (3.3-6)	0.58 (0.41-0.77)	1 (1-1)	-3.6 (-5.22.5)
Rocky North	16	0.3 (0.2-0.4)	1 (0.7-1.3)	0.13 (0.12-0.14)	1 (1-1)	-0.7 (-10.4)
Price	25	1.2 (0.9-1.7)	3 (2.3-4.1)	0.27 (0.16-0.45)	3 (3-3)	-2.9 (-3.92.1)
Liquanea	43	1.6 (1.2-2.2)	2.3 (1.7-3.1)	0.09 (0.04-0.19)	27 (36-19)	-2.2 (-31.7)
Lewis	131	0 (0-0)	0 (0-0)	0 (0-0)	145 (145-145)	0 (0-0)
East Island	14	0.4 (0.3-0.5)	1.6 (1.2-2.1)	0.18 (0.16-0.22)	1 (1-1)	-1.1 (-1.60.7)
South Neptune	6	0.1 (0.1-0.1)	0.7 (0.5-1)	0.38 (0.38-0.38)	1 (1-1)	-0.5 (-0.70.4)
Albatross	15	0.1 (0.1-0.2)	0.6 (0.4-0.8)	0.14 (0.13-0.14)	1 (1-1)	-0.2 (-0.4-0)
Fnglish	27	0 (0-0)	0 (0-0)	0.03 (0.03-0.03)	5 (5-5)	0.1(0.1-0.1)
Dangerous	709	0 (0-0)	0 (0-0)	0 (0-0)	145 (145-145)	0 (0-0)
North Islet	28	0 (0-0)	0 (0-0)	0.03 (0.03-0.03)	5 (5-5)	0.1 (0-0.1)
Peaked Rocks	24	0 (0-0)	0 (0-0)	0.05 (0.05-0.05)	2 (2-2)	0 (0-0)
N Casuarina	3	0 2 (0 2-0 3)	4 4 (3 3-6)	0.62 (0.54-0.76)	1 (1-1)	-1 6 (-2 31)
Cape Bouquer	3	0.1 (0.1-0.2)	2 6 (2-3 6)	0.51 (0.49-0.56)	1 (1-1)	-0 7 (-1 20 4)
Cave Point	3	0.1 (0.1-0.2)	25(19-34)	0.5 (0.49-0.55)	1 (1-1)	-0 7 (-1 10 4)
Seal Bay	260	63 (47-85)	1 5 (1 1-2)	0.0 (0.40 0.00)	145 (145-138)	-1 4 (-1 81)
Black Point	1	0.0 (0-0)	1 3 (0 9-1 7)	0 48 (0 48-0 48)	1 (1-1)	-0.1 (-0.3-0.1)
Seal Slide	, 16	0 (0-0)	0.1 (0.1-0.2)	0.12 (0.12-0.12)	1 (1-1)	0.2 (0.1-0.2)
SPage	331	0 (0-0)	0 (0.1 0.2)	0.12 (0.12 0.12) 0 (0-0)	145 (145-145)	0.(0.1)
NPage	258	0 (0-0)	0 (0-0)	0 (0-0)	145 (145-145)	0 (0-0)
Mean	3107	13 (10-18)	0.6 (0.5-0.9)	0.18 (0.17-0.2)	43 (44-43)	-0.3 (-0.50.2)
0/ of outpropo			(0.0 0.0)	52 (52-54)	69 (65-67)	63 (60-63)

Table 8.20. Subpopulation estimates of female bycatch, and percentage of females removed as bycatch mortality per breeding cycle. Terminal Extinction Risk (TER), Quasi-extinction Time (QET, and estimated growth rate over the next 20 breeding cycles (% per 17.5 months) are also given assuming an underlying stable intrinsic growth rate. \pm 95 CL are given in parentheses. The current estimated pup production per subpopulation is also shown. The table presents estimates based on the current distribution of the GHAT fishery off South Australia (100,000 km.hrs/yr), with removal of 0-100m depth range (no displaced effort). The % of subpopulations with TERs >0.1, QETs < 3 generations (33.3 yrs) and negative growth rates are given on the last line of the table.

generations (00	<u> yi3) and</u>	Ticgative grown				Output la set a
Subpop	Pup prod	Female bycatch	% remaies/sub		QEI	Growth rate
B9	17	0 (0-0)	0 (0-0)	0.1 (0.1-0.1)	2 (2-2)	0.3 (0.3-0.3)
B8	38	0 (0-0)	0 (0-0)	0.01 (0.01-0.01)	36 (36-36)	-0.1 (-0.10.1)
B7	3	0 (0-0)	0 (0-0)	0.48 (0.48-0.48)	1 (1-1)	0.5 (0.5-0.5)
B6	12	0 (0-0)	0 (0-0)	0.23 (0.23-0.23)	1 (1-1)	0.9 (0.9-0.9)
B5	43	0 (0-0)	0 (0-0)	0.01 (0.01-0.01)	94 (94-94)	-0.1 (-0.10.1)
B4	2	0 (0-0)	0 (0-0)	0.48 (0.48-0.48)	1 (1-1)	0.5 (0.5-0.5)
B3	31	0 (0-0)	0 (0-0)	0.02 (0.02-0.02)	13 (13-13)	-2.9 (-2.92.9)
B2	5	0 (0-0)	0 (0-0)	0.37 (0.37-0.37)	1 (1-1)	0.7 (0.7-0.7)
B1	15	0 (0-0)	0 (0-0)	0.13 (0.13-0.13)	1 (1-1)	0.4 (0.4-0.4)
NR W	12	0 (0-0)	0 (0-0)	0.23 (0.23-0.23)	1 (1-1)	0.9 (0.9-0.9)
NR E	3	0 (0-0)	0 (0-0)	0.48 (0.48-0.48)	1 (1-1)	0.5 (0.5-0.5)
Pt Fowler	1	0 (0-0)	0 (0-0)	0.48 (0.48-0.48)	1 (1-1)	0.5 (0.5-0.5)
Purdie	132	0 (0-0)	0 (0-0)	0 (0-0)	145 (145-145)	0 (0-0)
West	56	0 (0-0)	0 (0-0)	0.01 (0.01-0.01)	142 (142-142)	-0.1 (-0.10.1)
Fenelon	40	0 (0-0)	0 (0-0)	0.02 (0.02-0.02)	41 (41-41)	-0.1 (-0.10.1)
Lounds	34	0 (0-0)	0 (0-0)	0.03 (0.03-0.03)	14 (14-14)	-0.1 (-0.10.1)
B'water	17	0 (0-0)	0 (0-0)	0.1 (0.1-0.1)	2 (2-2)	0.3 (0.3-0.3)
Gliddon	7	0 (0-0)	0 (0-0)	0.36 (0.36-0.36)	1 (1-1)	0.8 (0.8-0.8)
Blefuscu	84	0 (0-0)	0 (0-0)	0 (0-0)	141 (141-141)	0 (0-0)
Lilliput	67	0 (0-0)	0 (0-0)	0 (0-0)	141 (141-141)	0 (0-0)
Olive	206	0 (0-0)	0 (0-0)	0 (0-0)	145 (145-145)	0 (0-0)
N Baudin	98	0 (0-0)	0 (0-0)	0 (0-0)	145 (145-145)	0 (0-0)
Pt Labatt	6	0 (0-0)	0 (0-0)	0.38 (0.38-0.38)	1 (1-1)	0 (0-0)
Jones	15	0 (0-0)	0 (0-0)	0.13 (0.13-0.13)	1 (1-1)	0.4 (0.4-0.4)
Dorothee	1	0 (0-0)	0 (0-0)	0.48 (0.48-0.48)	1 (1-1)	0.5 (0.5-0.5)
Pearson	35	0 (0-0)	0 (0-0)	0.02 (0.02-0.02)	18 (18-18)	-0.1 (-0.10.1)
Ward	45	0 (0-0)	0 (0-0)	0 (0-0)	126 (127-126)	-0.1 (-0.10.1)
Waldegrave	157	0 (0-0)	0 (0-0)	0 (0-0)	145 (145-145)	-0.1 (-0.10.1)
Four Hummocks	12	0(00)	0 (0 0)	0 23 (0 23-0 23)	1 (1-1)	0.5 (0.4-0.6)
Rocky North	16	0.1 (0.1-0.1)	0.4 (0.0-0.3)	0.23(0.23(0.23)) 0.12(0.12-0.12)	1 (1-1)	$0.3 (0.4 \ 0.0)$
Price	25	0 (0-0)	0 (0-0.1)	0.12(0.12-0.12) 0.05(0.05-0.05)	3 (3-3)	-0.2 (0.2-0.3)
Liquanaa	12	0.1(0.1-0.1)	0.3(0.20.4)	0.03(0.03-0.03)	79 (92 72)	0.2(0.5 - 0.1)
Liguariea	43	0.2 (0.2-0.3)	0.3 (0.2-0.4)		145 (145 145)	-0.4 (-0.30.3)
Lewis East Jaland	131	0(0-0)	0 (0-0)	0(0-0)	145 (145-145)	0(0-0)
Edst Isidiiu	14	0.1 (0.1-0.1)	0.5 (0.3-0.6)	0.15(0.15-0.15)	1 (1-1)	-0.1 (-0.2-0.1)
	0	0 (0-0)	0.1 (0.1-0.2)	0.36 (0.36-0.36)	1 (1-1)	-0.1 (-0.1-0)
Albatross	15	0 (0-0)	0.1 (0.1-0.1)	0.13 (0.13-0.13)	1 (1-1)	0.3 (0.3-0.3)
English	27	0 (0-0)	0 (0-0)	0.03 (0.03-0.03)	5 (5-5)	0.1 (0.1-0.1)
Dangerous	709	0 (0-0)	0 (0-0)	0 (0-0)	145 (145-145)	0 (0-0)
North Islet	28	0 (0-0)	0 (0-0)	0.03 (0.03-0.03)	5 (5-5)	0.1 (0.1-0.1)
Peaked Rocks	24	0 (0-0)	0 (0-0)	0.05 (0.05-0.05)	2 (2-2)	0 (0-0)
N Casuarina	3	0 (0-0)	0.2 (0.2-0.3)	0.48 (0.48-0.48)	1 (1-1)	0.4 (0.4-0.4)
Cape Bouguer	3	0 (0-0)	0.2 (0.1-0.3)	0.48 (0.48-0.48)	1 (1-1)	0.4 (0.4-0.4)
Cave Point	3	0 (0-0)	0.2 (0.1-0.2)	0.48 (0.48-0.48)	1 (1-1)	0.4 (0.4-0.4)
Seal Bay	260	0.2 (0.2-0.3)	0.1 (0-0.1)	0 (0-0)	145 (145-145)	0 (0-0)
Black Point	1	0 (0-0)	0 (0-0.1)	0.48 (0.48-0.48)	1 (1-1)	0.5 (0.5-0.5)
Seal Slide	16	0 (0-0)	0 (0-0)	0.12 (0.12-0.12)	1 (1-1)	0.3 (0.3-0.3)
SPage	331	0 (0-0)	0 (0-0)	0 (0-0)	145 (145-145)	0 (0-0)
NPage	258	0 (0-0)	0 (0-0)	0 (0-0)	145 (145-145)	0 (0-0)
Mean	3107	1 (1-1)	0 (0-0.1)	0.16 (0.16-0.16)	46 (46-46)	0.1 (0.1-0.1)
% of subpops.				50 (50-50)	67 (65-65)	44 (40-44)

Table 8.21. Subpopulation estimates of female bycatch, and percentage of females removed as bycatch mortality per breeding cycle. Terminal Extinction Risk (TER), Quasi-extinction Time (QET, and estimated growth rate over the next 20 breeding cycles (% per 17.5 months) are also given assuming an underlying stable intrinsic growth rate. \pm 95 CL are given in parentheses. The current estimated pup production per subpopulation is also shown. The table presents estimates based on the current distribution of the GHAT fishery off South Australia (100,000 km.hrs/yr), with removal of 0-120m depth range (no displaced effort). The % of subpopulations with TERs >0.1, QETs < 3 generations (33.3 yrs) and negative growth rates are given on the last line of the table.

Subpop	Pup prod	Female bycatch	% females/sub	TER	QET	Growth rate
B9	17	0 (0-0)	0 (0-0)	0.1 (0.1-0.1)	2 (2-2)	0.3 (0.3-0.3)
B8	38	0 (0-0)	0 (0-0)	0.01 (0.01-0.01)	36 (36-36)	-0.1 (-0.10.1)
B7	3	0 (0-0)	0 (0-0)	0.48 (0.48-0.48)	1 (1-1)	0.5 (0.5-0.5)
B6	12	0 (0-0)	0 (0-0)	0.23 (0.23-0.23)	1 (1-1)	0.9 (0.9-0.9)
B5	43	0 (0-0)	0 (0-0)	0.01 (0.01-0.01)	94 (94-94)	-0.1 (-0.10.1)
B4	2	0 (0-0)	0 (0-0)	0.48 (0.48-0.48)	1 (1-1)	0.5 (0.5-0.5)
B3	31	0 (0-0)	0 (0-0)	0.02 (0.02-0.02)	13 (13-13)	-2.9 (-2.92.9)
B2	5	0 (0-0)	0 (0-0)	0.37 (0.37-0.37)	1 (1-1)	0.7 (0.7-0.7)
B1	15	0 (0-0)	0 (0-0)	0.13 (0.13-0.13)	1 (1-1)	0.4 (0.4-0.4)
NR W	12	0 (0-0)	0 (0-0)	0.23 (0.23-0.23)	1 (1-1)	0.9 (0.9-0.9)
NR E	3	0 (0-0)	0 (0-0)	0.48 (0.48-0.48)	1 (1-1)	0.5 (0.5-0.5)
Pt Fowler	1	0 (0-0)	0 (0-0)	0.48 (0.48-0.48)	1 (1-1)	0.5 (0.5-0.5)
Purdie	132	0 (0-0)	0 (0-0)	0 (0-0)	145 (145-145)	0 (0-0)
West	56	0 (0-0)	0 (0-0)	0.01 (0.01-0.01)	142 (142-142)	-0.1 (-0.10.1)
Fenelon	40	0 (0-0)	0 (0-0)	0.02 (0.02-0.02)	41 (41-41)	-0.1 (-0.10.1)
Lounds	34	0 (0-0)	0 (0-0)	0.03 (0.03-0.03)	14 (14-14)	-0.1 (-0.10.1)
B'water	17	0 (0-0)	0 (0-0)	0.1 (0.1-0.1)	2 (2-2)	0.3 (0.3-0.3)
Gliddon	7	0 (0-0)	0 (0-0)	0.36 (0.36-0.36)	1 (1-1)	0.8 (0.8-0.8)
Blefuscu	84	0 (0-0)	0 (0-0)	0 (0-0)	141 (141-141)	0 (0-0)
Lilliput	67	0 (0-0)	0 (0-0)	0 (0-0)	141 (141-141)	0 (0-0)
Olive	206	0 (0-0)	0 (0-0)	0 (0-0)	145 (145-145)	0 (0-0)
N Baudin	98	0 (0-0)	0 (0-0)	0 (0-0)	145 (145-145)	0 (0-0)
Pt Labatt	6	0 (0-0)	0 (0-0)	0.38 (0.38-0.38)	, 1 (1-1)	0 (0-0)
Jones	15	0 (0-0)	0 (0-0)	0.13 (0.13-0.13)	1 (1-1)	0.4 (0.4-0.4)
Dorothee	1	0 (0-0)	0 (0-0)	0.48 (0.48-0.48)	1 (1-1)	0.5 (0.5-0.5)
Pearson	35	0 (0-0)	0 (0-0)	0.02 (0.02-0.02)	18 (18-18)	-0.1 (-0.10.1)
Ward	45	0 (0-0)	0 (0-0)	0 (0-0)	128 (128-128)	-0.1 (-0.10.1)
Waldegrave	157	0 (0-0)	0 (0-0)	0 (0-0)	145 (145-145)	-0.1 (-0.10.1)
Four Hummocks	12	0 (0-0)	0 (0-0)	0.23 (0.23-0.23)	1 (1-1)	0.9 (0.9-0.9)
Rocky North	16	0 (0-0)	0 (0-0)	0.12 (0.12-0.12)	1 (1-1)	0.3 (0.3-0.3)
Price	25	0 (0-0)	0 (0-0)	0.04 (0.04-0.04)	3 (3-3)	0.1 (0.1-0.1)
Liquanea	43	0 (0-0)	0 (0-0)	0.01 (0.01-0.01)	93 (93-92)	-0.1 (-0.10.1)
Lewis	131	0 (0-0)	0 (0-0)	0 (0-0)	145 (145-145)	0 (0-0)
East Island	14	0 (0-0)	0 (0-0)	0.15 (0.15-0.15)	1 (1-1)	0.4 (0.4-0.4)
South Neptune	6	0 (0-0)	0 (0-0)	0.38 (0.38-0.38)	1 (1-1)	0 (0-0)
Albatross	15	0 (0-0)	0 (0-0)	0.13 (0.13-0.13)	1 (1-1)	0.4 (0.4-0.4)
English	27	0 (0-0)	0 (0-0)	0.03 (0.03-0.03)	5 (5-5)	0.1 (0.1-0.1)
Dangerous	709	0 (0-0)	0 (0-0)	0 (0-0)	145 (145-145)	0 (0-0)
North Islet	28	0 (0-0)	0 (0-0)	0.03 (0.03-0.03)	5 (5-5)	0.1 (0.1-0.1)
Peaked Rocks	24	0 (0-0)	0 (0-0)	0.05 (0.05-0.05)	2 (2-2)	0 (0-0)
N Casuarina	3	0 (0-0)	0 (0-0)	0 48 (0 48-0 48)	= (= <i>=</i>) 1 (1-1)	0.5 (0.5-0.5)
Cape Bouquer	3	0 (0-0)	0 (0-0)	0.48 (0.48-0.48)	1 (1-1)	0.5 (0.5-0.5)
Cave Point	3	0 (0-0)	0 (0-0)	0 48 (0 48-0 48)	1 (1-1)	0.5 (0.5-0.5)
Seal Bay	260	0 (0-0)	0 (0-0)	0 (0-0)	145 (145-145)	0 (0-0)
Black Point	1	0 (0-0)	0 (0-0)	0 48 (0 48-0 48)	1 (1-1)	0.5 (0.5-0.5)
Seal Slide	16	0 (0-0)	0 (0-0)	0.12 (0.12-0.12)	1 (1-1)	0.3 (0.3-0.3)
SPage	331	0 (0-0)	0 (0-0)	0 (0-0)	145 (145-145)	0 (0-0)
NPage	258	0 (0-0)	0 (0-0)	0 (0-0)	145 (145-145)	0 (0-0)
Mean	3107	0 (0-0)	0 (0-0)	0.16 (0.16-0.16)	46 (46-46)	0.2 (0 2-0 2)
% of subpops.	0.07	0 (0 0)	0 (0 0)	50 (50-50)	67 (65-65)	33 (33-33)

Table 8.22. Subpopulation estimates of female bycatch, and percentage of females removed as bycatch mortality per breeding cycle. Terminal Extinction Risk (TER), Quasi-extinction Time (QET, and estimated growth rate over the next 20 breeding cycles (% per 17.5 months) are also given assuming an underlying stable intrinsic growth rate. \pm 95 CL are given in parentheses. The current estimated pup production per subpopulation is also shown. The table presents estimates based on the current distribution of the GHAT fishery off South Australia (100,000 km.hrs/yr), with removal of 0-20km minimum distance from ASL subpopulations (no displaced effort). The % of subpopulations with TERs >0.1, QETs < 3 generations (33.3 yrs) and negative growth rates are given on the last line of the table.

