Chapter 5: New Zealand fur seal (*Arctocephalus forsteri*) - Technical Summary

New Zealand fur seal
(*Arctocephalus forsteri*)

Not threatened (DOC 2019)

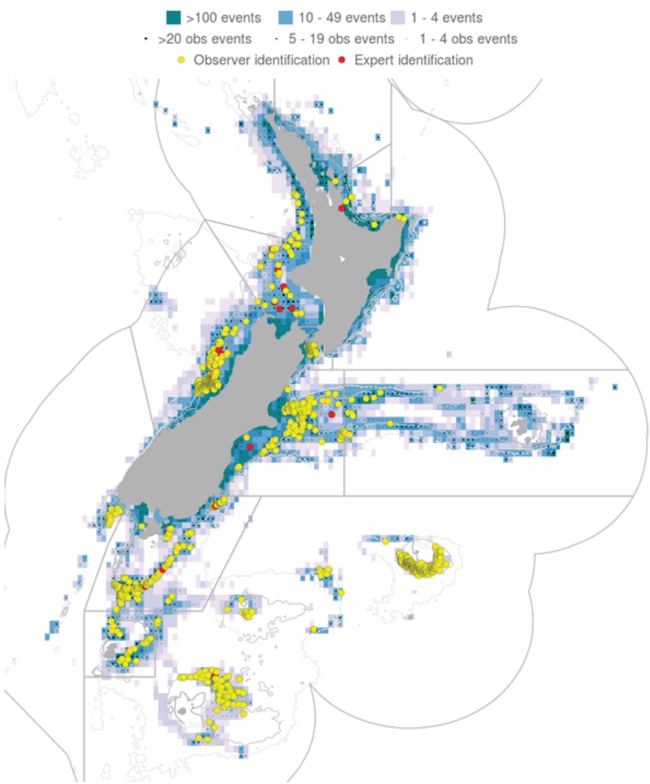
1. THE ISSUE IN BRIEF

- The New Zealand fur seal (*Arctocephalus forsteri*) is a pinniped, endemic to New Zealand
- NZ fur seals are attracted by fisheries operations, which can result in incidental captures and, potentially, deaths
- The NZ fur seal is abundant and classified as 'least concern' by DOC (population levels are increasing)
- Like other marine mammals, the NZ fur seal is rotected under the Marine Mammals Protection Act 1978 and the Fisheries Act 1996 but, because of its favourable conservation status, there is no Population Management Plan in place

2. CAUSES OF DEATH

- Current population estimates stand at nearly 100 000 individuals in the NZ Exclusive Economic Zone and numbers are increasing
- Starvation, stillbirth, suffocation, trampling, drowning, natural predation, and human disturbance are among the causes of pup mortality. Adult mortality causes include predation and fisheries interactions

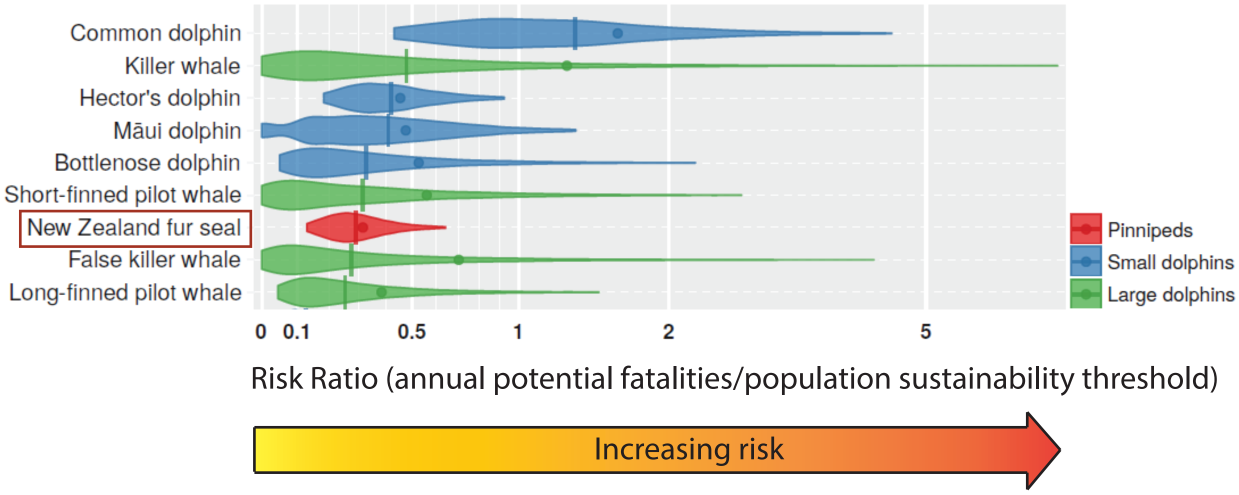
3. INCIDENTAL CAPTURES - LOCATION



- Between 2002–03 and 2017–18, there were 1691 observed incidental captures of NZ fur seals in trawl fisheries, 408 in surface longline fisheries, 58 in set net fisheries, 2 in bottom longlines fisheries, and 1 in purse seine fisheries
- The trawl fisheries mainly contributing to incidental captures of NZ fur seals are hoki (winter) and southern blue whiting (spring)
- The most common locations for incidental captures have been near Campbell Island and the Bounty Islands, as well as areas off the west coast of the South Island and the Cook Strait
- Observed captures are limited in the inshore trawl fishery, due to the low observer coverage

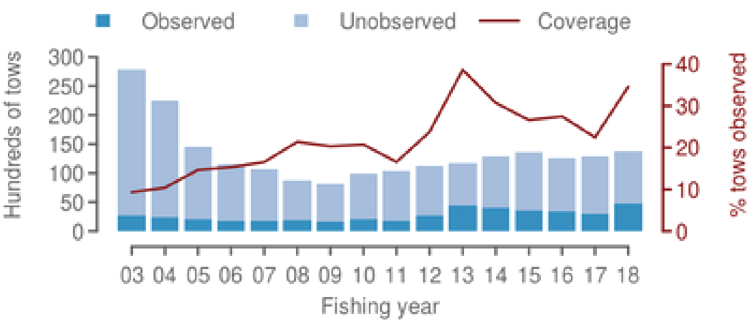
Map of NZ fur seal captures in NZ trawl fisheries between 2002 and 2018.
Yellow and red dots indicate NZ fur seal capture events, identified by observers and experts, respectively. Blue shades represent the trawl fishing effort