Subpop	Pup prod	Female bycatch	% females/sub	TER	QET	Growth rate
B9	17	0.3 (0.2-0.4)	1 (0.7-1.3)	0.11 (0.1-0.12)	2 (2-2)	-0.7 (-10.4)
B8	38	0.6 (0.5-0.8)	1 (0.7-1.3)	0.03 (0.02-0.04)	26 (28-23)	-1.1 (-1.40.8)
B7	3	0 (0-0.1)	1 (0.7-1.4)	0.48 (0.48-0.48)	1 (1-1)	0 (-0.1-0.1)
B6	12	0.2 (0.1-0.3)	1 (0.8-1.4)	0.23 (0.23-0.24)	1 (1-1)	-0.2 (-0.5-0.1)
B5	43	0.4 (0.3-0.6)	0.6 (0.5-0.9)	0.01 (0.01-0.01)	65 (72-57)	-0.7 (-0.90.5)
B4	2	0 (0-0)	0.6 (0.5-0.8)	0.48 (0.48-0.48)	1 (1-1)	0.2 (0.1-0.3)
B3	31	0.3 (0.2-0.4)	0.6 (0.4-0.8)	0.03 (0.03-0.03)	11 (12-11)	-3.1 (-3.23)
B2	5	0 (0-0)	0.3 (0.2-0.4)	0.37 (0.37-0.37)	1 (1-1)	0.4 (0.3-0.5)
B1	15	0 (0-0.1)	0.2 (0.1-0.2)	0.13 (0.13-0.13)	1 (1-1)	0.2 (0.2-0.3)
NR W	12	0.2 (0.1-0.2)	0.8 (0.6-1.1)	0.23 (0.23-0.23)	1 (1-1)	0.1 (-0.2-0.3)
NR E	3	0 (0-0.1)	0.8 (0.6-1.1)	0.48 (0.48-0.48)	1 (1-1)	0.1 (0-0.2)
Pt Fowler	1	0 (0-0)	0.8 (0.6-1.1)	0.48 (0.48-0.48)	1 (1-1)	0.1 (0-0.2)
Purdie	132	1.3 (1-1.8)	0.6 (0.4-0.8)	0 (0-0)	128 (133-122)	-0.6 (-0.80.5)
West	56	0.3 (0.2-0.4)	0.3 (0.2-0.4)	0.01 (0.01-0.01)	117 (123-110)	-0.4 (-0.50.3)
Fenelon	40	0.8 (0.6-1.1)	1.3 (0.9-1.7)	0.04 (0.02-0.06)	25 (29-22)	-1.3 (-1.71)
Lounds	34	0 (0-0)	0.1 (0-0.1)	0.03 (0.03-0.03)	13 (13-13)	-0.2 (-0.20.1)
B'water	17	0 (0-0)	0 (0-0)	0.1 (0.1-0.1)	2 (2-2)	0.2 (0.2-0.3)
Gliddon	7	0 (0-0)	0 (0-0)	0.36 (0.36-0.36)	1 (1-1)	0.8 (0.8-0.8)
Blefuscu	84	1.3 (1-1.8)	1 (0.7-1.3)	0 (0-0.01)	101 (110-90)	-0.9 (-1.20.7)
Lilliput	67	0.1 (0.1-0.1)	0.1 (0.1-0.1)	0 (0-0)	136 (138-135)	-0.1 (-0.10.1)
Olive	206	2.6 (1.9-3.5)	0.8 (0.6-1)	0 (0-0)	137 (142-131)	-0.8 (-10.6)
N Baudin	98	4.1 (3-5.6)	2.6 (1.9-3.5)	0.06 (0.02-0.14)	69 (83-54)	-2.5 (-3.31.8)
Pt Labatt	6	0.3 (0.2-0.4)	3.4 (2.5-4.6)	0.5 (0.43-0.61)	1 (1-1)	-2.5 (-3.31.8)
Jones	15	0.9 (0.7-1.3)	3.8 (2.8-5.2)	0.47 (0.32-0.65)	1 (1-1)	-3.4 (-4.72.4)
Dorothee	1	0.1 (0-0.1)	4.1 (3-5.5)	0.6 (0.52-0.72)	1 (1-1)	-1.4 (-2.10.9)
Pearson	35	2.4 (1.8-3.2)	4.1 (3.1-5.6)	0.39 (0.22-0.61)	7 (9-6)	-4 (-5.43)
Ward	45	3.4 (2.6-4.7)	4.7 (3.5-6.3)	0.46 (0.26-0.68)	9 (14-8)	-4.5 (-6.13.4)
Waldegrave	157	9.8 (7.3-13.3)	3.8 (2.8-5.2)	0.16 (0.06-0.36)	72 (86-56)	-3.6 (-4.92.7)
Four Hummocks	12	0.8 (0.6-1)	3.9 (2.9-5.3)	0.49 (0.35-0.69)	1 (1-1)	-3.1 (-4.42)
Rocky North	16	1 (0.8-1.4)	3.9 (2.9-5.3)	0.46 (0.31-0.64)	1 (1-1)	-3.4 (-4.82.5)
Price	25	1.5 (1.1-2)	3.6 (2.6-4.8)	0.36 (0.21-0.55)	3 (3-3)	-3.4 (-4.62.5)
Liguanea	43	1.8 (1.4-2.5)	2.6 (1.9-3.6)	0.13 (0.06-0.26)	23 (32-15)	-2.6 (-3.41.9)
Lewis	131	0 (0-0)	0 (0-0)	0 (0-0)	145 (145-145)	-0.1 (-0.1-0)
East Island	14	0.2 (0.2-0.3)	0.9 (0.7-1.2)	0.16 (0.15-0.16)	1 (1-1)	-0.5 (-0.80.3)
South Neptune	6	0 (0-0.1)	0.4 (0.3-0.5)	0.38 (0.38-0.38)	1 (1-1)	-0.2 (-0.30.2)
Albatross	15	0.1 (0.1-0.2)	0.5 (0.4-0.7)	0.13 (0.13-0.14)	1 (1-1)	-0.1 (-0.3-0)
English	27	0 (0-0)	0 (0-0)	0.03 (0.03-0.03)	5 (5-5)	0.1 (0.1-0.1)
Dangerous	709	0 (0-0)	0 (0-0)	0 (0-0)	145 (145-145)	0 (0-0)
North Islet	28	0.1 (0.1-0.1)	0.2 (0.1-0.3)	0.03 (0.03-0.03)	5 (5-5)	-0.1 (-0.20.1)
Peaked Rocks	24	0.2 (0.1-0.3)	0.5 (0.4-0.6)	0.05 (0.05-0.05)	2 (2-2)	-0.4 (-0.60.3)
N Casuarina	3	0.1 (0.1-0.1)	1.9 (1.4-2.6)	0.49 (0.48-0.5)	1 (1-1)	-0.4 (-0.70.2)
Cape Bouquer	3	0.2 (0.1-0.2)	3.2 (2.4-4.4)	0.54 (0.5-0.62)	1 (1-1)	-1 (-1.60.6)
Cave Point	3	0.2 (0.1-0.2)	3.3 (2.4-4.5)	0.54 (0.5-0.63)	1 (1-1)	-1 (-1.60.6)
Seal Bav	260	18.8 (13.9-25.5)	4.4 (3.3-6)	0.13 (0.04-0.37)	73 (98-51)	-4.1 (-5.63)
Black Point	1	0.1 (0.1-0.1)	5.1 (3.8-6.9)	0.68 (0.57-0.82)	1 (1-1)	-1.9 (-2.71.3)
Seal Slide	16	1.1 (0.9-1.6)	4.4 (3.3-5.9)	0.53 (0.36-0.71)	1 (1-1)	-3.9 (-5.42.8)
SPage	331	23 (17.1-31.2)	4.3 (3.2-5.8)	0.13 (0.04-0.35)	78 (92-62)	-4 (-5.43)
NPage	258	17.5 (12.9-23.6)	4.1 (3.1-5.6)	0.1 (0.03-0.3)	79 (104-55)	-3.8 (-5.22.8)
Mean	3107	96 (71-130)	1.8 (1.3-2.4)	0.24 (0.2-0.31)	31 (34-28)	-1.3 (-1.80.9)
% of subpops.		· /	. ,	67 (56-69)	77 (73-73)	77 (73-85)

Table 8.23. Subpopulation estimates of female bycatch, and percentage of females removed as bycatch mortality per breeding cycle. Terminal Extinction Risk (TER), Quasi-extinction Time (QET, and estimated growth rate over the next 20 breeding cycles (% per 17.5 months) are also given assuming an underlying stable intrinsic growth rate. \pm 95 CL are given in parentheses. The current estimated pup production per subpopulation is also shown. The table presents estimates based on the current distribution of the GHAT fishery off South Australia (100,000 km.hrs/yr), with removal of 0-40km minimum distance from ASL subpopulations (no displaced effort). The % of subpopulations with TERs >0.1, QETs < 3 generations (33.3 yrs) and negative growth rates are given on the last line of the table.

Subpop	Pup prod	Female bycatch	% females/sub	TER	QET	Growth rate
B9	17	0.2 (0.2-0.3)	0.8 (0.6-1.1)	0.1 (0.1-0.11)	2 (2-2)	-0.5 (-0.80.3)
B8	38	0.5 (0.4-0.7)	0.8 (0.6-1.1)	0.02 (0.02-0.03)	27 (29-25)	-0.9 (-1.20.7)
B7	3	0 (0-0.1)	0.8 (0.6-1.1)	0.48 (0.48-0.48)	1 (1-1)	0.1 (0-0.2)
B6	12	0.2 (0.1-0.2)	0.9 (0.6-1.2)	0.23 (0.23-0.23)	1 (1-1)	0 (-0.3-0.2)
B5	43	0.4 (0.3-0.5)	0.5 (0.4-0.7)	0.01 (0.01-0.01)	70 (76-63)	-0.6 (-0.70.4)
B4	2	0 (0-0)	0.5 (0.4-0.7)	0.48 (0.48-0.48)	1 (1-1)	0.3 (0.2-0.3)
B3	31	0.2 (0.2-0.3)	0.5 (0.3-0.6)	0.03 (0.02-0.03)	11 (12-11)	-3 (-3.13)
B2	5	0 (0-0)	0.2 (0.1-0.3)	0.37 (0.37-0.37)	1 (1-1)	0.5 (0.4-0.5)
B1	15	0 (0-0)	0.1 (0.1-0.1)	0.13 (0.13-0.13)	1 (1-1)	0.3 (0.3-0.3)
NR W	12	0.1 (0-0.1)	0.3 (0.2-0.4)	0.23 (0.23-0.23)	1 (1-1)	0.5 (0.4-0.6)
NR E	3	0 (0-0)	0.3 (0.2-0.5)	0.48 (0.48-0.48)	1 (1-1)	0.3 (0.3-0.4)
Pt Fowler	1	0 (0-0)	0.3 (0.2-0.5)	0.48 (0.48-0.48)	1 (1-1)	0.3 (0.3-0.4)
Purdie	132	0.1 (0.1-0.2)	0.1 (0-0.1)	0 (0-0)	145 (145-145)	-0.1 (-0.10.1)
West	56	0 (0-0.1)	0 (0-0.1)	0.01 (0.01-0.01)	137 (139-136)	-0.1 (-0.20.1)
Fenelon	40	0.3 (0.3-0.5)	0.5 (0.4-0.7)	0.02 (0.02-0.02)	34 (35-31)	-0.6 (-0.80.5)
Lounds	34	0 (0-0)	0 (0-0)	0.03 (0.03-0.03)	14 (14-14)	-0.1 (-0.10.1)
B'water	17	0 (0-0)	0 (0-0)	0.1 (0.1-0.1)	2 (2-2)	0.3 (0.3-0.3)
Gliddon	7	0 (0-0)	0 (0-0)	0.36 (0.36-0.36)	1 (1-1)	0.8 (0.8-0.8)
Blefuscu	84	0.3 (0.2-0.4)	0.2 (0.2-0.3)	0 (0-0)	130 (133-126)	-0.2 (-0.30.2)
Lilliput	67	0 (0-0)	0 (0-0)	0 (0-0)	141 (141-141)	0 (0-0)
Olive	206	0.4 (0.3-0.5)	0.1 (0.1-0.2)	0 (0-0)	145 (145-145)	-0.1 (-0.20.1)
N Baudin	98	1.1 (0.8-1.4)	0.7 (0.5-0.9)	0 (0-0)	117 (123-110)	-0.6 (-0.90.5)
Pt Labatt	6	0.1 (0-0.1)	0.6 (0.5-0.9)	0.38 (0.38-0.38)	1 (1-1)	-0.4 (-0.60.3)
Jones	15	0.1 (0.1-0.2)	0.6 (0.4-0.8)	0.14 (0.13-0.14)	1 (1-1)	-0.1 (-0.3-0)
Dorothee	1	0 (0-0)	0.8 (0.6-1)	0.48 (0.48-0.48)	1 (1-1)	0.1 (0-0.2)
Pearson	35	0.4 (0.3-0.6)	0.7 (0.5-1)	0.02 (0.02-0.03)	15 (16-14)	-0.8 (-10.6)
Ward	45	0.5 (0.4-0.7)	0.7 (0.5-0.9)	0 (0-0.01)	75 (86-63)	-0.7 (-0.90.5)
Waldegrave	157	0.5 (0.4-0.7)	0.2 (0.2-0.3)	0 (0-0)	145 (145-141)	-0.2 (-0.30.2)
Four Hummocks	12	0 (0-0.1)	0.2 (0.2-0.3)	0.23 (0.23-0.23)	1 (1-1)	0.6 (0.5-0.7)
Rocky North	16	0.1 (0.1-0.2)	0.5 (0.4-0.7)	0.12 (0.12-0.12)	1 (1-1)	-0.2 (-0.40.1)
Price	25	0.1 (0-0.1)	0.1 (0.1-0.2)	0.04 (0.04-0.04)	3 (3-3)	-0.1 (-0.1-0)
Liguanea	43	0.5 (0.4-0.7)	0.7 (0.5-0.9)	0.01 (0.01-0.02)	63 (70-55)	-0.7 (-10.6)
Lewis	131	0 (0-0)	0 (0-0)	0 (0-0)	145 (145-145)	0 (0-0)
East Island	14	0 (0-0)	0 (0-0)	0.15 (0.15-0.15)	1 (1-1)	0.3 (0.3-0.4)
South Neptune	6	0 (0-0)	0 (0-0)	0.38 (0.38-0.38)	1 (1-1)	0 (0-0)
Albatross	15	0 (0-0)	0.1 (0.1-0.2)	0.13 (0.13-0.13)	1 (1-1)	0.3 (0.3-0.3)
English	27	0 (0-0)	0 (0-0)	0.03 (0.03-0.03)	5 (5-5)	0.1 (0.1-0.1)
Dangerous	709	0 (0-0)	0 (0-0)	0 (0-0)	145 (145-145)	0 (0-0)
North Islet	28	0 (0-0)	0 (0-0)	0.03 (0.03-0.03)	5 (5-5)	0 (0-0)
Peaked Rocks	24	0.1 (0.1-0.1)	0.2 (0.2-0.3)	0.05 (0.05-0.05)	2 (2-2)	-0.2 (-0.20.1)
N Casuarina	3	0 (0-0)	0.2 (0.2-0.3)	0.48 (0.48-0.48)	1 (1-1)	0.4 (0.3-0.4)
Cape Bouquer	3	0.1 (0-0.1)	1.1 (0.8-1.5)	0.48 (0.48-0.48)	1 (1-1)	0 (-0.2-0.1)
Cave Point	3	0.1 (0-0.1)	1.2 (0.9-1.6)	0.48 (0.48-0.48)	1 (1-1)	-0.1 (-0.3-0.1)
Seal Bay	260	8.1 (6-11)	1.9 (1.4-2.6)	0 (0-0.01)	145 (145-118)	-1.8 (-2.41.3)
Black Point	1	0 (0-0.1)	2.5 (1.8-3.4)	0.5 (0.49-0.54)	1 (1-1)	-0.7 (-1.10.4)
Seal Slide	16	0.4 (0.3-0.6)	1.7 (1.2-2.2)	0.16 (0.14-0.22)	1 (1-1)	-1.3 (-1.90.9)
SPage	331	17.2 (12.8-23.4)	3.2 (2.4-4.3)	0.04 (0.01-0.13)	91 (104-77)	-3 (-42.2)
NPage	258	13.1 (9.7-17.7)	3.1 (2.3-4.2)	0.03 (0.01-0.11)	103 (127-78)	-2.9 (-3.92.1)
Mean	3107	46 (34-62)	0.6 (0.4-0.8)	0.16 (0.16-0.17)	41 (42-38)	-0.3 (-0.50.2)
% of subpops.		(0 . 0_)	(00)	50 (50-54)	69 (67-69)	60 (56-65)

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Table 8.24. Subpopulation estimates of female bycatch, and percentage of females removed as bycatch mortality per breeding cycle. Terminal Extinction Risk (TER), Quasi-extinction Time (QET, and estimated growth rate over the next 20 breeding cycles (% per 17.5 months) are also given assuming an underlying stable intrinsic growth rate. \pm 95 CL are given in parentheses. The current estimated pup production per subpopulation is also shown. The table presents estimates based on the current distribution of the GHAT fishery off South Australia (100,000 km.hrs/yr), with removal of 0-60km minimum distance from ASL subpopulations (no displaced effort). The % of subpopulations with TERs >0.1, QETs < 3 generations (33.3 yrs) and negative growth rates are given on the last line of the table.