4. RISK ASSESSMENT

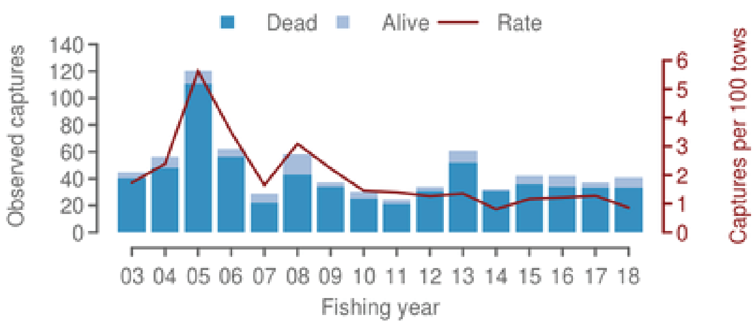


The multi-species marine mammal risk assessment (2017, see also Chapter 7) showed that the risk posed by fisheries to the NZ fur seal is comparable to that for several cetaceans, but has smaller uncertainty. However, the level of this risk is unlikely to pose a threat to the NZ fur seal population sustainability

5. INCIDENTAL CAPTURES - HOKI TRAWL FISHERIES



The observer coverage on board hoki trawl vessels has been increasing since 2003, reaching about 35% of the fishery in recent years



Capture rates of NZ fur seal peaked from 2003 to 2005, but have since slowly declined. Total capture numbers have been stable (with small fluctuations) over the last 10 years

Fishing effort (above) and observed captures (below) of NZ fur seals in NZ trawl fisheries

6. ONGOING RESEARCH

- Fishing interactions are considered unlikely to have adverse consequences for NZ fur seals at a national scale
- However, Fisheries New Zealand is trying to characterise the population structure and spatio-temporal foraging distribution of NZ fur seals and estimate commercial fisheries overlap and risk

5 NEW ZEALAND FUR SEAL (*ARCTOCEPHALUS FORSTERI*)

Status of chapter	This chapter has not been updated for AEBAR 2019–20.
Scope of chapter	This chapter describes: the biology New Zealand fur seals (*Arctocephalus forsteri)* the nature and extent of potential interactions with fisheries; management of fisheries interactions; means of estimating fisheries impacts and population level risk; and remaining sources of uncertainty, to guide future work.
Area	All of the New Zealand EEZ and Territorial Sea, but primarily in coastal environments extending to the continental slope.
Key locations	Areas with the potential for significant fisheries interactions include waters over or close to the continental shelf surrounding the South Island and southern offshore islands, notably Cook Strait, West Coast South Island, Banks Peninsula, Stewart-Snares Shelf, Campbell Rise, and the Bounty Islands, plus offshore of Bay of Plenty-East Cape. Interactions also occur off the west coast of the North Island.
Key issues	Improved means of estimating fisheries captures and and risk in poorly observed inshore fisheries; improved understanding of population size, structure and trend on a regional basis; improved understanding of spatio-temporal distributions affecting encounter rates between fur seals and fishing effort.
Emerging issues	Improved ability to assess risk and apply risk management solutions on a regional sub-population basis, or at finer spatial and temporal scales.
MPI research (current)	*PMM2018-04A: Estimate spatial distributions for at-risk marine mammals to assess fisheries overlap and risk: fur seal; PMM2018-07: Updated spatially explicit fisheries risk assessment for New Zealand marine mammal populations*
NZ government research (current)	DOC Marine Conservation Services Programme (CSP): INT2015-02 *To determine which marine mammal, turtle and protected fish species are captured in fisheries and their mode of capture*; MIT2014-01 *Protected species bycatch newsletter*.
Related chapters/issues	Chapter 3: Spatially Explicit Fisheries Risk Assessment (SEFRA); Chapter 4 New Zealand Sea Lions

5.1 CONTEXT

Management of fisheries impacts on New Zealand fur seals is legislated under the Marine Mammals Protection Act (MMPA) 1978 and the Fisheries Act (FA) 1996. Under s.3E of the MMPA or s.14F of the Wildlife Act 1953, the Minister of Conservation, with the concurrence of the Minister for Primary Industries (formerly the Minister of Fisheries), may approve a population management plan (PMP). There is no PMP in place for New Zealand fur seals.

In the absence of a PMP, the Ministry for Primary Industries (MPI) manages fishing-related mortality of New Zealand fur seals under s.15(2) of the FA '*to avoid, remedy, or mitigate the effect of fishing-related mortality on any protected species, and such measures may include setting a limit on fishing-related mortality.*'

All marine mammal species are designated as protected species under s.2(1) of the FA. In 2005, the Minister of Conservation approved the Conservation General Policy, which specifies in Policy 4.4 (f) that '*Protected marine species should be managed for their long-term viability and recovery throughout their natural range.*' DOC's Regional Conservation Management Strategies outline specific policies and objectives for protected marine species at a regional level. Baker et al. (2016) list New Zealand fur seals as Not Threatened in 2009, and the IUCN classification is Least Concern (Chilvers & Goldsworthy 2015).

In 2004, DOC approved the *Department of Conservation Marine Mammal Action Plan for 2005–2010*, which still reflects their need for marine mammal conservation (Suisted & Neale 2004). The plan specifies a number of species-specific key objectives for New Zealand fur seals, of which the following is most relevant for fisheries interactions: '*To control/mitigate fishing-related mortality of New Zealand fur seals in trawl fisheries (including the WCSI hoki and Bounty Island southern blue whiting fisheries).'* Management of New Zealand fur seal incidental captures aligns with Fisheries 2030 Objective 6: Manage impacts of fishing and aquaculture. Further, the management actions follow Strategic Action 6.2: *Set and monitor environmental standards, including for threatened and protected species and seabed impacts*.

All National Fisheries Plans except those for inshore shellfish and freshwater fisheries are relevant to the management of fishing-related mortality of New Zealand fur seals.

The relevant Fisheries Plan for the management of incidental captures of New Zealand fur seals is the 'National Fisheries Plan for Deepwater and Middle-depth Fisheries Part 1A' (the National Deepwater Plan). Under the National Deepwater Plan, the objective most relevant for management of New Zealand fur seals is Environmental Outcome 8: *Manage deepwater and middle-depth fisheries to avoid, remedy or mitigate the adverse effects of these fisheries on the long-term viability of endangered, threatened and protected species*

Specific objectives for the management of incidental captures of New Zealand fur seals are outlined in the fishery-specific chapters of the National Deepwater Plan for the fisheries with which New Zealand fur seals are most likely to interact. These fisheries include trawl fisheries for hoki, hake and ling, jack mackerel, and southern blue whiting. The chapters are being reviewed and updated in 2019.

Fisheries New Zealand works closely with the fishing industry to increase awareness amongst the fishing fleet of how to minimise interactions with fur seals, and emphasises the importance of adherence to the industry Marine Mammal Operational Procedures (MMOP). These procedures aim to reduce the risk of interactions with marine mammals by requiring that vessels:

- Minimise the length of time the fishing gear is on the surface;
- Remove all pieces of dead fish from the net before shooting the gear;
- Steam away from any congregations of marine mammals before shooting the gear; and
- Appoint a crew member to watch for marine mammal interactions every time the gear is shot or hauled.

Performance in relation to these procedures is audited by Fisheries New Zealand Observers and reported in the Deepwater Annual Review Report (ARR).

5.2 BIOLOGY

5.2.1 TAXONOMY

The New Zealand fur seal (*Arctocephalus forsteri*; Lesson 1828) is an otariid seal (Family Otariidae – eared seals, including fur seals and sea lions), one of two native to New Zealand, the other being the New Zealand sea lion (*Phocarctos hookeri*; Gray 1844).

5.2.2 DISTRIBUTION

Pre-European archaeological evidence suggests that New Zealand fur seals were present along much of the east coasts of the North Island (except the less rocky coastline of Bay of Plenty and Hawke's Bay) and the South Island, and, to a lesser extent, on the west coasts, where fewer areas of suitable habitat were available (Smith 1989, 2005, 2011). A combination of subsistence hunting and commercial harvest resulted in contraction of the species' range and in population decline almost to the point of extinction (Smith 1989, 2005, 2011, Ling 2002, Lalas 2008). New Zealand fur seals became fully protected in the 1890s and, with the exception of one year of licensed harvest in the 1950s, have remained protected since that time.

Currently, New Zealand fur seals occur throughout New Zealand waters, predominantly in waters south of 40°S and as far south as Macquarie Island. On land, New Zealand fur seals are distributed around the New Zealand coastline, on offshore islands, and on subantarctic islands (Crawley & Wilson 1976, Wilson 1981, Mattlin 1987). The recolonisation of the coastline by New Zealand fur seals has resulted in the northward expansion of the distribution of breeding colonies and haulouts (Lalas & Bradshaw 2001), and breeding colonies are now present on many exposed rocky areas (Baird 2011). The extent of breeding colony distribution in New Zealand waters is bounded to the north by a very small (space-limited) colony at Gannet Island off the North Island west coast (latitude 38°S), to the east by colonies of unknown sizes at the Chatham Islands group, to the west by colonies of unknown size on Fiordland offshore islands, and to the south by unknown numbers on Campbell Island. Outside New Zealand waters, breeding populations exist in South and Western Australia (Shaughnessy et al.

1994, Shaughnessy 1999, Goldsworthy et al. 2003), with smaller colonies in Tasmania (Gales et al. 2010).

The seasonal distribution of the New Zealand fur seals is determined by the sex and maturity of each animal. Males are generally at the breeding colonies from late October to late January then move to haulout areas around the New Zealand coastline (see Bradshaw et al. 1999), with peak density of males and sub-adult males at haulouts during July–August and lowest densities in September–October (Crawley & Wilson 1976). Females arrive at the breeding colony from November and lactating females remain at the colony (apart from short foraging trips) for about 10 months until the pups are weaned, usually during August–September (Crawley & Wilson 1976).

5.2.3 FORAGING ECOLOGY

Most New Zealand fur seal foraging research in New Zealand has focused on lactating females at Open Bay Islands off the South Island west coast (Mattlin et al. 1998), Otago Peninsula (Harcourt et al. 2002), and Ohau Point, Kaikoura (Boren 2005), using time-depth recorders, satellite-tracking, or very-high-frequency transmitters. Individual females show distinct dive pattern behaviour and may be relatively shallow or deep divers, but most forage at night and in depths shallower than 200 m. At Open Bay Islands, dives were generally deeper and longer in duration during autumn and winter. Females dove to at least 274 m (for a 5.67 min dive in autumn) and remained near the bottom at over 237 m for up to 11.17 min in winter (Mattlin et al. 1998). Females in some locations undertook longer dive trips, with some to deeper waters, in autumn (in over 1000 m beyond the continental shelf; Harcourt et al. 2002).

The relatively shallow dives and nocturnal feeding observed during summer suggests that seals feed on pelagic and vertical migrating prey species (for example, arrow squid, *Nototodarus sloanii*). Conversely, the deeper dives and increased number of dives in daylight during autumn and winter suggest that prey species at this time may include benthic, demersal, and pelagic species (Mattlin et al. 1998, Harcourt et al. 2002). The deeper dives enabled seals to forage along or off the continental shelf (within 10 km) of the studied colony (at Open Bay Islands). These deeper dives may be demersal or to depths in the water column where spawning hoki are concentrated.

Methods to analyse New Zealand fur seal diets have included investigation of freshly killed animals (Sorensen 1969), scats, and regurgitates (e.g., Allum & Maddigan 2012). Fish prey items can be recognised by the presence of otoliths, bones, scales, and lenses, while cephalopods are indicated by beaks and pens. Foraging modes appear to vary between specific individuals, and distinct diets may be apparent in the scats and regurgitations of males vs females vs juveniles from the same colony. These analyses can be biased, however, particularly if only one collection method is used, and this limits fully quantitative assessment of prey species composition.

Dietary studies of New Zealand fur seals have been conducted at colonies in Nelson-Marlborough, west coast South Island, Otago Peninsula, Kaikoura, Banks Peninsula, Snares Islands, and off Stewart Island, and summaries are provided by Carey (1992), Harcourt (2001), Boren (2010), and Baird (2011).