Subpop	Pup prod	Female bycatch	% females/sub	TER	QET	Growth rate
B9	17	0.1 (0.1-0.2)	0.4 (0.3-0.6)	0.1 (0.1-0.1)	2 (2-2)	-0.1 (-0.3-0)
B8	38	0.3 (0.2-0.3)	0.4 (0.3-0.6)	0.01 (0.01-0.02)	31 (32-30)	-0.5 (-0.70.4)
B7	3	0 (0-0)	0.4 (0.3-0.6)	0.48 (0.48-0.48)	1 (1-1)	0.3 (0.2-0.4)
B6	12	0.1 (0.1-0.1)	0.4 (0.3-0.5)	0.23 (0.23-0.23)	1 (1-1)	0.5 (0.3-0.6)
B5	43	0 (0-0.1)	0.1 (0-0.1)	0.01 (0.01-0.01)	91 (92-90)	-0.1 (-0.20.1)
B4	2	0 (0-0)	0.1 (0-0.1)	0.48 (0.48-0.48)	1 (1-1)	0.5 (0.5-0.5)
B3	31	0 (0-0)	0.1 (0-0.1)	0.02 (0.02-0.02)	13 (13-12)	-2.9 (-2.92.9)
B2	5	0 (0-0)	0 (0-0)	0.37 (0.37-0.37)	1 (1-1)	0.6 (0.6-0.6)
B1	15	0 (0-0)	0 (0-0)	0.13 (0.13-0.13)	1 (1-1)	0.4 (0.4-0.4)
NR W	12	0 (0-0)	0.2 (0.1-0.2)	0.23 (0.23-0.23)	1 (1-1)	0.7 (0.6-0.7)
NR E	3	0 (0-0)	0.2 (0.1-0.2)	0.48 (0.48-0.48)	1 (1-1)	0.4 (0.4-0.4)
Pt Fowler	1	0 (0-0)	0.2 (0.1-0.2)	0.48 (0.48-0.48)	1 (1-1)	0.4 (0.4-0.4)
Purdie	132	0 (0-0)	0 (0-0)	0 (0-0)	145 (145-145)	-0.1 (-0.10.1)
West	56	0 (0-0)	0 (0-0)	0.01 (0.01-0.01)	140 (141-140)	-0.1 (-0.10.1)
Fenelon	40	0.2 (0.1-0.2)	0.3 (0.2-0.3)	0.02 (0.02-0.02)	37 (38-36)	-0.3 (-0.40.3)
Lounds	34	0 (0-0)	0 (0-0)	0.03 (0.03-0.03)	14 (14-14)	-0.1 (-0.10.1)
B'water	17	0 (0-0)	0 (0-0)	0.1 (0.1-0.1)	2 (2-2)	0.3 (0.3-0.3)
Gliddon	7	0 (0-0)	0 (0-0)	0.36 (0.36-0.36)	1 (1-1)	0.8 (0.8-0.8)
Blefuscu	84	0.1 (0.1-0.2)	0.1 (0.1-0.1)	0 (0-0)	137 (138-135)	-0.1 (-0.10.1)
Lilliput	67	0 (0-0)	0 (0-0)	0 (0-0)	141 (141-141)	0 (0-0)
Olive	206	0.1 (0.1-0.1)	0 (0-0)	0 (0-0)	145 (145-145)	-0.1 (-0.10.1)
N Baudin	98	0.4 (0.3-0.5)	0.2 (0.2-0.3)	0 (0-0)	133 (135-130)	-0.2 (-0.30.2)
Pt Labatt	6	0 (0-0)	0.2 (0.2-0.3)	0.38 (0.38-0.38)	1 (1-1)	-0.1 (-0.20.1)
Jones	15	0 (0-0.1)	0.2 (0.1-0.2)	0.13 (0.13-0.13)	1 (1-1)	0.2 (0.2-0.3)
Dorothee	1	0 (0-0)	0.2 (0.1-0.2)	0.48 (0.48-0.48)	1 (1-1)	0.4 (0.4-0.4)
Pearson	35	0.1 (0.1-0.1)	0.2 (0.1-0.2)	0.02 (0.02-0.02)	17 (17-17)	-0.2 (-0.30.2)
Ward	45	0.1 (0.1-0.2)	0.2 (0.1-0.2)	0 (0-0)	110 (115-105)	-0.2 (-0.30.2)
Waldegrave	157	0 (0-0.1)	0 (0-0)	0 (0-0)	145 (145-145)	-0.1 (-0.10.1)
Four Hummocks	12	0 (0-0)	0 (0-0)	0.23 (0.23-0.23)	1 (1-1)	0.9 (0.8-0.9)
Rocky North	16	0 (0-0)	0 (0-0)	0.12 (0.12-0.12)	1 (1-1)	0.3 (0.3-0.3)
Price	25	0 (0-0)	0 (0-0)	0.04 (0.04-0.04)	3 (3-3)	0.1 (0.1-0.1)
Liquanea	43	0.2 (0.2-0.3)	0.3 (0.2-0.4)	0.01 (0.01-0.01)	79 (83-75)	-0.4 (-0.50.3)
Lewis	131	0 (0-0)	0 (0-0)	0 (0-0)	145 (145-145)	0 (0-0)
East Island	14	0 (0-0)	0 (0-0)	0.15 (0.15-0.15)	1 (1-1)	0.4 (0.4-0.4)
South Neptune	6	0 (0-0)	0 (0-0)	0.38 (0.38-0.38)	1 (1-1)	0 (0-0)
Albatross	15	0 (0-0)	0 (0-0.1)	0.13 (0.13-0.13)	1 (1-1)	0.4(0.3-0.4)
Fnglish	27	0 (0-0)	0 (0-0)	0.03 (0.03-0.03)	5 (5-5)	0.1 (0.1-0.1)
Dangerous	709	0 (0-0)	0 (0-0)	0 (0-0)	145 (145-145)	0 (0-0)
North Islet	28	0 (0-0)	0 (0-0)	0.03 (0.03-0.03)	5 (5-5)	0.1 (0-0.1)
Peaked Rocks	24	0.1 (0-0.1)	0.1 (0.1-0.2)	0.05 (0.05-0.05)	2 (2-2)	-0.1 (-0.1-0)
N Casuarina	3	0 (0-0)	0 (0-0)	0.48 (0.48-0.48)	1 (1-1)	0.5 (0.5-0.5)
Cape Bouquer	3	0 (0-0)	0.1 (0.1-0.1)	0.48 (0.48-0.48)	1 (1-1)	0.5 (0.4-0.5)
Cave Point	3	0 (0-0)	0.1 (0.1-0.1)	0.48 (0.48-0.48)	1 (1-1)	0.5 (0.4-0.5)
Seal Bay	260	1.4 (1.1-1.9)	0.3 (0.2-0.5)	0 (0-0)	145 (145-145)	-0.3 (-0.40.2)
Black Point		0 (0-0)	0.6 (0.4-0.8)	0.48 (0.48-0.48)	1 (1-1)	0.2 (0.1-0.3)
Seal Slide	16	0.1 (0.1-0.1)	0.4 (0.3-0.6)	0.12 (0.12-0.12)	1 (1-1)	-0,1 (-0.3-0)
SPage	331	9.7 (7.2-13.1)	1.8 (1.3-2.4)	0 (0-0.01)	114 (123-103)	-1.7 (-2.31.3)
NPage	258	7.2 (5.3-9.7)	1.7 (1.3-2.3)	0 (0-0.01)	145 (145-127)	-1.6 (-2.11.2)
Mean	3107	20 (15-28)	0.2 (0.1-0.3)	0.16 (0.16-0.16)	44 (45-43)	0 (-0.1-0)
% of subpops.		. ((50 (50-50)	69 (67-67)	48 (48-48)

Table 8.25. Subpopulation estimates of female bycatch, and percentage of females removed as bycatch mortality per breeding cycle. Terminal Extinction Risk (TER), Quasi-extinction Time (QET, and estimated growth rate over the next 20 breeding cycles (% per 17.5 months) are also given assuming an underlying stable intrinsic growth rate. \pm 95 CL are given in parentheses. The current estimated pup production per subpopulation is also shown. The table presents estimates based on the current distribution of the GHAT fishery off South Australia (100,000 km.hrs/yr), with removal of 0-80km minimum distance from ASL subpopulations (no displaced effort). The % of subpopulations with TERs >0.1, QETs < 3 generations (33.3 yrs) and negative growth rates are given on the last line of the table.

Subpop	Pup prod	Female bycatch	% females/sub	TER	QET	Growth rate
B9	17	0 (0-0)	0.1 (0-0.1)	0.1 (0.1-0.1)	2 (2-2)	0.2 (0.2-0.2)
B8	38	0 (0-0.1)	0.1 (0-0.1)	0.01 (0.01-0.01)	35 (35-35)	-0.2 (-0.20.2)
B7	3	0 (0-0)	0.1 (0-0.1)	0.48 (0.48-0.48)	1 (1-1)	0.5 (0.5-0.5)
B6	12	0 (0-0)	0.1 (0-0.1)	0.23 (0.23-0.23)	1 (1-1)	0.8 (0.8-0.8)
B5	43	0 (0-0)	0 (0-0)	0.01 (0.01-0.01)	94 (94-94)	-0.1 (-0.10.1)
B4	2	0 (0-0)	0 (0-0)	0.48 (0.48-0.48)	1 (1-1)	0.5 (0.5-0.5)
B3	31	0 (0-0)	0 (0-0)	0.02 (0.02-0.02)	13 (13-13)	-2.9 (-2.92.9)
B2	5	0 (0-0)	0 (0-0)	0.37 (0.37-0.37)	1 (1-1)	0.7 (0.7-0.7)
B1	15	0 (0-0)	0 (0-0)	0.13 (0.13-0.13)	1 (1-1)	0.4 (0.4-0.4)
NR W	12	0 (0-0)	0 (0-0)	0.23 (0.23-0.23)	1 (1-1)	0.8 (0.8-0.8)
NR E	3	0 (0-0)	0 (0-0)	0.48 (0.48-0.48)	1 (1-1)	0.5 (0.5-0.5)
Pt Fowler	1	0 (0-0)	0 (0-0)	0.48 (0.48-0.48)	1 (1-1)	0.5 (0.5-0.5)
Purdie	132	0 (0-0)	0 (0-0)	0 (0-0)	145 (145-145)	0 (0-0)
West	56	0 (0-0)	0 (0-0)	0.01 (0.01-0.01)	142 (142-142)	-0.1 (-0.10.1)
Fenelon	40	0 (0-0)	0 (0-0)	0.02 (0.02-0.02)	41 (41-41)	-0.1 (-0.10.1)
Lounds	34	0 (0-0)	0 (0-0)	0.03 (0.03-0.03)	14 (14-14)	-0.1 (-0.10.1)
B'water	17	0 (0-0)	0 (0-0)	0.1 (0.1-0.1)	2 (2-2)	0.3 (0.3-0.3)
Gliddon	7	0 (0-0)	0 (0-0)	0.36 (0.36-0.36)	1 (1-1)	0.8 (0.8-0.8)
Blefuscu	84	0 (0-0)	0 (0-0)	0 (0-0)	141 (141-140)	0 (0-0)
Lilliput	67	0 (0-0)	0 (0-0)	0 (0-0)	141 (141-141)	0 (0-0)
Olive	206	0 (0-0)	0 (0-0)	0 (0-0)	145 (145-145)	0 (0-0)
N Baudin	98	0.1 (0-0.1)	0 (0-0.1)	0 (0-0)	140 (141-140)	-0.1 (-0.1-0)
Pt Labatt	6	0 (0-0)	0 (0-0)	0.38 (0.38-0.38)	1 (1-1)	0 (0-0)
Jones	15	0 (0-0)	0 (0-0)	0.13 (0.13-0.13)	1 (1-1)	0.4 (0.4-0.4)
Dorothee	1	0 (0-0)	0 (0-0)	0.48 (0.48-0.48)	1 (1-1)	0.5 (0.5-0.5)
Pearson	35	0 (0-0)	0 (0-0)	0.02 (0.02-0.02)	18 (18-18)	-0.1 (-0.10.1)
Ward	45	0 (0-0)	0 (0-0)	0 (0-0)	125 (125-124)	-0.1 (-0.10.1)
Waldegrave	157	0 (0-0)	0 (0-0)	0 (0-0)	145 (145-145)	-0.1 (-0.10.1)
Four Hummocks	12	0 (0-0)	0 (0-0)	0.23 (0.23-0.23)	1 (1-1)	0.9 (0.9-0.9)
Rocky North	16	0 (0-0)	0 (0-0)	0.12 (0.12-0.12)	1 (1-1)	0.3 (0.3-0.3)
Price	25	0 (0-0)	0 (0-0)	0.04 (0.04-0.04)	3 (3-3)	0.1 (0.1-0.1)
Liguanea	43	0.1 (0.1-0.1)	0.1 (0.1-0.2)	0.01 (0.01-0.01)	87 (89-85)	-0.2 (-0.30.2)
Lewis	131	0 (0-0)	0 (0-0)	0 (0-0)	145 (145-145)	0 (0-0)
East Island	14	0 (0-0)	0 (0-0)	0.15 (0.15-0.15)	1 (1-1)	0.4 (0.4-0.4)
South Neptune	6	0 (0-0)	0 (0-0)	0.38 (0.38-0.38)	1 (1-1)	0 (0-0)
Albatross	15	0 (0-0)	0 (0-0)	0.13 (0.13-0.13)	1 (1-1)	0.4 (0.4-0.4)
English	27	0 (0-0)	0 (0-0)	0.03 (0.03-0.03)	5 (5-5)	0.1 (0.1-0.1)
Dangerous	709	0 (0-0)	0 (0-0)	0 (0-0)	145 (145-145)	0 (0-0)
North Islet	28	0 (0-0)	0 (0-0)	0.03 (0.03-0.03)	5 (5-5)	0.1 (0.1-0.1)
Peaked Rocks	24	0 (0-0)	0 (0-0)	0.05 (0.05-0.05)	2 (2-2)	0 (0-0)
N Casuarina	3	0 (0-0)	0 (0-0)	0.48 (0.48-0.48)	1 (1-1)	0.5 (0.5-0.5)
Cape Bouquer	3	0 (0-0)	0 (0-0)	0.48 (0.48-0.48)	1 (1-1)	0.5 (0.5-0.5)
Cave Point	3	0 (0-0)	0 (0-0)	0.48 (0.48-0.48)	1 (1-1)	0.5 (0.5-0.5)
Seal Bay	260	0.1 (0.1-0.2)	0 (0-0)	0 (0-0)	145 (145-145)	0 (0-0)
Black Point	1	0 (0-0)	0.1 (0.1-0.1)	0.48 (0.48-0.48)	1 (1-1)	0.5 (0.4-0.5)
Seal Slide	16	0 (0-0)	0.1 (0.1-0.2)	0.12 (0.12-0.12)	1 (1-1)	0.2 (0.1-0.2)
SPage	331	5.9 (4.4-8)	1.1 (0.8-1.5)	0 (0-0)	127 (133-120)	-1 (-1.40.8)
NPage	258	4.3 (3.2-5.9)	1 (0.8-1.4)	0 (0-0)	145 (145-145)	-0.9 (-1.30.7)
Mean	3107	11 (8-15)	0,1 (0-0.1)	0.16 (0.16-0.16)	45 (46-45)	0.1 (0.1-0.1)
% of subpops.				50 (50-50)	67 (65-65)	40 (40-40)

Table 8.26. Subpopulation estimates of female bycatch, and percentage of females removed as bycatch mortality per breeding cycle. Terminal Extinction Risk (TER), Quasi-extinction Time (QET, and estimated growth rate over the next 20 breeding cycles (% per 17.5 months) are also given assuming an underlying stable intrinsic growth rate. \pm 95 CL are given in parentheses. The current estimated pup production per subpopulation is also shown. The table presents estimates based on the current distribution of the GHAT fishery off South Australia (100,000 km.hrs/yr), with removal of 0-100km minimum distance from ASL subpopulations (no displaced effort). The % of subpopulations with TERs >0.1, QETs < 3 generations (33.3 yrs) and negative growth rates are given on the last line of the table.

$\begin{array}{c c c c c c c c c c c c c c c c c c c $	Subpop	Pup prod	Female bycatch	% females/sub	TER	QET	Growth rate
B8 38 0 (0-0) 0 (0-0) 0.01 (0.01-0.01) 36 (36-36) -0.1 (-0.1-0.1) B7 3 0 (0-0) 0 (0-0) 0.48 (0.48-0.48) 1 (1-1) 0.5 (0.5-0.5) B6 12 0 (0-0) 0 (0-0) 0.23 (0.23-0.23) 1 (1-1) 0.9 (0.9-0.9) B5 43 0 (0-0) 0 (0-0) 0.01 (0.01-0.01) 94 (94-94) -0.1 (-0.1-0.1) B4 2 0 (0-0) 0 (0-0) 0.02 (0.02-0.02) 13 (13-13) -2.9 (-2.9-2.9) B3 31 0 (0-0) 0 (0-0) 0.37 (0.37-0.37) 1 (1-1) 0.7 (0.7-0.7) B1 15 0 (0-0) 0 (0-0) 0.23 (0.23-0.23) 1 (1-1) 0.9 (0.9-0.9) NR W 12 0 (0-0) 0 (0-0) 0.48 (0.48-0.48) 1 (1-1) 0.5 (0.5-0.5) Ptrowler 1 0 (0-0) 0 (0-0) 0.48 (0.48-0.48) 1 (1-1) 0.5 (0.5-0.5) Purdie 132 0 (0-0) 0 (0-0) 0.02 (0.22-0.02) 41 (41-41) 0.0 (-0.1) Lounds </td <td>B9</td> <td>17</td> <td>0 (0-0)</td> <td>0 (0-0)</td> <td>0.1 (0.1-0.1)</td> <td>2 (2-2)</td> <td>0.3 (0.3-0.3)</td>	B9	17	0 (0-0)	0 (0-0)	0.1 (0.1-0.1)	2 (2-2)	0.3 (0.3-0.3)
B7 3 0 (0-0) 0 (0-0) 0.48 (0.48-0.48) 1 (1-1) 0.5 (0.5-0.5) B6 12 0 (0-0) 0 (0-0) 0.23 (0.23-0.23) 1 (1-1) 0.9 (0.9-0.9) B5 43 0 (0-0) 0 (0-0) 0.01 (0.01-0.01) 94 (94-94) -0.1 (-0.1-0.1) B4 2 0 (0-0) 0 (0-0) 0.02 (0.02-0.02) 13 (13-13) -2.9 (-2.9-2.9) B2 5 0 (0-0) 0 (0-0) 0.37 (0.37-0.37) 1 (1-1) 0.7 (0.7-0.7) B1 15 0 (0-0) 0 (0-0) 0.23 (0.23-0.23) 1 (1-1) 0.9 (0.9-0.9) NR W 12 0 (0-0) 0 (0-0) 0.48 (0.48-0.48) 1 (1-1) 0.4 (0.4-0.4) NR W 12 0 (0-0) 0 (0-0) 0.48 (0.48-0.48) 1 (1-1) 0.5 (0.5-0.5) Purdie 132 0 (0-0) 0 (0-0) 0.48 (0.48-0.48) 1 (1-1) 0.5 (0.5-0.5) Purdie 132 0 (0-0) 0 (0-0) 0.48 (0.48-0.48) 1 (1-1) 0.5 (0.5-0.5) Purdie	B8	38	0 (0-0)	0 (0-0)	0.01 (0.01-0.01)	36 (36-36)	-0.1 (-0.10.1)
B6 12 0 (0-0) 0 (0-0) 0.23 (0.23-0.23) 1 (1-1) 0.9 (0.9-0.9) B5 43 0 (0-0) 0 (0-0) 0.01 (0.01-0.01) 94 (94-94) -0.1 (-0.1-0.1) B4 2 0 (0-0) 0 (0-0) 0.48 (0.48-0.48) 1 (1-1) 0.5 (0.5-0.5) B3 31 0 (0-0) 0 (0-0) 0.02 (0.02-0.02) 13 (13-13) -2.9 (-2.9-2.9) B2 5 0 (0-0) 0 (0-0) 0.37 (0.37-0.37) 1 (1-1) 0.7 (0.7-0.7) B1 15 0 (0-0) 0 (0-0) 0.23 (0.23-0.23) 1 (1-1) 0.9 (0.9-0.9) NR E 3 0 (0-0) 0 (0-0) 0.23 (0.23-0.23) 1 (1-1) 0.9 (0.9-0.9) NR E 3 0 (0-0) 0 (0-0) 0.48 (0.48-0.48) 1 (1-1) 0.5 (0.5-0.5) Purdie 132 0 (0-0) 0 (0-0) 0.01 (0.01-0.01) 142 (142-142) -0.1 (-0.1-0.1) Lounds 34 0 (0-0) 0.02 (0.02-0.02) 41 (41-41) -0.1 (-0.1-0.1) Biefuscu	B7	3	0 (0-0)	0 (0-0)	0.48 (0.48-0.48)	1 (1-1)	0.5 (0.5-0.5)
B5 43 0 (0-0) 0 (0-0) 0.01 (0.01-0.01) 94 (94-94) -0.1 (-0.1-0.1) B4 2 0 (0-0) 0 (0-0) 0 (0-0) 0.48 (0.48-0.48) 1 (1-1) 0.5 (0.5-0.5) B3 31 0 (0-0) 0 (0-0) 0.02 (0.02-0.02) 13 (13-13) -2.9 (-2.9-2.9) B2 5 0 (0-0) 0 (0-0) 0.37 (0.37-0.37) 1 (1-1) 0.7 (0.7-0.7) B1 15 0 (0-0) 0 (0-0) 0.33 (0.32-0.23) 1 (1-1) 0.4 (0.4-0.4) NR W 12 0 (0-0) 0 (0-0) 0.48 (0.48-0.48) 1 (1-1) 0.5 (0.5-0.5) Pt Fowler 1 0 (0-0) 0 (0-0) 0.48 (0.48-0.48) 1 (1-1) 0.5 (0.5-0.5) Purdie 132 0 (0-0) 0 (0-0) 0.48 (0.48-0.48) 1 (1-1) 0.5 (0.5-0.5) Purdie 132 0 (0-0) 0 (0-0) 0.145 (145-145) 0 (0-0) West 56 0 (0-0) 0 (0-0) 0.01 (0.01-0.01) 142 (142-142) -0.1 (-0.1-0.1) Loun	B6	12	0 (0-0)	0 (0-0)	0.23 (0.23-0.23)	1 (1-1)	0.9 (0.9-0.9)
B4 2 0 (0-0) 0 (0-0) 0.48 (0.48-0.48) 1 (1-1) 0.5 (0.5-0.5) B3 31 0 (0-0) 0 (0-0) 0.02 (0.02-0.02) 13 (13-13) -2.9 (-2.92.9) B2 5 0 (0-0) 0 (0-0) 0.37 (0.37-0.37) 1 (1-1) 0.7 (0.7-0.7) B1 15 0 (0-0) 0 (0-0) 0.33 (0.13-0.13) 1 (1-1) 0.4 (0.4-0.4) NR W 12 0 (0-0) 0 (0-0) 0.23 (0.23-0.23) 1 (1-1) 0.9 (0.9-0.9) NR E 3 0 (0-0) 0 (0-0) 0.48 (0.48-0.48) 1 (1-1) 0.5 (0.5-0.5) Pt Fowler 1 0 (0-0) 0 (0-0) 0.48 (0.48-0.48) 1 (1-1) 0.5 (0.5-0.5) Purdie 132 0 (0-0) 0 (0-0) 0.48 (0.48-0.48) 1 (1-1) 0.5 (0.5-0.5) Purdie 132 0 (0-0) 0 (0-0) 0.48 (0.48-0.48) 1 (1-1) 0.5 (0.5-0.5) West 56 0 (0-0) 0 (0-0) 0.01 (0.01-0.01) 142 (142-142) -0.1 (-0.1-0.1)	B5	43	0 (0-0)	0 (0-0)	0.01 (0.01-0.01)	94 (94-94)	-0.1 (-0.10.1)
B3 31 0 (0-0) 0 (0-0) 0.02 (0.02-0.02) 13 (13-13) -2.9 (-2.92.9) B2 5 0 (0-0) 0 (0-0) 0.37 (0.37-0.37) 1 (1-1) 0.7 (0.7-0.7) B1 15 0 (0-0) 0 (0-0) 0.13 (0.13-0.13) 1 (1-1) 0.4 (0.4-0.4) NR W 12 0 (0-0) 0 (0-0) 0.23 (0.23-0.23) 1 (1-1) 0.9 (0.9-0.9) NR E 3 0 (0-0) 0 (0-0) 0.48 (0.48-0.48) 1 (1-1) 0.5 (0.5-0.5) Ptrowler 1 0 (0-0) 0 (0-0) 0.48 (0.48-0.48) 1 (1-1) 0.5 (0.5-0.5) Purdie 132 0 (0-0) 0 (0-0) 0.48 (0.48-0.48) 1 (1-1) 0.5 (0.5-0.5) Purdie 132 0 (0-0) 0 (0-0) 0.48 (0.48-0.48) 1 (1-1) 0.5 (0.5-0.5) Purdie 132 0 (0-0) 0 (0-0) 0.01 (0.01-0.01) 142 (142-142) -0.1 (-0.1-0.1) Lounds 34 0 (0-0) 0 (0-0) 0.03 (0.03-0.03) 14 (14-141) -0.1 (-0.1-0.1)	B4	2	0 (0-0)	0 (0-0)	0.48 (0.48-0.48)	1 (1-1)	0.5 (0.5-0.5)
B2 5 0 (0-0) 0 (0-0) 0.37 (0.37-0.37) 1 (1-1) 0.7 (0.7-0.7) B1 15 0 (0-0) 0 (0-0) 0.13 (0.13-0.13) 1 (1-1) 0.4 (0.4-0.4) NR W 12 0 (0-0) 0 (0-0) 0.23 (0.23-0.23) 1 (1-1) 0.9 (0.9-0.9) NR E 3 0 (0-0) 0 (0-0) 0.48 (0.48-0.48) 1 (1-1) 0.5 (0.5-0.5) Pt Fowler 1 0 (0-0) 0 (0-0) 0.48 (0.48-0.48) 1 (1-1) 0.5 (0.5-0.5) Purdie 132 0 (0-0) 0 (0-0) 0 (0-0) 145 (145-145) 0 (0-0) West 56 0 (0-0) 0 (0-0) 0.01 (0.01-0.01) 142 (142-142) -0.1 (-0.10.1) Lounds 34 0 (0-0) 0 (0-0) 0.03 (0.03-0.03) 14 (14-14) -0.1 (-0.10.1) Bivater 17 0 (0-0) 0 (0-0) 0.03 (0.36-0.36) 1 (1-1) 0.8 (0.8-0.8) Bilefuscu 84 0 (0-0) 0 (0-0) 0 (0-0) 141 (141-141) 0 (0-0) Olive	B3	31	0 (0-0)	0 (0-0)	0.02 (0.02-0.02)	13 (13-13)	-2.9 (-2.92.9)
B1 15 0 (0-0) 0 (0-0) 0.13 (0.13-0.13) 1 (1-1) 0.4 (0.4-0.4) NR W 12 0 (0-0) 0 (0-0) 0.23 (0.23-0.23) 1 (1-1) 0.9 (0.9-0.9) NR E 3 0 (0-0) 0 (0-0) 0.48 (0.48-0.48) 1 (1-1) 0.5 (0.5-0.5) Pt Fowler 1 0 (0-0) 0 (0-0) 0.48 (0.48-0.48) 1 (1-1) 0.5 (0.5-0.5) Purdie 132 0 (0-0) 0 (0-0) 0 (0-0) 145 (145-145) 0 (0-0) West 56 0 (0-0) 0 (0-0) 0.01 (0.01-0.01) 142 (142-142) -0.1 (-0.10.1) Lounds 34 0 (0-0) 0 (0-0) 0.03 (0.03-0.03) 14 (14-14) -0.1 (-0.10.1) B'water 17 0 (0-0) 0 (0-0) 0.01 (0.1-0.1) 2 (2-2) 0.3 (0.3-0.3) Gliddon 7 0 (0-0) 0 (0-0) 0 (0-0) 141 (141-141) 0 (0-0) Liliput 67 0 (0-0) 0 (0-0) 0 (0-0) 141 (141-141) 0 (0-0) Dive	B2	5	0 (0-0)	0 (0-0)	0.37 (0.37-0.37)	1 (1-1)	0.7 (0.7-0.7)
NR W 12 0 (0-0) 0 (0-0) 0.23 (0.23-0.23) 1 (1-1) 0.9 (0.9-0.9) NR E 3 0 (0-0) 0 (0-0) 0.48 (0.48-0.48) 1 (1-1) 0.5 (0.5-0.5) Pt Fowler 1 0 (0-0) 0 (0-0) 0.48 (0.48-0.48) 1 (1-1) 0.5 (0.5-0.5) Purdie 132 0 (0-0) 0 (0-0) 0 (0-0) 145 (145-145) 0 (0-0) West 56 0 (0-0) 0 (0-0) 0.01 (0.01-0.01) 142 (142-142) -0.1 (-0.1-0.1) Lounds 34 0 (0-0) 0 (0-0) 0.02 (0.02-0.02) 41 (41-41) -0.1 (-0.1-0.1) B'water 17 0 (0-0) 0 (0-0) 0.03 (0.03-0.03) 14 (14-14) -0.1 (-0.1-0.1) B'water 17 0 (0-0) 0 (0-0) 0.1 (0.1-0.1) 2 (2-2) 0.3 (0.3-0.3) Gliddon 7 0 (0-0) 0 (0-0) 0.36 (0.36-0.36) 1 (1-1) 0.8 (0.8-0.8) Blefuscu 84 0 (0-0) 0 (0-0) 0 (0-0) 141 (141-141) 0 (0-0)	B1	15	0 (0-0)	0 (0-0)	0.13 (0.13-0.13)	1 (1-1)	0.4 (0.4-0.4)
NR E30 (0-0)0 (0-0)0.48 (0.48-0.48)1 (1-1)0.5 (0.5-0.5)Pt Fowler10 (0-0)0 (0-0)0 (0-0)0.48 (0.48-0.48)1 (1-1)0.5 (0.5-0.5)Purdie1320 (0-0)0 (0-0)0 (0-0)145 (145-145)0 (0-0)West560 (0-0)0 (0-0)0.01 (0.01-0.01)142 (142-142)-0.1 (-0.10.1)Fenelon400 (0-0)0 (0-0)0.02 (0.02-0.02)41 (41-41)-0.1 (-0.10.1)Lounds340 (0-0)0 (0-0)0.03 (0.03-0.03)14 (14-14)-0.1 (-0.10.1)B'water170 (0-0)0 (0-0)0.36 (0.36-0.36)1 (1-1)0.8 (0.8-0.8)Blefuscu840 (0-0)0 (0-0)0 (0-0)141 (141-141)0 (0-0)Lilliput670 (0-0)0 (0-0)0 (0-0)145 (145-145)0 (0-0)Olive2060 (0-0)0 (0-0)0 (0-0)141 (141-141)0 (0-0)N Baudin980 (0-0)0 (0-0)0 (0-0)141 (142-141)0 (0-0)Jones150 (0-0)0 (0-0)0.38 (0.38-0.38)1 (1-1)0.4 (0.4-0.4)Dorothee10 (0-0)0 (0-0)0.48 (0.48-0.48)1 (1-1)0.5 (0.5-0.5)Pearson350 (0-0)0 (0-0)0.02 (0.02-0.02)18 (18-18)-0.1 (-0.1-0.1)	NR W	12	0 (0-0)	0 (0-0)	0.23 (0.23-0.23)	1 (1-1)	0.9 (0.9-0.9)
Pt Fowler 1 0 (0-0) 0 (0-0) 0 (48 (0.48-0.48) 1 (1-1) 0.5 (0.5-0.5) Purdie 132 0 (0-0) 0 (0-0) 0 (0-0) 145 (145-145) 0 (0-0) West 56 0 (0-0) 0 (0-0) 0 (0-0) 142 (142-142) -0.1 (-0.10.1) Fenelon 40 0 (0-0) 0 (0-0) 0.02 (0.02-0.02) 41 (41-41) -0.1 (-0.10.1) Lounds 34 0 (0-0) 0 (0-0) 0.03 (0.03-0.03) 14 (14-14) -0.1 (-0.10.1) B'water 17 0 (0-0) 0 (0-0) 0.1 (0.1-0.1) 2 (2-2) 0.3 (0.3-0.3) Gliddon 7 0 (0-0) 0 (0-0) 0.36 (0.36-0.36) 1 (1-1) 0.8 (0.8-0.8) Blefuscu 84 0 (0-0) 0 (0-0) 0 (0-0) 141 (141-141) 0 (0-0) Lilliput 67 0 (0-0) 0 (0-0) 0 (0-0) 141 (141-141) 0 (0-0) View 206 0 (0-0) 0 (0-0) 0 (0-0) 141 (141-141) 0 (0-0) N Baudin	NR E	3	0 (0-0)	0 (0-0)	0.48 (0.48-0.48)	1 (1-1)	0.5 (0.5-0.5)
Purdie 132 0 (0-0) 0 (0-0) 0 (0-0) 145 (145-145) 0 (0-0) West 56 0 (0-0) 0 (0-0) 0 (0-0) 0.01 (0.01-0.01) 142 (142-142) -0.1 (-0.10.1) Fenelon 40 0 (0-0) 0 (0-0) 0.02 (0.02-0.02) 41 (41-41) -0.1 (-0.10.1) Lounds 34 0 (0-0) 0 (0-0) 0.03 (0.03-0.03) 14 (14-14) -0.1 (-0.10.1) B'water 17 0 (0-0) 0 (0-0) 0.1 (0.1-0.1) 2 (2-2) 0.3 (0.3-0.3) Gliddon 7 0 (0-0) 0 (0-0) 0.1 (0.1-0.1) 2 (2-2) 0.3 (0.3-0.3) Blefuscu 84 0 (0-0) 0 (0-0) 0.36 (0.36-0.36) 1 (1-1) 0.8 (0.8-0.8) Blefuscu 84 0 (0-0) 0 (0-0) 0 (0-0) 141 (141-141) 0 (0-0) Olive 206 0 (0-0) 0 (0-0) 0 (0-0) 141 (141-141) 0 (0-0) N Baudin 98 0 (0-0) 0 (0-0) 0 (0-0) 141 (142-141) 0 (0-0)	Pt Fowler	1	0 (0-0)	0 (0-0)	0.48 (0.48-0.48)	1 (1-1)	0.5 (0.5-0.5)
West560 (0-0)0 (0-0)0.01 (0.01-0.01)142 (142-142)-0.1 (-0.1-0.1)Fenelon400 (0-0)0 (0-0)0.02 (0.02-0.02)41 (41-41)-0.1 (-0.10.1)Lounds340 (0-0)0 (0-0)0.03 (0.03-0.03)14 (14-14)-0.1 (-0.10.1)B'water170 (0-0)0 (0-0)0.1 (0.1-0.1)2 (2-2)0.3 (0.3-0.3)Gliddon70 (0-0)0 (0-0)0.36 (0.36-0.36)1 (1-1)0.8 (0.8-0.8)Blefuscu840 (0-0)0 (0-0)0 (0-0)141 (141-141)0 (0-0)Lilliput670 (0-0)0 (0-0)0 (0-0)145 (145-145)0 (0-0)Olive2060 (0-0)0 (0-0)0 (0-0)141 (142-141)0 (0-0)N Baudin980 (0-0)0 (0-0)0 (0-0)141 (142-141)0 (0-0)Jones150 (0-0)0 (0-0)0.38 (0.38-0.38)1 (1-1)0.4 (0.4-0.4)Dorothee10 (0-0)0 (0-0)0 (0-0)0.48 (0.48-0.48)1 (1-1)0.5 (0.5-0.5)Pearson350 (0-0)0 (0-0)0.02 (0.02-0.02)18 (18-18)-0.1 (-0.10.1)	Purdie	132	0 (0-0)	0 (0-0)	0 (0-0)	145 (145-145)	0 (0-0)