New Zealand fur seals are opportunistic foragers and, depending on the time of year, method of analysis, and location, their diet includes at least 61 taxa (Holborow 1999) of mainly fish (particularly lanternfish (myctophids) in all studied colonies except Tonga Island (in Golden Bay; Willis et al. 2008), as well as anchovy (*Engraulis australis*), aruhu (*Auchenoceros punctatus*), barracouta (*Thrysites atun*), hoki (*Macruronus novaezelandiae*), jack mackerel (*Trachurus* spp.), pilchard (*Sardinops sagax*), red cod (*Pseudophycis bachus*), red gurnard (*Chelidonichthys kumu*), silverside (*Argentina elongate*), sprat (*Sprattus* spp.) and cephalopods (octopus (*Macroctopus maorum*), squid (*Nototodarus sloanii*, *Sepioteuthis bilineata*)). For example, myctophids were present in Otago scats throughout the year (representing offshore foraging), but aruhu, sprat, and juvenile red cod were present only during winter-spring (Fea et al. 1999). Medium-large arrow squid predominated in summer and autumn. Jack mackerel species, barracouta, and octopus were dominant in winter and spring. Prey such as lanternfish and arrow squid rise in the water column at night, the time when New Zealand fur seals exhibit shallow foraging (Harcourt et al. 1995, Mattlin et al. 1998, Fea et al. 1999).

Recent foraging and dietary studies include one on male fur seal diets by Lalas & Webster (2014) and one on lactating females by Meynier et al. (2013). Arrow squid was the most important dietary item in fur seal scats and regurgitations sampled from male fur seals at The Snares during February 2012 (Lalas & Webster 2014). Meynier et al. (2013) assess the trophic and spatial overlap between fur seals from two different South Island locations with local fisheries using analyses of dietary fatty acids, stable isotope signals, and telemetry. Lactating females from the east coast rookery at Ohau Point fed on oceanic prey in summer and females from the west coast rookery at Cape Foulwind fed on benthic or coastal prey over the continental shelf in summer and winter. The west coast females spent 50% of their at-sea time in winter in and near the Hokitika Canyon, where the winter spawning hoki fishery operates.

5.2.4 REPRODUCTIVE BIOLOGY

New Zealand fur seals are sexually dimorphic and polygynous (Crawley & Wilson 1976); males may weigh up to 160 kg, whereas females weigh up to about 50 kg (Miller 1975, Mattlin 1978a, 1987, Troy et al. 1999). Adult males are much larger around the neck and shoulders than females and breeding males are on average 3.5 times the weight of breeding females (Crawley & Wilson 1976). Females are philopatric and are sexually mature at 4–6 years, whereas males mature at 5–9 years (Mattlin 1987, Dickie & Dawson 2003). The maximum age recorded for New Zealand fur seals in New Zealand waters is 22 years for females (Dickie & Dawson 2003) and 15 years for males (Mattlin 1978a).

New Zealand fur seals are annual breeders and generally produce one pup after a gestation period of about 10 months (Crawley & Wilson 1976). Twinning can occur and females may foster a pup (Dowell et al. 2008), although both are rare. Breeding animals come ashore to mate after a period of sustained feeding at sea. Breeding males arrive at the colonies to establish territories during October–November. Breeding females arrive at the colony from late November and give birth shortly after. Peak pupping occurs in mid-December (Crawley & Wilson 1976).

Females remain at the colony with their newborn pups for about 10 days, by which time they have usually mated. Females then leave the colony on short foraging trips of 3–5 days before returning to suckle pups for 2–4 days (Crawley & Wilson 1976). As the pups grow, these foraging trips are progressively longer in duration. Pups remain at the breeding colony from birth until weaning (at 8–12 months of age).

Breeding males generally disperse after mating to feed and occupy haulout areas, often in more northern areas (Crawley & Wilson 1976). This movement of breeding adults away from the colony area during January allows for an influx of sub-adults from nearby areas. Little is described about the ratio of males to females on breeding colonies (Crawley & Wilson 1976), or the reproductive success. Boren (2005) reported a fecundity rate of 62% for a Kaikoura colony, based on two annual samples of between about 5 and 8% of the breeding female population. This rate is similar to the 67% estimated by Goldsworthy & Shaughnessy (1994) for a South Australian colony.

Newborn pups are about 55 cm long and weigh about 3.5 kg (Crawley & Wilson 1976). Male pups are generally heavier than female pups at birth and throughout their growth (Crawley & Wilson 1976, Mattlin 1981, Chilvers et al. 1995, Bradshaw et al. 2003b, Boren 2005). Pup growth rates may vary by colony (see Harcourt 2001). The proximity of a colony to easily accessible rich food sources will vary, and pup condition at a colony can vary markedly between years (Mattlin 1981, Bradshaw et al. 2000, Boren 2005). Food availability may be affected by climate variation, and pup growth rates probably represent variation in the ability of mothers to provision their pups from year to year. The sex ratio of pups at a colony may vary by season (Bradshaw et al. 2003a, 2003b, Boren 2005), and in years of high food resource availability, more mothers may produce males or more males may survive (Bradshaw et al. 2003a, 2003b).

5.2.5 POPULATION BIOLOGY

Historically, the population of New Zealand fur seals in New Zealand was thought to number above 1.25 million animals (possibly as high as 1.5 to 2 million) before the extensive sealing of the early 19th century (Richards 1994). Present day population estimates for New Zealand fur seals in New Zealand are dated, few and highly localised. In the most comprehensive attempt to quantify the total New Zealand fur seal population, Wilson (1981) summarised population surveys of mainland New Zealand and offshore islands undertaken in the 1970s and estimated the population size within the New Zealand region at between 30 000 and 50 000 animals. Since then, several authors have suggested a population size of ~100 000 animals (Taylor 1990, see Harcourt 2001), but this estimate is very much an approximation and its accuracy is difficult to assess in the absence of comprehensive surveys.

Fur seal colonies provide the best data for consistent estimates of population numbers, generally based on pup production in a season (see Shaughnessy et al. 1994). Data used to provide colony population estimates of New Zealand fur seals have been, and generally continue to be, collected in an ad hoc fashion. Regular pup counts are made at some discrete populations. A 20-year time series of Otago Peninsula colony data is updated, maintained, and published primarily by Chris Lalas (assisted by Sanford (South Island) Limited), and the most recent published estimate is 20 000–30 000 animals (Lalas 2008). Lalas & MacDiarmid (submitted) applied a logistic growth model, using established parameters, to 13 years of pup production estimates from colonies at Oamaru south to Slope Point, and indicated the 2009 population was at 95% of the asymptote of 19 600 animals (plausible range of 13 000–28 800). In this region, 90% of the population growth occurred over 24–27 years; and the growth rate was faster in seasons up to 1998, than in later years.