Fenelon400 (0-0)0 (0-0)0 (0-0)0.02 (0.02-0.02)41 (41-41) -0.1 (-0.10.1)Lounds340 (0-0)0 (0-0)0.03 (0.03-0.03)14 (14-14) -0.1 (-0.10.1)B'water170 (0-0)0 (0-0)0.1 (0.1-0.1)2 (2-2)0.3 (0.3-0.3)Gliddon70 (0-0)0 (0-0)0.36 (0.36-0.36)1 (1-1)0.8 (0.8-0.8)Blefuscu840 (0-0)0 (0-0)0 (0-0)141 (141-141)0 (0-0)Lilliput670 (0-0)0 (0-0)0 (0-0)141 (141-141)0 (0-0)Olive2060 (0-0)0 (0-0)0 (0-0)145 (145-145)0 (0-0)N Baudin980 (0-0)0 (0-0)0 (0-0)141 (142-141)0 (0-0)Jones150 (0-0)0 (0-0)0.38 (0.38-0.38)1 (1-1)0.4 (0.4-0.4)Dorothee10 (0-0)0 (0-0)0.48 (0.48-0.48)1 (1-1)0.5 (0.5-0.5)Pearson350 (0-0)0 (0-0)0.02 (0.02-0.02)18 (18-18)-0.1 (-0.10.1)	West	56	0 (0-0)	0 (0-0)	0.01 (0.01-0.01)	142 (142-142)	-0.1 (-0.10.1)
Lounds340 (0-0)0 (0-0)0.03 (0.03-0.03)14 (14-14) -0.1 (-0.10.1)B'water170 (0-0)0 (0-0)0.1 (0.1-0.1)2 (2-2)0.3 (0.3-0.3)Gliddon70 (0-0)0 (0-0)0.36 (0.36-0.36)1 (1-1)0.8 (0.8-0.8)Blefuscu840 (0-0)0 (0-0)0 (0-0)141 (141-141)0 (0-0)Lilliput670 (0-0)0 (0-0)0 (0-0)141 (141-141)0 (0-0)Olive2060 (0-0)0 (0-0)0 (0-0)145 (145-145)0 (0-0)N Baudin980 (0-0)0 (0-0)0 (0-0)141 (142-141)0 (0-0)Pt Labatt60 (0-0)0 (0-0)0.38 (0.38-0.38)1 (1-1)0.4 (0.4-0.4)Dorothee10 (0-0)0 (0-0)0.48 (0.48-0.48)1 (1-1)0.5 (0.5-0.5)Pearson350 (0-0)0 (0-0)0.02 (0.02-0.02)18 (18-18)-0.1 (-0.10.1)	Fenelon	40	0 (0-0)	0 (0-0)	0.02 (0.02-0.02)	41 (41-41)	-0.1 (-0.10.1)
B'water 17 0 (0-0) 0 (0-0) 0.1 (0.1-0.1) 2 (2-2) 0.3 (0.3-0.3) Gliddon 7 0 (0-0) 0 (0-0) 0.36 (0.36-0.36) 1 (1-1) 0.8 (0.8-0.8) Blefuscu 84 0 (0-0) 0 (0-0) 0 (0-0) 141 (141-141) 0 (0-0) Lilliput 67 0 (0-0) 0 (0-0) 0 (0-0) 145 (145-145) 0 (0-0) Olive 206 0 (0-0) 0 (0-0) 0 (0-0) 141 (142-141) 0 (0-0) N Baudin 98 0 (0-0) 0 (0-0) 0 (0-0) 141 (142-141) 0 (0-0) Pt Labatt 6 0 (0-0) 0 (0-0) 0 (0-0) 141 (142-141) 0 (0-0) Jones 15 0 (0-0) 0 (0-0) 0 (0-0) 141 (142-141) 0 (0-0) Jones 15 0 (0-0) 0 (0-0) 0 (0-0) 141 (142-141) 0 (0-0) Jones 15 0 (0-0) 0 (0-0) 0.38 (0.38-0.38) 1 (1-1) 0.4 (0.4-0.4) Dorothee 1 0 (0-0)<	Lounds	34	0 (0-0)	0 (0-0)	0.03 (0.03-0.03)	14 (14-14)	-0.1 (-0.10.1)
Gliddon 7 0 (0-0) 0 (0-0) 0.36 (0.36-0.36) 1 (1-1) 0.8 (0.8-0.8) Blefuscu 84 0 (0-0) 0 (0-0) 0 (0-0) 141 (141-141) 0 (0-0) Lilliput 67 0 (0-0) 0 (0-0) 0 (0-0) 141 (141-141) 0 (0-0) Olive 206 0 (0-0) 0 (0-0) 0 (0-0) 145 (145-145) 0 (0-0) N Baudin 98 0 (0-0) 0 (0-0) 0 (0-0) 141 (142-141) 0 (0-0) Pt Labatt 6 0 (0-0) 0 (0-0) 0 (0-0) 141 (142-141) 0 (0-0) Jones 15 0 (0-0) 0 (0-0) 0 (0-0) 141 (142-141) 0 (0-0) Jones 15 0 (0-0) 0 (0-0) 0.38 (0.38-0.38) 1 (1-1) 0.4 (0.4-0.4) Dorothee 1 0 (0-0) 0 (0-0) 0.13 (0.13-0.13) 1 (1-1) 0.5 (0.5-0.5) Pearson 35 0 (0-0) 0 (0-0) 0.02 (0.02-0.02) 18 (18-18) -0.1 (-0.10.1)	B'water	17	0 (0-0)	0 (0-0)	0.1 (0.1-0.1)	2 (2-2)	0.3 (0.3-0.3)
Blefuscu 84 0 (0-0) 0 (0-0) 0 (0-0) 141 (141-141) 0 (0-0) Lilliput 67 0 (0-0) 0 (0-0) 0 (0-0) 141 (141-141) 0 (0-0) Olive 206 0 (0-0) 0 (0-0) 0 (0-0) 145 (145-145) 0 (0-0) N Baudin 98 0 (0-0) 0 (0-0) 0 (0-0) 141 (142-141) 0 (0-0) Pt Labatt 6 0 (0-0) 0 (0-0) 0 (0-0) 141 (142-141) 0 (0-0) Jones 15 0 (0-0) 0 (0-0) 0 (0-0) 141 (141-141) 0 (0-0) Jones 15 0 (0-0) 0 (0-0) 0 (0-0) 141 (142-141) 0 (0-0) Jones 15 0 (0-0) 0 (0-0) 0.38 (0.38-0.38) 1 (1-1) 0.4 (0.4-0.4) Dorothee 1 0 (0-0) 0 (0-0) 0.48 (0.48-0.48) 1 (1-1) 0.5 (0.5-0.5) Pearson 35 0 (0-0) 0 (0-0) 0.02 (0.02-0.02) 18 (18-18) -0.1 (-0.10.1)	Gliddon	7	0 (0-0)	0 (0-0)	0.36 (0.36-0.36)	1 (1-1)	0.8 (0.8-0.8)
Lilliput 67 0 (0-0) 0 (0-0) 0 (0-0) 141 (141-141) 0 (0-0) Olive 206 0 (0-0) 0 (0-0) 0 (0-0) 145 (145-145) 0 (0-0) N Baudin 98 0 (0-0) 0 (0-0) 0 (0-0) 141 (142-141) 0 (0-0) Pt Labatt 6 0 (0-0) 0 (0-0) 0 (0-0) 141 (142-141) 0 (0-0) Jones 15 0 (0-0) 0 (0-0) 0 (0-0) 0.38 (0.38-0.38) 1 (1-1) 0.4 (0.4-0.4) Dorothee 1 0 (0-0) 0 (0-0) 0.48 (0.48-0.48) 1 (1-1) 0.5 (0.5-0.5) Pearson 35 0 (0-0) 0 (0-0) 0.02 (0.02-0.02) 18 (18-18) -0.1 (-0.10.1)	Blefuscu	84	0 (0-0)	0 (0-0)	0 (0-0)	141 (141-141)	0 (0-0)
Olive 206 0 (0-0) 0 (0-0) 0 (0-0) 145 (145-145) 0 (0-0) N Baudin 98 0 (0-0) 0 (0-0) 0 (0-0) 141 (142-141) 0 (0-0) Pt Labatt 6 0 (0-0) 0 (0-0) 0.38 (0.38-0.38) 1 (1-1) 0 (0-0) Jones 15 0 (0-0) 0 (0-0) 0.48 (0.48-0.48) 1 (1-1) 0.4 (0.4-0.4) Dorothee 1 0 (0-0) 0 (0-0) 0.02 (0.02-0.02) 18 (18-18) -0.1 (-0.10.1)	Lilliput	67	0 (0-0)	0 (0-0)	0 (0-0)	141 (141-141)	0 (0-0)
N Baudin 98 0 (0-0) 0 (0-0) 0 (0-0) 141 (142-141) 0 (0-0) Pt Labatt 6 0 (0-0) 0 (0-0) 0.38 (0.38-0.38) 1 (1-1) 0 (0-0) Jones 15 0 (0-0) 0 (0-0) 0.13 (0.13-0.13) 1 (1-1) 0.4 (0.4-0.4) Dorothee 1 0 (0-0) 0 (0-0) 0.48 (0.48-0.48) 1 (1-1) 0.5 (0.5-0.5) Pearson 35 0 (0-0) 0 (0-0) 0.02 (0.02-0.02) 18 (18-18) -0.1 (-0.10.1)	Olive	206	0 (0-0)	0 (0-0)	0 (0-0)	145 (145-145)	0 (0-0)
Pt Labatt 6 0 (0-0) 0 (0-0) 0.38 (0.38-0.38) 1 (1-1) 0 (0-0) Jones 15 0 (0-0) 0 (0-0) 0.13 (0.13-0.13) 1 (1-1) 0.4 (0.4-0.4) Dorothee 1 0 (0-0) 0 (0-0) 0.48 (0.48-0.48) 1 (1-1) 0.5 (0.5-0.5) Pearson 35 0 (0-0) 0 (0-0) 0.22 (0.02-0.02) 18 (18-18) -0.1 (-0.10.1)	N Baudin	98	0 (0-0)	0 (0-0)	0 (0-0)	141 (142-141)	0 (0-0)
Jones 15 0 (0-0) 0 (0-0) 0.13 (0.13-0.13) 1 (1-1) 0.4 (0.4-0.4) Dorothee 1 0 (0-0) 0 (0-0) 0.48 (0.48-0.48) 1 (1-1) 0.5 (0.5-0.5) Pearson 35 0 (0-0) 0 (0-0) 0.02 (0.02-0.02) 18 (18-18) -0.1 (-0.10.1)	Pt Labatt	6	0 (0-0)	0 (0-0)	0.38 (0.38-0.38)	1 (1-1)	0 (0-0)
Dorothee 1 0 (0-0) 0 (0-0) 0.48 (0.48-0.48) 1 (1-1) 0.5 (0.5-0.5) Pearson 35 0 (0-0) 0 (0-0) 0.02 (0.02-0.02) 18 (18-18) -0.1 (-0.10.1)	Jones	15	0 (0-0)	0 (0-0)	0.13 (0.13-0.13)	1 (1-1)	04(04-04)
Pearson 35 0 (0-0) 0 (0-0) 0.02 (0.02-0.02) 18 (18-18) -0.1 (-0.10.1) Word 45 0 (0 0) 0 (0 0) 0 (0 0) 0 (10	Dorothee	1	0 (0-0)	0 (0-0)	0.48 (0.48-0.48)	1 (1-1)	0.5 (0.5-0.5)
	Pearson	35	0 (0-0)	0 (0-0)	0.02 (0.02-0.02)	18 (18-18)	-0 1 (-0 10 1)
v_{1} vv arg 45 U_{1} U_{1} U_{2} U_{1} U_{2} $U_$	Ward	45	0 (0-0)	0 (0-0)	0.02 (0.02 0.02)	126 (127-126)	-0.1 (-0.10.1)
Waldegrave 157 0 (0-0) 0 (0-0) 0 (0-0) 145 (145-145) -0.1 (-0.1-0.1)	Waldegrave	157	0 (0-0)	0 (0-0)	0 (0-0)	145 (145-145)	-0.1 (-0.10.1)
Four Hummocks 12 $0 (0-0)$ $0 (0-0)$ $0 (23 (0 23 - 0.23))$ $1 (1-1)$ $0.9 (0.9 - 0.9)$	Four Hummocks	12	0 (0-0)	0 (0-0)	0 23 (0 23-0 23)	1 (1-1)	0 9 (0 9-0 9)
Rocky North 16 $0 (0-0)$ $0 (0-0)$ $0 (2 - 0)$ $1 (1 - 1)$ $0 (3 (0 3 - 0 3))$	Rocky North	16	0 (0-0)	0 (0-0)	0.12 (0.12-0.12)	1 (1-1)	0.3 (0.3-0.3)
Price 25 0 (0-0) <t< td=""><td>Price</td><td>25</td><td>0 (0-0)</td><td>0 (0-0)</td><td>0.12(0.120.12) 0.04(0.04-0.04)</td><td>3 (3-3)</td><td>0.1 (0.1-0.1)</td></t<>	Price	25	0 (0-0)	0 (0-0)	0.12(0.120.12) 0.04(0.04-0.04)	3 (3-3)	0.1 (0.1-0.1)
Liquanea 43 $0(0-0.1)$ $0.1(0-0.1)$ $0.01(0.01-0.01)$ $90(91-89)$ $-0.2(-0.2-0.1)$	Liquanea	43	0 (0-0 1)	0 1 (0-0 1)	0.01 (0.01-0.01)	90 (91-89)	-0.2 (-0.20.1)
Lewis 131 $0(0-0)$ $0(0-0)$ $0(0-0)$ $145(145-145)$ $0(0-0)$	Lewis	131	0 (0-0)	0 (0-0)	0 (0-0)	145 (145-145)	0 (0-0)
East Island 14 0 (0-0) 0 (100) 0 (100) 1 (1-1) 0 4 (0 4-0 4)	East Island	14	0 (0-0)	0 (0-0)	0 15 (0 15-0 15)	1 (1-1)	04(04-04)
South Neptune 6 $0(0-0)$ $0(0-0)$ $0.38(0.38-0.38)$ $1(1-1)$ $0(0-0)$	South Neptune	6	0 (0-0)	0 (0-0)	0.38 (0.38-0.38)	1 (1-1)	0 (0-0)
Albetross 15 $0 (0-0)$ $0 (0-0)$ $0 (13 (0 13 - 0 13))$ $1 (1-1)$ $0 4 (0 4 - 0 4)$	Albatross	15	0 (0-0)	0 (0-0)	0.13 (0.13-0.13)	1 (1-1)	04(04-04)
Final locs 0	Fnalish	27	0 (0-0)	0 (0-0)	0.03 (0.03-0.03)	5 (5-5)	0.1 (0.1-0.1)
Dangerous 709 $0(0-0)$ $0(0-0)$ $0(0-0)$ $145(145-145)$ $0(0-0)$	Dangerous	709	0 (0-0)	0 (0-0)	0 (0-0)	145 (145-145)	0 (0-0)
North Islet 28 $0(0-0)$ $0(0-0)$ $0(0-0)$ $0(0-0)$ $0(0-0)$ $0(0-0)$ $0(0-0)$	North Islet	28	0 (0-0)	0 (0-0)	0.03 (0.03-0.03)	5 (5-5)	0 1 (0 1-0 1)
Peaked Rocks 24 0 (0-0) 0 (0-0) 0 (0.05 (0.05 0.05) 2 (2-2) 0 (0-0)	Peaked Rocks	24	0 (0-0)	0 (0-0)	0.05 (0.05-0.05)	2 (2-2)	0 (0-0)
N Casuarina 3 0 (0-0) 0 (0 0) 0.00 (0.00 0.00) 2 (2 2) 0 (0 0)	N Casuarina	27	0 (0-0)	0 (0-0)	0.48 (0.48-0.48)	2 (2 2) 1 (1-1)	0 5 (0 5-0 5)
Cape Bouquer 3 $0(0-0)$ $0(0-0)$ $0(48(0.48-0.48)$ $1(1-1)$ $0.5(0.5-0.5)$	Cape Bouquer	3	0 (0-0)	0 (0-0)	0.48 (0.48-0.48)	1 (1-1)	0.5 (0.5-0.5)
Cave Point 3 $0(0-0)$ $0(0-0)$ $0(48(0.48-0.48)$ $1(1-1)$ $0.5(0.5-0.5)$	Cave Point	3	0 (0-0)	0 (0-0)	0.48 (0.48-0.48)	1 (1-1)	0.5 (0.5-0.5)
Seal Bay 260 $0(0-0)$ $0(0-0)$ $0(0-0)$ $0(0-0)$ $145(145-145)$ $0(0-0)$	Seal Bay	260	0 (0-0)	0 (0-0)	0+.0-0+.0)	145(145-145)	0.0 (0.0-0.0)
Black Point 1 $0(0-0)$ $0(0-0)$ $0(0-0)$ $0(0-0)$ $143(1+3)$ $0(0-0)$ $0(0-0)$	Black Point	1	0 (0-0)	0 (0-0)	0.48 (0.48-0.48)	1 (1-1)	0 5 (0 5-0 5)
Seal Slide 16 $0(0-0)$ $0(0-01)$ $0(12 - 0(12-0))$ $1(1-1)$ $0(2(0.2-0.3))$	Seal Slide	16	0 (0-0)	0 (0-0)	0 12 (0 12-0 12)	1 (1-1)	0.2 (0.2-0.3)
SPage 331 3 (2 3-4 1) $0.6 (0.4-0.8)$ $0.(0-0)$ 138 (145-134) $-0.6 (-0.7-0.4)$	SPage	331	3 (2 3-4 1)	0 (0-0.1)	0.12 (0.12 ⁰ 0.12) 0 (0_0)	138 (145-134)	-0.6 (-0.70.4)
NPage 258 $2.2 (1.6-3)$ $0.5 (0.4-0.7)$ $0.0 (0.7-0.4)$	NPage	258	2 2 (1 6-3)	0.5 (0.4-0.7)	0 (0-0)	145 (145-145)	-0.5 (-0.60.3)
Mean 3107 $5(4-7)$ $0.0(0.4, 0.7)$ $0.6(0.5, 0.7)$ $0.6(0.5, 0.7)$	Mean	3107	5 (4-7)	0.0 (0.4 0.17)	0 16 (0 16-0 16)	46 (46-46)	0.1 (0.1-0.1)
% of subpops. 50 (50-50) 67 (65-65) 38 (38-38)	% of subpops.	0.07	0(11)	0 (0 0)	50 (50-50)	67 (65-65)	38 (38-38)

Table 8.27. Subpopulation estimates of female bycatch, and percentage of females removed as bycatch mortality per breeding cycle. Terminal Extinction Risk (TER), Quasi-extinction Time (QET, and estimated growth rate over the next 20 breeding cycles (% per 17.5 months) are also given assuming an underlying stable intrinsic growth rate. \pm 95 CL are given in parentheses. The current estimated pup production per subpopulation is also shown. The table presents estimates based on the current distribution of the GHAT fishery off South Australia (100,000 km.hrs/yr), with removal of 0-120km minimum distance from ASL subpopulations (no displaced effort). The % of subpopulations with TERs >0.1, QETs < 3 generations (33.3 yrs) and negative growth rates are given on the last line of the table.

Subpop	Pup prod	Female bycatch	% females/sub	TER	QET	Growth rate
B9	17	0 (0-0)	0 (0-0)	0.1 (0.1-0.1)	2 (2-2)	0.3 (0.3-0.3)
B8	38	0 (0-0)	0 (0-0)	0.01 (0.01-0.01)	36 (36-36)	-0.1 (-0.10.1)
B7	3	0 (0-0)	0 (0-0)	0.48 (0.48-0.48)	1 (1-1)	0.5 (0.5-0.5)
B6	12	0 (0-0)	0 (0-0)	0.23 (0.23-0.23)	1 (1-1)	0.9 (0.9-0.9)
B5	43	0 (0-0)	0 (0-0)	0.01 (0.01-0.01)	94 (94-94)	-0.1 (-0.10.1)
B4	2	0 (0-0)	0 (0-0)	0.48 (0.48-0.48)	1 (1-1)	0.5 (0.5-0.5)
B3	31	0 (0-0)	0 (0-0)	0.02 (0.02-0.02)	13 (13-13)	-2.9 (-2.92.9)
B2	5	0 (0-0)	0 (0-0)	0.37 (0.37-0.37)	1 (1-1)	0.7 (0.7-0.7)
B1	15	0 (0-0)	0 (0-0)	0.13 (0.13-0.13)	1 (1-1)	0.4 (0.4-0.4)
NR W	12	0 (0-0)	0 (0-0)	0.23 (0.23-0.23)	1 (1-1)	0.9 (0.9-0.9)
NR E	3	0 (0-0)	0 (0-0)	0.48 (0.48-0.48)	1 (1-1)	0.5 (0.5-0.5)
Pt Fowler	1	0 (0-0)	0 (0-0)	0.48 (0.48-0.48)	1 (1-1)	0.5 (0.5-0.5)
Purdie	132	0 (0-0)	0 (0-0)	0 (0-0)	145 (145-145)	0 (0-0)
West	56	0 (0-0)	0 (0-0)	0.01 (0.01-0.01)	142 (142-142)	-0.1 (-0.10.1)
Fenelon	40	0 (0-0)	0 (0-0)	0.02 (0.02-0.02)	41 (41-41)	-0.1 (-0.10.1)
Lounds	34	0 (0-0)	0 (0-0)	0.03 (0.03-0.03)	14 (14-14)	-0.1 (-0.10.1)
B'water	17	0 (0-0)	0 (0-0)	0.1 (0.1-0.1)	2 (2-2)	0.3 (0.3-0.3)
Gliddon	7	0 (0-0)	0 (0-0)	0.36 (0.36-0.36)	1 (1-1)	0.8 (0.8-0.8)
Blefuscu	84	0 (0-0)	0 (0-0)	0 (0-0)	141 (141-141)	0 (0-0)
Lilliput	67	0 (0-0)	0 (0-0)	0 (0-0)	141 (141-141)	0 (0-0)
Olive	206	0 (0-0)	0 (0-0)	0 (0-0)	145 (145-145)	0 (0-0)
N Baudin	.98	0 (0-0)	0 (0-0)	0 (0-0)	145 (145-145)	0 (0-0)
Pt Labatt	6	0 (0-0)	0 (0-0)	0.38 (0.38-0.38)	1 (1-1)	0 (0-0)
Jones	15	0 (0-0)	0 (0-0)	0.13 (0.13-0.13)	1 (1-1)	0.4(0.4-0.4)
Dorothee	1	0 (0-0)	0 (0-0)	0 48 (0 48-0 48)	1 (1-1)	0.5 (0.5-0.5)
Pearson	35	0 (0-0)	0 (0-0)	0.02 (0.02-0.02)	18 (18-18)	-0.1 (-0.10.1)
Ward	45	0 (0-0)	0 (0-0)	0.02 (0.02 0.02)	128 (128-127)	-0.1 (-0.10.1)
Waldegrave	157	0 (0-0)	0 (0-0)	0 (0-0)	145 (145-145)	-0.1 (-0.10.1)
Four Hummocks	12	0 (0-0)	0 (0-0)	0 23 (0 23-0 23)	1 (1-1)	0 9 (0 9-0 9)
Rocky North	16	0 (0-0)	0 (0-0)	0.12 (0.12-0.12)	1 (1-1)	0.3 (0.3-0.3)
Price	25	0 (0-0)	0 (0-0)	0.12(0.120.12) 0.04(0.04-0.04)	3 (3-3)	0.1 (0.1-0.1)
Liquanea	43	0 (0-0)	0 (0-0)	0.01 (0.01-0.01)	93 (93-93)	-0.1 (-0.10.1)
Lewis	131	0 (0-0)	0 (0-0)	0.01 (0.01 0.01)	145 (145-145)	0 (0-0)
Fast Island	14	0 (0-0)	0 (0-0)	0 15 (0 15-0 15)	1 (1-1)	04(04-04)
South Nentune	6	0 (0-0)	0 (0-0)	0.38 (0.38-0.38)	1 (1-1)	0 (0-0)
Albatross	15	0 (0-0)	0 (0-0)	0.13 (0.13-0.13)	1 (1-1)	04(04-04)
Fnalish	27	0 (0-0)	0 (0-0)	0.03 (0.03-0.03)	5 (5-5)	0.1 (0.1-0.1)
Dangerous	709	0 (0-0)	0 (0-0)	0.00 (0.00 0.00)	145 (145-145)	0.0-0)
North Islet	28	0 (0-0)	0 (0-0)	0.03 (0.03-0.03)	5 (5-5)	0 1 (0 1-0 1)
Peaked Rocks	24	0 (0-0)	0 (0-0)	0.05 (0.05-0.05)	2 (2-2)	0 (0-0)
N Casuarina	3	0 (0-0)	0 (0-0)	0.48 (0.48-0.48)	2 (2 2) 1 (1-1)	05(05-05)
Cape Bouquer	3	0 (0-0)	0 (0-0)	0.48 (0.48-0.48)	1 (1-1)	0.5 (0.5-0.5)
Cave Point	3	0 (0-0)	0 (0-0)	0.48 (0.48-0.48)	1 (1-1)	0.5 (0.5-0.5)
Seal Bay	260	0 (0-0)	0 (0-0)	0+.0-0+.0)	145 (145-145)	0.0 (0.0-0.0)
Black Point	1	0 (0-0)	0 (0-0)	0 48 (0 48-0 48)	1 (1-1)	05(0505)
Seal Slide	16	0 (0-0)	0 (0-0) 0 (0-0)	0.12 (0.10-0.40)	1 (1-1)	0.3 (0.3-0.3)
SPage	321	0 (0-0)	0(0.0)	0.12 (0.12 ⁻ 0.12) 0 (0_0)	145 (145-145)	-0.1 (-0.20.1)
NPage	258	0.0 (0.4-0.0)	0.1 (0.1-0.1) 0.1 (0.1-0.1)	0 (0-0)	145 (145-145)	-0.1 (-0.20.1)
Mean	3107	1 (1_1)	0.1 (0.1-0.1)	0.16 (0.16-0.16)	46 (46-46)	0.2 (0.2-0.2)
% of subnons	5107	1 (1-1)	0 (0-0)	50 (50-50)	67 (65-65)	35 (35-35)
					0. (00 00)	(00 00)
Table 8.28. Subpopulation estimates of female bycatch, and percentage of females removed as bycatch mortality per breeding cycle. Terminal Extinction Risk (TER), Quasi-extinction Time (QET, and estimated growth rate over the next 20 breeding cycles (% per 17.5 months) are also given assuming an underlying stable intrinsic growth rate. \pm 95 CL are given in parentheses. The current estimated pup production per subpopulation is also shown. The table presents estimates based on the current distribution of the GHAT fishery off South Australia (100,000 km.hrs/yr), with removal of 0-140km minimum distance from ASL subpopulations (no displaced effort). The % of subpopulations with TERs >0.1, QETs < 3 generations (33.3 yrs) and negative growth rates are given on the last line of the table.

Subpop	Pup prod	Female bycatch	% females/sub	TER	QET	Growth rate
B9	17	0 (0-0)	0 (0-0)	0.1 (0.1-0.1)	2 (2-2)	0.3 (0.3-0.3)
B8	38	0 (0-0)	0 (0-0)	0.01 (0.01-0.01)	36 (36-36)	-0.1 (-0.10.1)
B7	3	0 (0-0)	0 (0-0)	0.48 (0.48-0.48)	1 (1-1)	0.5 (0.5-0.5)
B6	12	0 (0-0)	0 (0-0)	0.23 (0.23-0.23)	1 (1-1)	0.9 (0.9-0.9)
B5	43	0 (0-0)	0 (0-0)	0.01 (0.01-0.01)	94 (94-94)	-0.1 (-0.10.1)
B4	2	0 (0-0)	0 (0-0)	0.48 (0.48-0.48)	1 (1-1)	0.5 (0.5-0.5)
B3	31	0 (0-0)	0 (0-0)	0.02 (0.02-0.02)	13 (13-13)	-2.9 (-2.92.9)
B2	5	0 (0-0)	0 (0-0)	0.37 (0.37-0.37)	1 (1-1)	0.7 (0.7-0.7)
B1	15	0 (0-0)	0 (0-0)	0.13 (0.13-0.13)	1 (1-1)	0.4 (0.4-0.4)
NR W	12	0 (0-0)	0 (0-0)	0.23 (0.23-0.23)	1 (1-1)	0.9 (0.9-0.9)
NR E	3	0 (0-0)	0 (0-0)	0.48 (0.48-0.48)	1 (1-1)	0.5 (0.5-0.5)
Pt Fowler	1	0 (0-0)	0 (0-0)	0.48 (0.48-0.48)	1 (1-1)	0.5 (0.5-0.5)
Purdie	132	0 (0-0)	0 (0-0)	0 (0-0)	145 (145-145)	0 (0-0)
West	56	0 (0-0)	0 (0-0)	0.01 (0.01-0.01)	142 (142-142)	-0.1 (-0.10.1)
Fenelon	40	0 (0-0)	0 (0-0)	0.02 (0.02-0.02)	41 (41-41)	-0.1 (-0.10.1)
Lounds	34	0 (0-0)	0 (0-0)	0.03 (0.03-0.03)	14 (14-14)	-0.1 (-0.10.1)
B'water	17	0 (0-0)	0 (0-0)	0.1 (0.1-0.1)	2 (2-2)	0.3 (0.3-0.3)
Gliddon	7	0 (0-0)	0 (0-0)	0.36 (0.36-0.36)	1 (1-1)	0.8 (0.8-0.8)
Blefuscu	84	0 (0-0)	0 (0-0)	0 (0-0)	141 (141-141)	0 (0-0)
Lilliput	67	0 (0-0)	0 (0-0)	0 (0-0)	141 (141-141)	0 (0-0)
Olive	206	0 (0-0)	0 (0-0)	0 (0-0)	145 (145-145)	0 (0-0)
N Baudin	98	0 (0-0)	0 (0-0)	0 (0-0)	145 (145-145)	0 (0-0)
Pt Labatt	6	0 (0-0)	0 (0-0)	0.38 (0.38-0.38)	1 (1-1)	0 (0-0)
Jones	15	0 (0-0)	0 (0-0)	0.13 (0.13-0.13)	1 (1-1)	0.4 (0.4-0.4)
Dorothee	1	0 (0-0)	0 (0-0)	0.48 (0.48-0.48)	1 (1-1)	0.5 (0.5-0.5)
Pearson	35	0 (0-0)	0 (0-0)	0.02 (0.02-0.02)	18 (18-18)	-0.1 (-0.10.1)
Ward	45	0 (0-0)	0 (0-0)	0 (0-0)	128 (128-128)	-0.1 (-0.10.1)
Waldegrave	157	0 (0-0)	0 (0-0)	0 (0-0)	145 (145-145)	-0.1 (-0.10.1)
Four Hummocks	12	0 (0-0)	0 (0-0)	0.23 (0.23-0.23)	1 (1-1)	0.9 (0.9-0.9)
Rocky North	16	0 (0-0)	0 (0-0)	0.12 (0.12-0.12)	1 (1-1)	0.3 (0.3-0.3)
Price	25	0 (0-0)	0 (0-0)	0.04 (0.04-0.04)	3 (3-3)	0.1 (0.1-0.1)
Liguanea	43	0 (0-0)	0 (0-0)	0.01 (0.01-0.01)	94 (94-94)	-0.1 (-0.10.1)
Lewis	131	0 (0-0)	0 (0-0)	0 (0-0)	145 (145-145)	0 (0-0)
East Island	14	0 (0-0)	0 (0-0)	0.15 (0.15-0.15)	1 (1-1)	0.4 (0.4-0.4)
South Neptune	6	0 (0-0)	0 (0-0)	0.38 (0.38-0.38)	1 (1-1)	0 (0-0)
Albatross	15	0 (0-0)	0 (0-0)	0.13 (0.13-0.13)	1 (1-1)	0.4 (0.4-0.4)
English	27	0 (0-0)	0 (0-0)	0.03 (0.03-0.03)	5 (5-5)	0.1 (0.1-0.1)
Dangerous	709	0 (0-0)	0 (0-0)	0 (0-0)	145 (145-145)	0 (0-0)
North Islet	28	0 (0-0)	0 (0-0)	0.03 (0.03-0.03)	5 (5-5)	0.1 (0.1-0.1)
Peaked Rocks	24	0 (0-0)	0 (0-0)	0.05 (0.05-0.05)	2 (2-2)	0 (0-0)
N Casuarina	3	0 (0-0)	0 (0-0)	0.48 (0.48-0.48)	1 (1-1)	0.5 (0.5-0.5)
Cape Bouguer	3	0 (0-0)	0 (0-0)	0.48 (0.48-0.48)	1 (1-1)	0.5 (0.5-0.5)
Cave Point	3	0 (0-0)	0 (0-0)	0.48 (0.48-0.48)	1 (1-1)	0.5 (0.5-0.5)
Seal Bay	260	0 (0-0)	0 (0-0)	0 (0-0)	145 (145-145)	0 (0-0)
Black Point	1	0 (0-0)	0 (0-0)	0.48 (0.48-0.48)	1 (1-1)	0.5 (0.5-0.5)
Seal Slide	16	0 (0-0)	0 (0-0)	0.12 (0.12-0.12)	1 (1-1)	0.3 (0.3-0.3)
SPage	331	0.1 (0.1-0.2)	0 (0-0)	0 (0-0)	145 (145-145)	-0.1 (-0.1-0)
NPage	258	0.1 (0.1-0.1)	0 (0-0)	0 (0-0)	145 (145-145)	0 (0-0)
Mean	3107	0 (0-0)	0 (0-0)	0.16 (0.16-0.16)	46 (46-46)	0.2 (0.2-0.2)
% of subpops.		. ,	. ,	50 (50-50)	67 (65-65)	35 (35-35)