Similar population growth rates occurred at Kaikoura, where the population expanded by 32% per annum over the years 1990–2005 (Boren et al. 2006). An estimate of 600 pups was reported for 2005 (Boren 2005), 1508 (s.e. = 28) pups were estimated for 2009, and 2390 (s.e. = 226) pups for 2011 (L. Boren, DOC, pers. comm.).

Since 1991, the Department of Conservation has monitored New Zealand fur seal pup production at three breeding colonies on the West Coast, at Cape Foulwind, Wekakura Point, and Taumaka (Open Bay Islands) (see Best 2011). A DOC-commissioned project is underway to compile the tag, measurement, and mark-recapture data from these colonies and create a New Zealand fur seal database (Roberts & Best 2016). The data have been made available by the scientists who complete the fieldwork, most recently by Hugh Best, who coordinates the population monitoring programme, DOC Regional and District staff, Tai Poutini Papatipu Runanga, and the trustee owners of Taumaka me Popotai. Once the database has been through a quality assurance process, it will be made publically available. The pup production estimates for these colonies are derived using direct counts of dead pups and mark recapture methodology undertaken in the last week of January each year. At Taumaku Island, the largest of the Open Bay Islands and the most southern of these three colonies, approximately 800 pups are marked each year, and the first 100 pups of each sex are weighed and measured. At Cape Foulwind, approximately 200 pups are marked each year, and the first 50 of each sex are weighed and measured. At the most northern of the three colonies, Wekakura Point, approximately 500 pups are marked and 75 of each sex are weighed and measured.

Other studies of breeding colonies generally provide estimates for one or two seasons, but many of these are more than 10 years old. Published estimates suggest that populations have stabilised at the Snares Islands after a period of growth in the 1950s and 1960s (Carey 1998) and increased at the Bounty Islands (Taylor 1996), Nelson-Marlborough region (Taylor et al. 1995), Kaikoura (Boren 2005), Otago (Lalas & Harcourt 1995, Lalas & Murphy 1998, Lalas 2008, Lalas & MacDiarmid, submitted), and near Wellington (Dix 1993).

For many areas where colonies or haulouts exist, count data have been collected opportunistically (generally by Department of Conservation staff during their field activities) and thus data are not often comparable because counts may represent different life stages, different assessment methods, and different seasons (see Baird 2011). Known breeding locations (as at October 2012) are summarised in the NABIS supporting lineage document for the '*Breeding colonies distribution of New Zealand fur seal*' layer[1].

Baker et al. (2010) conducted an aerial survey of the South Island west coast from Farewell Spit to Puysegur Point and Solander Island in 2009, but their counts were quite different, i.e., lower than ground counts collected at a similar time at the main colonies (Mellina & Cawthorn 2009). This discrepancy was thought to be a result mainly of the survey design and the nature of the terrain. However, the aerial survey confirmed the localities shown by Wilson (1981) of potentially large numbers of pups at sites such as Cascade Point, Yates Point, Chalky Island, and Solander Island.

Population numbers for some areas, especially more isolated ones, are not well known. The most recent counts for the Chatham Islands were collected in the 1970s (Wilson

[1] http://www2.nabis.govt.nz/LayerDetails.aspx?layer=Breeding%20colonies%20distribution%20of%20New%20Zealand%20fur%20seal.

1981), and the most recent reported for the Bounty Islands were made in 1993–94. Taylor (1996) reported an increase in pup production at the Bounty Islands since 1980, and estimated that the total population was at least 21 500, occupying over 50% of the available area. Information is sparse for populations at Campbell Island, the Auckland Islands group and the Antipodes Islands

Little is reported about the natural mortality of New Zealand fur seals, other than reports of sources and estimates of pup mortality for some breeding colonies. Estimates of pup mortality or pup survival vary in the manner in which they were determined and in the number of seasons they represent, and are not directly comparable. Each colony will be affected by different sources of mortality related to habitat, location, food availability, environment, and year, as well as the ability of observers to count all the dead pups (may be limited by terrain, weather, or time of day).

Reported pup mortality rates vary: 8% for Otago Peninsula pups up to 30 days old and 23% for pups up to 66 days old (Lalas & Harcourt 1995); 20% from birth to 50 days and about 40% from birth to 300 days for Taumaka Island, Open Bay Islands pups (Mattlin 1978b); and in one year, 3% of Kaikoura pups before the age of 50 days (Boren 2005). Starvation was the major cause of death, although stillbirth, suffocation, trampling, drowning, predation, and human disturbance also occur. Pup survival of at least 85% was estimated for a mean 47-day interval for three Otago colonies, incorporating data such as pup body mass (Bradshaw et al. 2003b), though pup mortality before the first capture effort was unknown. Other sources of natural mortality for New Zealand fur seals include predators such as sharks and New Zealand sea lions (Mattlin 1978b, Bradshaw et al. 1998).

Human-induced sources of mortality include: fishing, for example, entanglement or capture in fishing gear; vehicle-related deaths (Lalas & Bradshaw 2001, Boren 2005, Boren et al. 2006, 2008); and mortality through shooting, bludgeoning, and dog attacks. New Zealand fur seals are vulnerable to certain bacterial diseases and parasites and environmental contaminants, though it is not clear how life-threatening these are. The more obvious problems include tuberculosis infections, *Salmonella*, hookworm enteritis, phocine distemper, and septicaemia (associated with abortion) (Duignan 2003, Duignan & Jones 2007). Low food availability and persistent organohalogen compounds (which can affect the immune and the reproductive systems) may also affect New Zealand fur seal health.

Various authors have investigated fur seal genetic differentiation among colonies and regions in New Zealand (Lento et al. 1994, Robertson & Gemmell 2005). Lento et al. (1994) described the geographic distribution of mitochondrial cytochrome *b* DNA haplotypes. Robertson & Gemmell (2005) described low levels of genetic differentiation (consistent with homogenising gene flow between colonies and an expanding population) based on genetic material from New Zealand fur seal pups from seven colonies. One aim of the latter work is to determine the provenance of animals captured during fishing activities, through the identification and isolation of any colony genetic differences.