Figure 8.1. Current distribution of the gillnet sector GHAT fishery off South Australia (blue), above, and the scenario with South Australian state waters closed to the fishery, below. The outer limit of the fishery is 183m depth.



Figure 8.2. Fishery closure scenarios in the gillnet sector GHAT fishery off South Australia based on increasing minimum percentage of female ASL core foraging areas closed to the fishery. Area available (in blue) is based on closure scenarios ranging from 10% (top left) to 100% (bottom right). The outer limit of the fishery is 183m depth.



Figure 8.3. Fishery closure scenarios in the gillnet sector GHAT fishery off South Australia based on minimum distances from ASL subpopulations. Six figures range from 20 (top left) to120km (bottom right). The outer limit of the fishery is 183m depth.



Figure 8.4. Fishery closure scenarios in the gillnet sector GHAT fishery off South Australia based on minimum depth ranges, from 20m (top left) to 120m (bottom right). The outer limit of the fishery is 183m depth.



Figure 8.5. Reductions in female ASL bycatch mortality that are estimated to result from spatial management scenarios relating to fishery closures based on female core foraging area (top); minimum depth fished (middle) and minimum distance from a subpopulations fished (bottom). Red and blue lines indicate estimated bycatch reduction where closed fishing effort is removed or displaced, respectively.



Figure 8.6. Effect of three closure scenarios on the gillnet sector of the GHAT fishery aimed at reducing the bycatch of female Australian sea lions, in terms of area lost to the fishery. The closure scenarios are based on female core foraging area, depth and distance. Solid lines indicate where fishery area is removed; dotted lines indicate where it is displaced. The figure demonstrates that management strategies based around core foraging area are most likely to produce the greatest benefit in terms of bycatch reduction with the minimum cost to the fishery.

9 DEVELOP PERFORMANCE INDICATORS TO EVALUATE THE EFFECTIVENESS OF THE DIFFERENT MITIGATION OPTIONS DEVELOPED FOR EACH FISHERY

Performance indicators to evaluate the effectiveness of the different mitigation options are either fishery based or population based. These are discussed separately below.

Fishery based performance measures

Southern rock lobster fishery

If the use of pot spikes to prevent entrapment of Australian sea lions (ASL) is adopted as a management measure in the South Australian rock lobster fishery (SARLF), the effectiveness of that measure should be assessed. At no point in the development of this project was there an aim to assess and measure the incidence of bycatch in the fishery, because rates of bycatch were likely to be low, and would require a large proportion of fishing effort to be monitored. This would have been logistically difficult and expensive. If pot spikes were introduced into the fishery, then bycatch incidence is expected to be even lower, and the observer effort required to provide meaningful measures would be even greater. For the same reasons, there is no independent monitoring and verification of ASL bycatch rates in the WA west coast rock lobster fishery where the use of sea lion exclusion spikes is mandated in parts of the commercial and recreational sectors (Campbell et al. 2008a). Verification is provided indirectly by assessing compliance rates (Campbell et al. 2008a). If pot spikes were to be mandated in parts of the SARLF and the recreational sector, then efforts should be made to ensure correct fitting and specification of spikes, and that compliance rates are high. Further encouragement for fishers to record all ASL interactions, along with other threatened, endangered and protected (TEP) species should be encouraged.

Shark gillnet sector

A clear need following the implementation of management measures to mitigate ASL bycatch in the shark gillnet sector of the GHAT fishery would be to assess if such measures have significantly reduced total ASL bycatch in the fishery. The independent observer study undertaken in this project is the largest that has been conducted in the fishery to

quantitatively assess the incidence of ASL bycatch. This included 234 observed net sets from 146 sea-days over 10 fishing trips, representing about 2.4% of the total fishing effort over the 23 month period of the study. Power analyses of these observer data indicate that an identical repeat survey of the same fishing locations and effort, would only be able to detect a 95% change in bycatch rates with 80% power and P = 0.05 (Figure 9.1). To detect a 20% change in bycatch rates (with 80% power, P= 0.05) would require 5281 net sets to be observed, more than is currently fished off SA each year. Closure of high ASL foraging areas to the fishery may occur as part of management measures to mitigate ASL bycatch. One outcome of restricting the fishery to areas of lower ASL foraging density would be a reduction in statistical power to detect changes in bycatch rates (Figure 9.1). For example to detect a larger (50%) change in bycatch rates (with 80% power, P= 0.05) in low (0-5 seal days/year), medium (5-10 seal days/year) and high (10-70 seal days/year) density foraging areas (bottom days/year), would require 1878, 543, and 168 net sets to be observed (Figure 9.1). AFMA have been experimenting with electronic monitoring methods in the shark gillnet fishery. If these can be demonstrated to reliably detect ASL bycatch in the absence of an observer, this approach may well overcome some of the practical and financial challenges that come with the need for increasing observer coverage in the fishery.

However, as determined in Chapter 8, bycatch rates vary as a function of ASL foraging density. Such relationships should remain unchanged in areas open to the fishery and consequently, the only means by which bycatch rates will decline is as a consequence of population decline (i.e., reduction in overall foraging effort). Conversely, increases in bycatch rates are likely to indicate population growth. As such, the power to detect a change in the bycatch rate is of less importance than determining the actual change in numbers of sea lions caught, and from which subpopulations they originate. The latter points (bycatch numbers and source colonies) are the fundamental performance indicators needed to assess the success of bycatch mitigation measures in the fishery. The methodology to achieve these measures has been developed and described in detail in Chapter 7. They used the best available data to undertake the current assessment of bycatch numbers, but should be improved if they are to be used for ongoing performance indicators in the fishery. This will require improvements to:

- bycatch rate estimation models,
- ASL foraging models, and
- ASL population models.

Recommended improvements in each of these models are detailed below. Bycatch rate estimation models

The independent observer program in the gillnet sector of the GHAT fishery should aim to collect additional data to improve the current bycatch rate estimation models. This would require increasing the number of net-sets observed in low, medium and high ASL foraging effort areas, as well as ensuring better spatial and temporal representation of observer effort across the range of the fishery. Critically, observers will need to be trained to monitor ASL bycatch. This will require observers to monitor the net as it ascends though the upper water column and onto the roller due to the high drop-out rate of ASL (Chapter 8). This is demanding on observers because achieving an unimpeded view of the ascending net requires them to lean out over the gunwale. Historically, the AFMA observer program has conducted Integrated Scientific Monitoring Program (ISMP) trips on fishing vessels, where observers spent every net-haul on the deck measuring every species (and relevant biological information) that came aboard the vessel. Recent improvements to the observer program have been introduced that require observers to alternate between ASL (where observers monitor the net as it ascends out of the water and onto the roller), and ISMP observed net hauls. As part of the WTO interim measures, observer effort has been increased in SA during the 2009/10 season.

Increasing the sample size of ASL focused observed net-hauls that can be used to improve the bycatch rate estimation models should be a priority. Each year, as more observer data are collected, these can be added to the current 234 observations, increasing the robustness and power of the current bycatch rate estimation model. The benefit of estimating bycatch numbers (and not rates) is that it focuses more on the quality of observer effort undertaken, rather the quantity. This should enhance the feasibility of maintaining adequate independent observer program in the fishery.

ASL foraging models

Some of the limitations of the current ASL foraging models have been identified in the Study Limitations section of Chapter 7. Foraging distribution models are central to estimating ASL bycatch and the impacts to individual subpopulations. Improvement to the representativeness of the satellite tracking data sets from which foraging models are based is needed at the subpopulation, age/sex class and individual level. Priority subpopulations will be those assessed to forage within areas remaining open to the fishery. For these, improved representation of the distribution of foraging effort of adult females, adult males and juveniles based on satellite tracking is needed. Stable isotope methods are presently being developed that enable the value-adding of satellite telemetry data sets, and provide a means to assess the representativeness of female foraging data from individual subpopulations (A. Lowther unpublished data). Preliminary data indicate that the stable representativeness of the satellite tracking data.

isotope signatures of pups (~2-3 month of age) reflect those of their mothers, and that inshore and offshore foraging patterns in adult females can be distinguished by their stable isotope signatures. The potential is that by screening the stable isotope signatures of a percentage of a subpopulation's pup production, the proportion females undertaking inshore and offshore foraging trips in the subpopulation can be estimated. With a sample of females satellite tracked, this method can potentially provide a quantitative basis to the

ASL population models

Up to date and comprehensive pup production surveys will be needed to improve estimates of the size of subpopulations and hence models of the distribution of foraging effort. There are many subpopulations which have not been assessed in recent years, and others for which current estimates are based on few observations. The robustness of population estimates would be improved considerably by achieving a state-wide census of all subpopulations within a 2-3 year period. Furthermore, increased information on the demography of ASL populations, based on the long-term demography study being undertaken at Seal Bay (Kangaroo Island), will be critical to improving estimates of age-structure and of total subpopulation abundance.

Population based performance measures

Ultimately, the best measure of the success of different mitigation measures adopted in the SARLF and the shark gillnet sector of the GHAT fishery will be the recovery of the South Australian ASL population. This will require adequate baseline data on the present status of subpopulations and the establishment of a monitoring program that will enable changes in subpopulation sizes to be measured over time. Changes in the size of seal populations are usually assessed by monitoring pup production, because pups represent the only cohort that is easily recognisable (by their natal coat) and ashore at one time (shortly after birth). Methods have been developed that provide accurate measures of pup production in sea lion colonies and improve the capacity to detect trends in abundance over the shortest possible time-series (Goldsworthy et al. 2007b, 2008a, 2008b, 2009b, 2009c). Furthermore, Goldsworthy et al. (2007c) identified a subset of eight SA subpopulations that provided the best opportunity for monitoring trends in pup production by virtue of their accessibility, logistic costs and representativeness. There is, however, no coordination by state or national environment departments of ASL subpopulation monitoring. Lack of ongoing support for such programs has resulted in trend data being available for only three of the 48 subpopulations in SA (Goldsworthy et al. 2009b). The need for the development of a national survey strategy for Australian sea lions to underpin the Recovery Plan process was emphasised by Goldsworthy et al. (2008b). Key aspects of this strategy would be the identification of regionally representative colonies ("key monitoring sites") that can form the basis for ongoing monitoring across the range of the species, agreement on survey methodology and frequency, and strategies to ensure adequate funding is available to support ongoing surveys at key monitoring sites. The implementation of such a strategy will be critical if ASL population recovery becomes a key performance indicator of the effectiveness of mitigation strategies in the SA rock lobster and shark gillnet fisheries. Which subpopulations will be most appropriate as key monitoring sites and performance indicators in the gillnet sector of the GHAT fishery, will depend on the location and size of spatial closures introduced.

Seal Bay is the most intensely studied ASL subpopulation. Pups and some adult females have been micro-chipped over the last 20 years. Since 2002, most pups that survive to 6 months of age have been microchipped (Goldsworthy et al. 2008a). Regular scanning and resighting efforts provide detailed individual survival records, enabling the survival of individuals and cohorts to be accurately monitored (McIntosh 2007, Goldsworthy et al. 2008a). Survival rates of juveniles in the subpopulation are presently low, and pup production has been declining for at least 25 years (Shaughnessy et al. 2006, McIntosh 2007, Goldsworthy et al. 2008a). It is believed that this decline is principally due to fishing bycatch mortality (Goldsworthy & Page 2007, Goldsworthy et al. 2009d). The Seal Bay subpopulation therefore provides an important opportunity to not only assess population recovery, but also to assess the demographic response following the introduction of bycatch mitigation measures. Monitoring changes in cohort and annual survival rates should enable the signs of recovery to be detected much earlier than would be expected from pup production monitoring, as peak recruitment does not occurs until females are between 6 and 9 years of age (McIntosh 2007). Furthermore, there is a baseline of data (pre-introduction of management measures) from which changes in vital demographic rates can be compared. A measured change in survival rates that leads to a recovery of a subpopulation following the introduction of bycatch mitigation measures would provide excellent causal evidence that mitigation measures are actually working, especially after such a long and sustained decline in the subpopulation. This approach will have significantly more power than any series of cross-sectional surveys, and will demonstrate the mechanism of recovery following the introduction of mitigation measures. Because this cannot be directly assessed for any other subpopulation, maintenance and support of the Seal Bay ASL monitoring program into the future is critical.

Performance indicators

It is important to reinforce that the success (or otherwise) of mitigation measures needs to be validated, and is now required as part of Condition 6c of the SESSF WTO. This will require additional resources to supporting ongoing data collection, analyses and modelling. In summary, fisheries and threatened species management agencies should consider adopting the following performance indicators to evaluate the effectiveness of bycatch mitigation measures.

- Monitoring the numbers of ASL bycatch in the shark gillnet fishery, and from which subpopulations they originate
- Monitoring the trends in abundance of key (selected) ASL subpopulations
- Monitoring the demographic response of the Seal Bay subpopulation
- ensuring high compliance to new management measures
- educating and supporting fishers to report all TEP species interactions

All of these will require some additional resources and coordination between government agencies if they are to be used as performance indicators of the effectiveness of ASL bycatch mitigation measures in the SARLF and gillnet sector GHAT fishery.



Figure 9.1. Power analyses indicating the sample size (number of net hauls) required to be observed in the shark gillnet sector of the GHAT fishery in order to detect a percentage change in Australian sea lion bycatch rate. Analyses are based on 234 observed net sets in the fishery (all observer data), and three subsets of these data comparing observations in low (0-5 seal days/y), medium (5-10 seal days/y) and high (10-70 seal days/y) sea lion foraging areas (bottom days/y). Due to the higher bycatch rates in high sea lion foraging effort areas, lower observer effort would be required to detect a given level of change with 80% power at P = 0.05.

10 BENEFITS AND ADOPTION

Sectors of the fishing industry, government and community that will benefit directly from the research include:

- Shark gillnet fishers (in Commonwealth GHAT fishery and SA Marine Scalefish Fishery)
- South Australian commercial rock lobster fishers (especially in the Northern Zone) and recreational rock lobster fishers
- Victorian and Tasmanian commercial and recreational rock lobster fishers
- AFMA SESSF GHAT Fishery and MAC and Shark RAG
- PIRSA Fisheries Rock lobster fishery and Marine Scalefish Fishery managers
- DAFF Sustainable Resource Management Division
- Department of Primary Industries Victoria (PIRVIC)
- Department of Primary Industries, Parks, Water and the Environment (DPIPWE) Tasmania
- DEWHA Sustainable Fisheries Section, Marine Conservation (Temperate West) Section
- SA DEH Conservation Policy and Programs, Coast and Marine Conservation, Seal Bay Conservation Park
- SA eco- tourism industry Tourism Kangaroo Island, Baird Bay Ocean Eco Experience (Swim with sea lions), Adventure Bay Charters (Port Lincoln – Swim with sea lions)
- South Australian Tourism Commission
- NGOs Humane Society International, The Wilderness Society, South Australian Conservation Council.

From an industry perspective, the critical benefits that this research will provide in terms of mitigating fishery interactions with the threatened ASL will be the maintenance of Wildlife Trade Operation (WTO) exemptions under Part 13A of the EPBC Act.