In 2015–16, Gooday et al. (unpub., 2016) conducted trials of unmanned aerial vehicle (UAV) technology combined with thermal imaging in the Ohau Point fur seal colony, as part of an investigation into non-invasive population sampling. They found aerial surveys using a T320 19 mm infrared camera were successful in detecting fur seals in open areas and distinguishing them from rocks, but were unsuccessful in areas of high canopy cover (>80%). Ground surveys were also conducted using a higher resolution Optris PL450™ infrared camera and detected more fur seals than paired photographs during cooler times of the day (morning and evening). In the Ohau Stream where seal pups visit the waterfall, the Optris PL450™ detected pups hiding in the forested areas better than the naked eye, but was less effective when they were swimming or if they had recently left the water. The Optris PL450™ is currently under development to be mounted to the UAV, which is expected to increase aerial counts dramatically. Gooday et al. (unpub., 2016) concluded that thermal imagery has the potential to become an effective and widely used tool for ecological population surveys.

5.2.6 CONSERVATION BIOLOGY AND THREAT CLASSIFICATION

Threat classification is an established approach for identifying species at risk of extinction (IUCN 2014). The risk of extinction for New Zealand fur seals has been assessed under two threat classification systems: the New Zealand Threat Classification System (Townsend et al. 2008) and the International Union for the Conservation of Nature (IUCN) Red List of Threatened Species (IUCN 2014).

In 2008, the IUCN updated the Red List status of New Zealand fur seals, listing them as Least Concern on the basis of their large and apparently increasing population size (Chilvers & Goldsworthy 2015). In 2010, DOC updated the New Zealand Threat Classification status of all New Zealand marine mammals (Baker et al. 2016). In the revised list, New Zealand fur seals were classified as Not Threatened with the qualifiers increasing (Inc) and secure overseas (SO) (Baker et al. 2016).

5.3 GLOBAL UNDERSTANDING OF FISHERIES INTERACTIONS

New Zealand fur seals are found in both Australian and New Zealand waters. Overall abundance has been suggested to be as high as 200 000, with about half of the population in Australian waters (Goldsworthy & Gales 2008). However, this figure is very much an approximation, and its accuracy is difficult to assess in the absence of comprehensive surveys.

Pinnipeds are caught incidentally in a variety of fisheries worldwide (Read et al. 2006). Outside New Zealand waters, species captured include: New Zealand fur seals, Australian fur seals, and Australian sea lions in Australian trawl and inshore fisheries (e.g., Shaughnessy 1999, Norman 2000); Cape fur seals in South African fisheries (Shaughnessy & Payne 1979); South American sea lions in trawl fisheries off Patagonia (Dans et al. 2003); and seals and sea lions in United States waters (Moore et al. 2009).

5.4 STATE OF KNOWLEDGE IN NEW ZEALAND

New Zealand fur seals are attracted to feeding opportunities offered by various fishing gears. Anecdotal evidence suggests that the sound of winches as trawlers haul their gear acts as a cue. The attraction of fish in a trawl net, on longline hooks, or caught in a set net provide opportunities for New Zealand fur seals to interact with fishing gear, which can result in capture and, potentially, death via drowning

Most captures occur in trawl fisheries and New Zealand fur seals are most at risk from capture during shooting and hauling (Shaughnessy & Payne 1979), when the net mouth is within diving depths. Once in the net some animals may have difficulty in finding their way out within their maximum breath-hold time (Shaughnessy & Davenport 1996). The operational aspects that are associated with New Zealand fur seal captures on trawlers include factors that attract the New Zealand fur seals, such as the presence of offal and discards, the sound of the winches, vessel lights, and the presence of 'stickers' in the net (Baird 2005). It is considered that New Zealand fur seals are at particular risk of capture when a vessel partially hauls the net during a tow and executes a turn with the gear close to the surface. At the haul, New Zealand fur seals often attempt to feed from the codend as it is hauled and dive after fish that come loose and escape from the net (Baird 2005).

Factors identified as important influences on the potential capture of New Zealand fur seals in trawl gear include the year or season, the fishery area, gear type and fishing strategies (often specific to certain nationalities within the fleet), time of day, and distance to shore (Baird & Bradford 2000, Mormede et al. 2008, Smith & Baird 2009). These analyses did not include any information on New Zealand fur seal numbers or activity in the water at the stern of the vessel because of a lack of data. Other influences on New Zealand fur seal capture rate (of Australian and New Zealand fur seals) may include inclement weather and sea state, vessel tow and haul speed, increased numbers of vessels and trawl frequency, and potentially the weight of the fish catch and the presence of certain bycatch fish species (Hamer & Goldsworthy 2006). This Australian study found similar mortality rates for tows with and without Seal Exclusion Devices (see also Hooper et al. 2005). The use of fur seal exclusion devices is not required in New Zealand fisheries.

The spatial and temporal overlap of commercial fishing grounds and New Zealand fur seal foraging areas has resulted in New Zealand fur seal captures in fishing gear (Mattlin 1987, Rowe 2009). Most fisheries with observed captures occur in waters over or close to the continental shelf. Because the topography around much of the South Island and offshore islands slopes steeply to deeper waters, most captures occur close to colonies and haulouts. Locations of captures by trawl vessels and surface longline vessels are shown in Figures 5.1 and 5.2. Winter hoki fisheries attract New Zealand fur seals off the west coast South Island and in Cook Strait between late June and September (Table 5.1). In August–October, New Zealand fur seals are caught in southern blue whiting effort near the Bounty Islands and Campbell Island. In September–October captures may occur in hoki and ling fisheries off Puysegur Point on the south-western coast of the South Island.

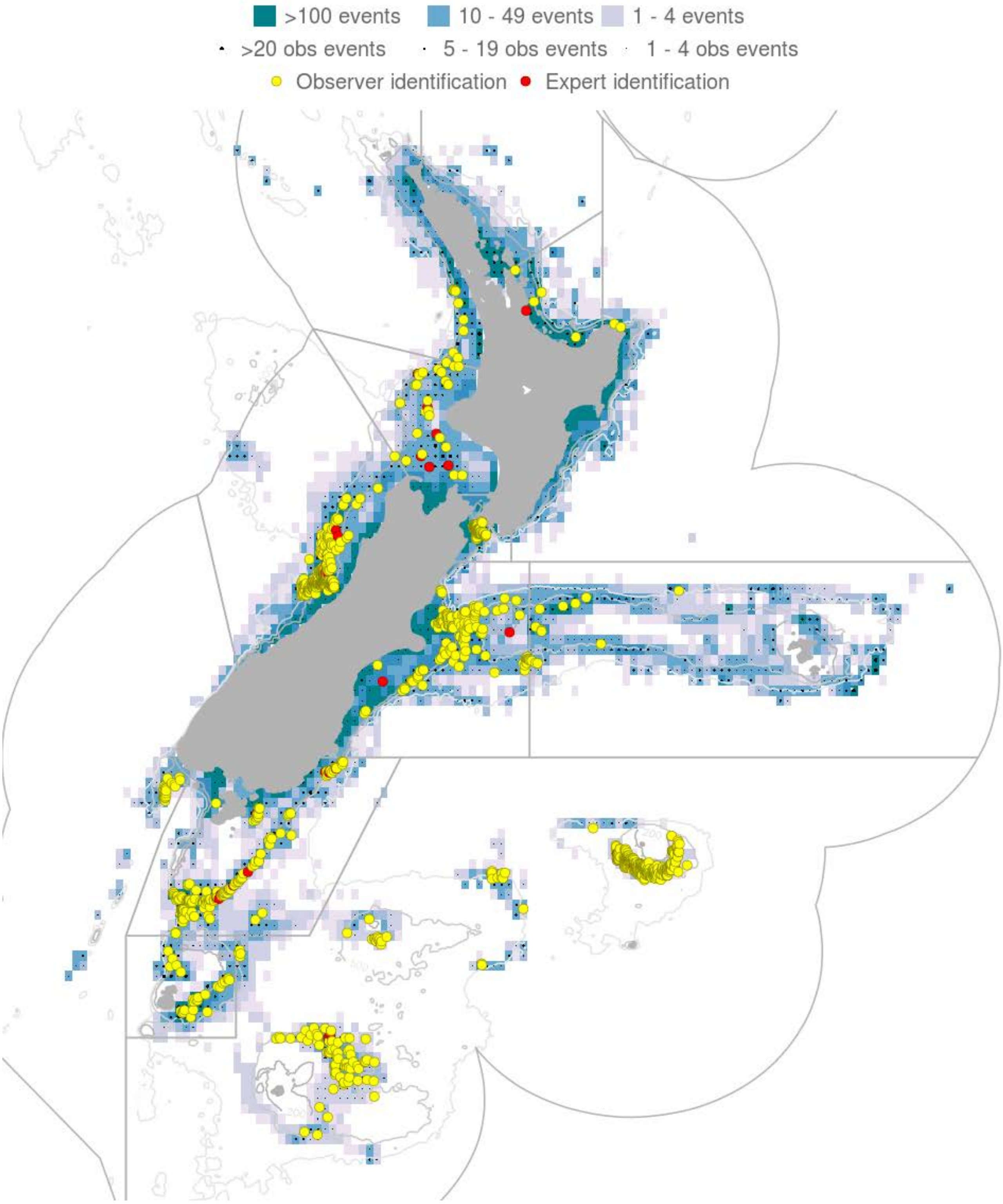


Figure 5.1: Distribution of trawl fishing effort and observed New Zealand fur seal captures, 2002–03 to 2017–18 (for more information see MPI data analysis at http://data.dragonfly.co.nz/psc, data version 2019v1). Fishing effort is mapped into 0.2-degree cells, coloured to represent the amount of effort. Observed fishing events are indicated by black dots, and observed captures are indicated by red dots. Fishing effort is shown for all tows with latitude and longitude data, where three or more vessels fished within a cell.