The benefits and beneficiaries identified are similar to those in the original application. The major new beneficiaries identified are the SA eco-tourism industry, especially those that benefit directly from sea lion viewing (e.g., Seal Bay, Kangaroo Island) and swim with sea

lion operators (e.g., at Baird Bay and Port Lincoln). Seal Bay receives about 110,000 visitors each year and underpins a valuable regional tourism industry worth over \$100 million (Goldsworthy et al. 2008a).

Prior to publishing this report, communication of the research results has been restricted to AFMA, DEWHA and DAFF to assist in developing management strategies to mitigate fishery bycatch of ASL. When published, the research will benefit the broader range of stakeholders detailed above.

11 FURTHER DEVELOPMENT

Further development of this research would benefit a number of areas.

In the rock lobster fishery:

- Improvements to pot design to enhance bycatch mitigation and prevent removal of baits by seals.
- Assess appropriateness of the introduction of pot-protection measures for other seals species (e.g. fur seals) and in other sectors of the fishery (Victoria, Tasmania, New South Wales).

In the shark gillnet fishery:

- Improved models for estimating ASL bycatch in the fishery and the impacts of bycatch on individual subpopulations. These will require improvements to bycatch rate estimation models from increased observer coverage, and ASL foraging and population models (see below).
- Development of electronic monitoring methods to assess bycatch rates of ASL.
- Improved quantification of the extent of drop-out of ASL bycatch, and the factors that contribute to it.
- Assessing and mitigating ASL bycatch in the WA shark gillnet fishery.

With respect to ASL foraging ecology and population monitoring:

- Improved satellite tracking data: include subpopulations not tracked, and increase the number of animals tracked from subpopulations in areas remaining within the fishery. Assessment of representativeness of tracking based on stable isotope analyses.
- Improve habitat based modelling of the distribution of ASL foraging effort.
- Development and implementation of an ASL monitoring program in SA and nationwide.
- Improved assessment of ASL population demography and population models.
- Genetic analysis to determine stock structure and management units of ASL populations.

Many of these research projects are directly linked to the development of performance indicators for assessing the effectiveness of ASL bycatch mitigation. Of these, priority projects are the development and implementation of an ASL population monitoring program, and ongoing assessments of the ASL bycatch number and subpopulation origin in the gillnet sector GHAT fishery. Assessing and mitigating ASL bycatch in the WA shark gillnet fishery, and determining the genetic ASL population structure should also be given priority.

12 PLANNED OUTCOMES

The planned outcomes detailed in the project application were:

- The project will specifically address all the identified Needs, by ensuring that i) southern rock lobster and gillnet SESSF fisheries are managed according to ESD principles, and ii) that ESD recommendations with respect to seal interactions are measured, assessed and mitigated.
- The benefits of these achievements will be:
 - ESD Recommendations and Bycatch Action Plans to develop methods to mitigate seal bycatch addressed,
 - maintenance of EPBC Act export exemptions in the SARLF,
 - a significant reduction in seal bycatch in these fisheries,
 - assisting in the recovery of the threatened Australian sea lion.
- Benefits to the SESSF, southern rock lobster fishery, state and Commonwealth fisheries managers, Commonwealth DEWHA, SA DEH and the general community will accrue from the mitigation of seal bycatch, and the greater ecological sustainability of these fisheries.

The project has developed bycatch mitigation options for both the SARLF and the shark gillnet sector of the GHAT, in addition to providing quantitative estimates of the level of ASL bycatch in the shark gillnet fishery. Effective implementation of these mitigating options will achieve the planned outcomes of reducing ASL bycatch, maintain industry export exemptions under the EPBC Act and assist in the recovery of the threatened ASL.

13 CONCLUSIONS

Bycatch in rock lobster and shark gillnet fisheries has been identified as a key threat to the threatened Australian sea lion (ASL). This project aimed to i) develop pot protection devices to mitigate entrapment of sea lions in the South Australian rock lobster fishery; ii) assess the significance of ASL bycatch in the gillnet sector of the GHAT fishery; iii) develop options for spatial closures in the shark gillnet fishery to mitigate ASL bycatch and iv) develop performance indicators to evaluate the success of the mitigation options for each fishery.

ASL lobster pot interaction trials were undertaken to test the effectiveness of different spike heights (treatments) in reducing pot entry success. Trials undertaken with juvenile ASL demonstrated their propensity to enter pots without pot protection measures (controls) and remove lobsters. Results demonstrated a marked reduction in entry success of treatment pots as spike height (relative to the base of the pot collar) increased. None of the juvenile seals fully entered a pot and became trapped. Measurements taken from 4-5 month old pups indicated they would be able to pass through the collar of an unprotected pot. With a spike extending to the base of the pot collar, the diameter of the pot collar was reduced to less than the shoulder diameter of the smallest pup measured, and should prevent pups from becoming fully trapped. Follow-up pot interaction trials on pups confirmed that they can become easily trapped in unprotected pots, but no pups successfully entered or became trapped in the treatment pot.

The results provide additional support that appropriately configured spikes can reduce the likelihood of sea lion pot entry. Industry trials demonstrated that the addition of a spike extending to 20 mm below or flush with the base of the pot-collar had no significant effect on the catch rate or size of rock lobsters caught. Results indicate that a correctly fitted spike extending up to the base of the pot collar will significantly reduce the likelihood of sea lion entrapment (bycatch mortality) while having no effect on the catch rate and size selectivity of the fishery.

This report has provided the first quantitative assessment of the risks to ASL subpopulations from bycatch mortality in the gillnet sector of the GHAT fishery off South Australia. It has achieved this by analysing and modelling all of the available satellite tracking data for the species to provide a best estimate of the distribution of foraging effort, using data collected from a dedicated sea lion bycatch observer program in the gillnet sector of the GHAT fishery,

and detailed spatial data on the distribution of current fishing effort. Bycatch mortality rates based on observer data were highly correlated with estimated sea lion foraging density, enabling levels of total bycatch mortality to be estimated.

Spatial analyses showed almost complete overlap between the distributions of ASL foraging areas and effort in the gillnet sector of the GHAT fishery. Based on the current distribution of fishing effort, an estimated 374 (272-506, ±95%CL) ASL bycatch mortalities occur off SA each breeding cycle (17.5 months). A little over half (52.6%) are females (197, 142-266 ±95%CL), with annual bycatch representing about a 35% increase above natural mortality levels. The estimated impact of this bycatch mortality varied considerably among subpopulations depending on their foraging distributions and their proximity to fishing effort.

Bycatch models and population viability analyses (PVA) suggest that between 42 and 96% of ASL subpopulations are presently declining due to bycatch mortality, that most (65-81%) subpopulations will decline to below 5 pups within 3 generations (i.e., in the next 33.3 years), and that between 31 and 77% of subpopulations will be extinct within 100 breeding cycles. Results indicate that the majority of ASL subpopulations in SA are exposed to unsustainable levels of bycatch mortality and, if current levels and distribution of fishing effort are not modified, further declines, subpopulation extinctions and reductions in range are likely. Based on effort in the shark gillnet fishery since 1973, bycatch impact on ASL subpopulations is likely to have been substantial and the most significant factor contributing to the depletion (and possible extinction) of subpopulations in SA over at least 36 years.

Based on this assessment of the impacts of bycatch mortality from the gillnet sector of the GHAT fishery off South Australia, the likelihood of further declines and potential extinctions of ASL subpopulations would be minimised, and the capacity for the species to recover would be enhanced if that bycatch could be reduced. The greatest benefit would be obtained if female bycatch mortality were reduced to zero. If this is not achieved, some subpopulations are likely to continue to decline.

A range of closure scenarios was examined based upon: all SA State waters; female core foraging areas; minimum depth range; and distance from subpopulations. These analyses indicated that fishery closures would need to be very large if they are to significantly reduce the bycatch impacts on ASL subpopulations. Closure scenarios based on core female foraging areas provided the greatest reduction in bycatch while minimising the area closed to the fishery, but would be difficult to implement. In contrast, closures based around minimum depth ranges would be more easily implemented. The benefit of fishing closures, in terms of reduction in bycatch mortalities, was greatest when fishing effort was removed, and was unchanged and significantly reduced when fishing effort was displaced to remaining areas of the fishery. Fisheries and threatened species managers should be aware that if closures do not completely protect female foraging areas, changes in fishing behaviour and displacement of fishing effort could lead to increased levels of bycatch and extinction risks for some subpopulations.

The most direct and ultimate performance indicators for the success of bycatch mitigation measures in both the shark gillnet and lobster fisheries will be provided by monitoring the trends in abundance of key (selected) ASL subpopulations and the demographic response of the Seal Bay subpopulation will provide. Neither coordinated nor fully funded monitoring programs are presently established. Monitoring the numbers of ASL bycatch in the shark gillnet fishery, and from which subpopulations they originate should also be a key performance indicator, but will require additional investment and improvements to independent observer programs, to ASL foraging distribution and to population modelling. Observer programs required to assess bycatch reduction in the SA rock lobster fishery would need to be very large and are considered to be unfeasible. Instead, fishery managers should ensure high compliance to new management measures and further educate and support fishers to report all TEP species interactions.

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15 APPENDIX 1

Appendix 1. Known breeding sites for the Australian sea lion and range of pup counts. From Goldsworthy et al. (2009a). The location of known breeding sites for the Australian sea lion and range of pup counts over the 23 years from 1985. Locations are given in decimal degrees. Local names are noted by quotation marks. States are indicated as SA (South Australia) and WA (Western Australia). The year and method used for the most recent pup count for each location are given. Methods range in decreasing order of accuracy from: 1 (most accurate) to 4 (highly inaccurate). 'UK' indicates timing of breeding season unknown. Sources of pup count data are: (1) Shaughnessy (2005), Shaughnessy and Goldsworthy (2007), (2) Goldsworthy et al. (2008b), (3) Goldsworthy et al. (2008a), (4) Gales et al. (1994), (5) Goldsworthy et al. (2009d), (6) Goldsworthy et al. (2007b), (7) Shaughnessy et al. (2005), (8) Robinson et al. (1988), (9) Dennis (2005), (10) Shaughnessy (2005), (11) Shaughnessy (2008), (12) Goldsworthy et al. (2007a), (13) S. Goldsworthy (unpublished data), (14) Goldsworthy et al. (2003)*, (15) Campbell and Gales (unpublished), (16) Shaughnessy et al.(2009), (17) Dennis and Shaughnessy (1996), (18) Dennis and Shaughnessy (1999), (19) N. Gales (unpublished data), (20) Goldsworthy et al. (2009d).

* 26 pups from haul-out sites (Dennis & Shaughnessy 1996) were apportioned to B1-B6, B8, B9 on the basis of the proportion of pups at each site.

-		_	Breeding		Best available	e recent pup s	urvey	
Site	Lat.	Long.	seasons surveyed (1985-2008)	Pup count range (1985-2008)	Year	Method	Pup count	Source
North Pages Island	-35.7590	138.3011	13	177-312	2005	1	258	1
South Pages Island	-35.7771	138.2917	13	197-331	2005	1	331	1
'Seal Slide' (Kangaroo Is)	-36.0257	137.5361	11	1-16	2007	1	16	2
'Black Point', Cape Gantheaume Wilderness Area (Kangaroo Island)	-36.0382	137.4063	2	1-1	2002	4	1	16
Seal Bay (Kangaroo Is)	-35.9965	137.3270	16	122-260	2007	1	260	3
Cave Point, Cape Bouguer Wilderness Area (Kangaroo Island)	-36.0258	136.9574	2	1-3	1990	3	3	16
Cape Bouguer, main site (Kangaroo Island)	-36.0416	136.9088	6	0-3	1999	3	3	16

			Breeding seasons	Pup count	Best available recent pup survey			
Site	Lat.	Long.	surveyed (1985-2008)	range (1985-2008)	Year	Method	Pup count	Source
North Casuarina Island	-36.0682	136.7025	4	1-3	1996	3	3	16
Peaked Rocks	-35.1868	136.4830	2	15-24	1990	3	24	4
North Island	-35.1207	136.4761	3	1-28	2005	3	28	5
Dangerous Reef	-34.8170	136.2170	11	248-709	2007	1	709	6
English Island	-34.6379	136.1958	6	4-27	2005	2	27	5
Albatross Island	-35.0686	136.1814	2	12-15	2005	4	15	5
South Neptune (Main) Islands	-35.3303	136.1118	6	0-6	2008	3	6	13
North Neptune (East) Islands	-35.2301	136.0683	2	11-14	2005	3	14	5
Lewis Island	-34.9570	136.0317	2	78-131	2007	1	131	2
Liguanea Island	-34.9984	135.6199	3	1-43	2004	2	43	5
Price Island	-34.7076	135.2895	1	-	1996	3	25	7
Rocky Island (North)	-34.2587	135.2605	1	-	1996	3	16	7
Four Hummocks (North) Island	-34.7577	135.0421	1	-	1996	3	12	7
West Waldegrave Island	-33.5962	134.7615	4	79-157	2003	2	157	7
Jones Island	-33.1853	134.3671	7	5-15	2007	1	15	2
Ward Island	-33.7409	134.2850	3	2-45	2006	3	45	8

			Breeding	Pup count	Best availab	le recent pup s	survey	
Site	Lat.	Long.	surveyed (1985-2008)	range (1985-2008)	Year	Method	Pup count	Source
Dorothee Island	-33.9969	134.2487	UK	-	1996	3	1	7
Pearson Island	-33.9486	134.2614	7	1-35	2005	3	35	9
Point Labatt	-33.1523	134.2607	8	1-6	2005	4	6	10
Nicolas Baudin Island	-33.0157	134.1330	5	49-98	2006	2	98	11
Olive Island	-32.7191	133.9698	8	12-206	2006	1	206	12
Lilliput Island	-32.4486	133.6685	3	46-67	2005	1	67	5
Blefuscu Island	-32.4623	133.6392	3	75-84	2005	1	84	5
Gliddon Reef	-32.32	133.56	2	7	2005	3	7	5
Breakwater Island	-32.3217	133.5613	4	6-17	2005	1	17	5
Lounds Island	-32.2730	133.3657	4	4-34	2008	3	34	20
Fenelon Island	-32.5810	133.2817	5	10-40	2008	3	40	20
West Island	-32.5108	133.2513	3	14-56	2005	2	56	5
Purdie Island	-32.2698	133.2284	5	34-132	2005	3	132	5
Point Fowler ('Camel-foot Bay')	-32.0108	132.4378	1	-	1994	3	1	17
Nuyts Reef (middle)	-32.1386	132.1414	UK	-	1990	3	3	4
Nuyts Reef (west)	-32.1186	132.1314	1	-	2004	3	12	7

			Breeding		Best availa	ble recent pup s	survey	
Site	Lat.	Long.	seasons surveyed (1985-2008)	range (1985-2008)	Year	Method	Pup count	Source
'Bunda Cliffs B1'	-31.5175	131.0611	2	11-15	1995	3	15	14
'Bunda Cliffs B2'	-31.5862	130.5808	3	1-5	1995	4	5	14
'Bunda Cliffs B3'	-31.5823	130.1259	4	5-31	1995	4	31	14
'Bunda Cliffs B5'	-31.5851	130.0306	3	1-43	1995	4	43	14
'Bunda Cliffs B6'	-31.6094	129.7618	3	3-12	1995	4	12	14
'Bunda Cliffs B8'	-31.6396	129.3810	3	2-38	1995	4	38	14
'Bunda Cliffs B9'	-31.6467	129.3114	2	7-17	1995	4	17	14
'Bunda Cliffs B4'	-31.5856	130.0611	2		1995	4	2	14
'Bunda Cliffs B7'	-31.6250	129.5105	UK		1994	4	3	14

16 INTELLECTUAL PROPERTY

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18 ACRONYMS

AFMA	Australian Fisheries Management Authority
ANOVA	Analysis of Variance
ASL	Australian sea lion
BPZ	Benthic Protection Zone
CPUE	catch-per unit effort
DEWHA	Department of the Environment, Water, Heritage and the Arts
df	degrees of freedom
EPBC Act	Environment Protection and Biodiversity Conservation Act
ERA	Environmental Risk Assessment
ERM	Environmental Risk Management
ESD	Ecologically Sustainable Development
FRDC	Fisheries Research and Development Corporation
GAB	Great Australian Bight
GABMP	Great Australian Bight Marine Park
GHAT	Gillnet Hook and Trap fishery
GPS	geographic positioning system
IUCN	International Union for the Conservation of Nature
JASDGDLF	Southern Demersal Gillnet and Demersal Longline Joint Authority
	Fishery
MFA	Marine Fishing Area
mm	millimetres
MMPZ	Marine Mammal Protection Zone
OCS	Offshore Constitutional Settlement
Р	Probability
PBR	Potential Biological Removal
PIRSA	Department of Primary Industries and Resources SA
PLSD	Protracted Least Significance Difference
PTT	platform transmitting terminal
PVA	Population Viability Analysis
SA	South Australia
SARLF	SA Rock Lobster Fishery
SD	standard deviation
SESSF	Southern and Eastern Scalefish and Shark Fishery
SFR	statutory fishing rights
SLED	sea lion exclusion device
TACC	Total Allowable Commercial Catch
TDR	time-depth recorder
TEPS	Threatened Endangered and Protected Species
WA	Western Australia
WCDG DLF	West Coast Demersal Gillnet and Demersal Longline Fishery
WRLF	Western Rock Lobster Fishery
WTO	Wildlife Trade Operation