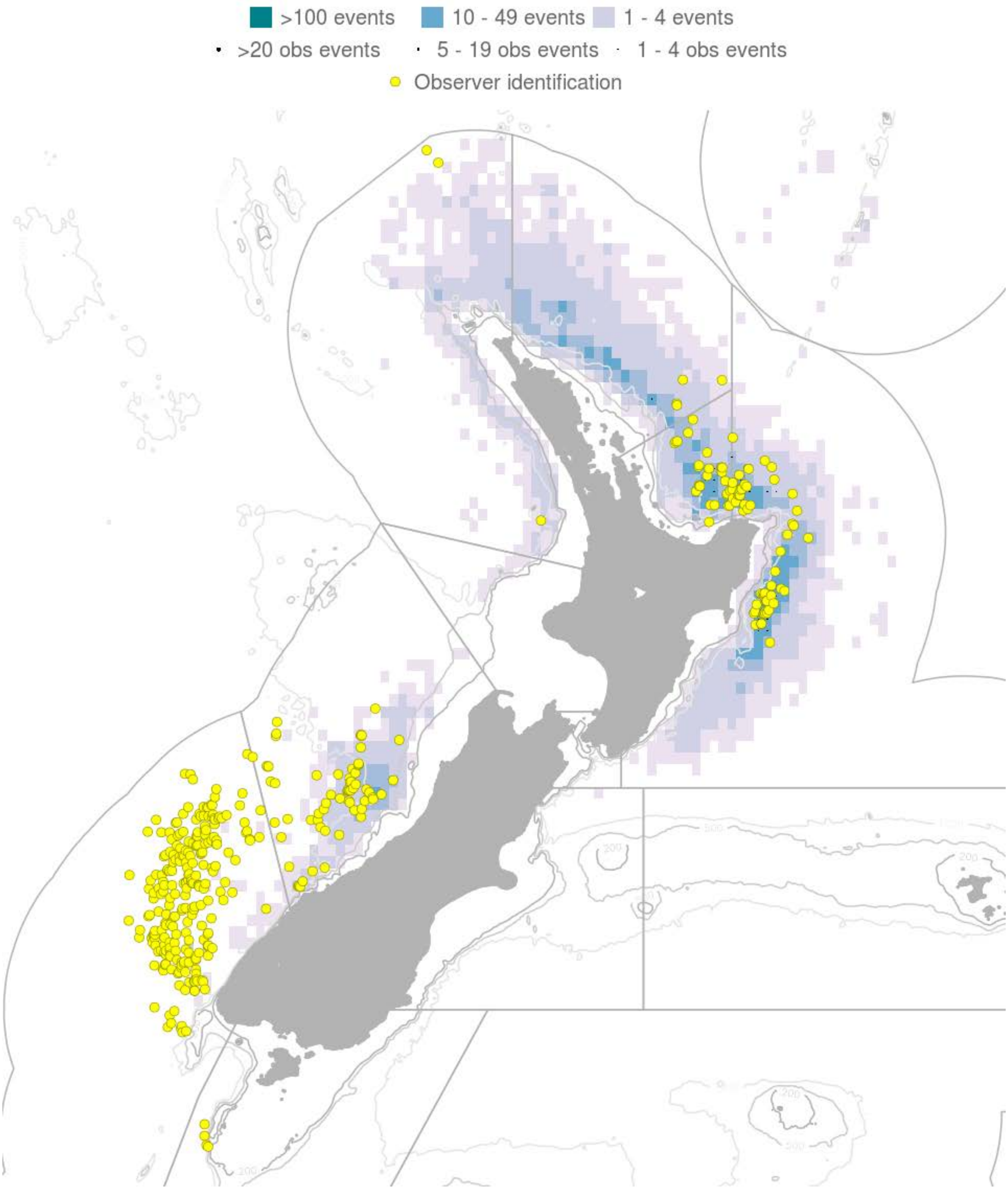


Figure 5.2: Distribution of surface-longline fishing effort and observed New Zealand fur seal captures, 2002–03 to 2017–18 (for more information see MPI data analysis at http://data.dragonfly.co.nz/psc, data version 2019v1). Fishing effort is mapped into 0.2-degree cells, coloured to represent the amount of effort. Observed fishing events are indicated by black dots, and observed captures are indicated by red dots. Fishing effort is shown for sets with latitude and longitude data, where three or more vessels and three or more companies or persons fished within a cell. For these years, 89.6% of the effort is shown.

Captures are also reported from the Stewart-Snares shelf fisheries that operate during summer months, mainly for hoki and other middle depths species and squid, and from fisheries throughout the year on the Chatham Rise though captures have not been observed east of longitude 180° on the Chatham Rise.

Captures were reported from trawl fisheries for species such as hoki, hake (*Merluccius australis*), ling (*Genypterus blacodes*), squid, southern blue whiting, jack mackerel, and barracouta (Baird & Smith 2007, Abraham et al. 2010b). Between 1 and 3% of observed tows targeting middle-depths fish species catch New Zealand fur seals compared with about 1% for squid tows, and under 1% of observed tows targeting deepwater species such as orange roughy (*Hoplostethus atlanticus*) and oreo species (for example, *Allocyttus niger*, *Pseudocyttus maculatus*) (Baird & Smith 2007). The main fishery areas that contribute to the estimated annual catch of New Zealand fur seals (modelled from observed captures) in middle depths and deepwater trawl fisheries are Cook Strait hoki, west coast South Island middle-depths fisheries (mainly hoki), western Chatham Rise hoki, and the Bounty Islands southern blue whiting fishery (Baird & Smith 2007, Thompson & Abraham 2010). Captures on longlines occur when the New Zealand fur seals attempt to feed on the fish catch during hauling. Most New Zealand fur seals are released alive from surface and bottom longlines, typically with a hook and short snood or trace still attached.

5.4.1 QUANTIFYING FISHERIES INTERACTIONS

Observer data and commercial effort data have been used to characterise fur seal incidental captures and estimate the total catches (Baird & Smith 2007, Smith & Baird 2009, Thompson & Abraham 2010, Abraham & Thompson 2011, Abraham et al. 2017). This approach is currently applied using information collected under DOC project INT2013-01 and analysed under MPI project PRO2013-01 (Thompson et al. 2011, Thompson et al. 2012, Abraham et al. 2017). The analytical methods used to estimate capture numbers across commercial fisheries vary depending on the quantity and quality of the data, i.e., total numbers of observed captures and the representativeness of the observer coverage. Initially, stratified ratio estimates were provided for the main trawl fisheries, starting in the late 1980s, after scientific observers reported 198 New Zealand fur seal deaths during the July to September west coast South Island spawning hoki fishery (Mattlin 1994a, 1994b). In subsequent years, ratio estimation was used to estimate New Zealand fur seal captures in the Taranaki Bight jack mackerel fisheries and Bounty Platform, Pukaki Rise, and Campbell Rise southern blue whiting fisheries, based on observed catches and stratified by area, season, and gear type (Baird 1994).

In the last 10 years, model-based estimates of captures have been developed for all trawl fisheries in waters south of 40°S (Baird & Smith 2007, Smith & Baird 2009, Thompson & Abraham 2010, Abraham & Thompson 2011, Thompson et al. 2011, Thompson et al. 2012, Abraham et al. 2017). These models use fisheries observer data and fishing effort data in a hierarchical Bayesian model that includes season and vessel-season random effects and other covariates (for example, day of fishing year, time of day, tow duration, distance from shore, gear type, target) to model variation in capture rates among tows. This method compensates in part for the lack of representativeness of the observer coverage and includes the contribution from correlation in the capture rate among tows by the same vessel. The method is limited by the very large differences in the observed and non-observed proportions of data for the different vessel sizes; most observer coverage is on larger vessels that generally operate in waters deeper than 200 m. The operation of inshore vessels in terms of the location of effort, gear, and the vessel behaviour is only poorly understood compared with the deepwater fisheries. Nonetheless, following changes to reporting requirements, data collection is improving such that inshore trawl effort (not including flatfish trawl effort) is now included in the captures estimation modelling (Thompson et al. 2012, see also description of the Trawl Catch Effort Return, TCER, in use since 2007–08, in Chapter 11 on benthic effects).

Since 2005, there has been a downward, then relatively flat trend in estimated capture rates and total annual estimated captures of New Zealand fur seals in trawl fisheries (Smith & Baird 2009, Thompson & Abraham 2010, Abraham & Thompson 2011, Thompson et al. 2011, Thompson et al. 2012, Abraham et al. 2017; Figure 5.3). This may reflect bycatch reduction efforts undertaken by vessels (see Section 5.4.2) combined with a reduction in fishing effort since the late 1990s. Simultaneous with this decrease in effort is an increase in fisheries observer coverage, especially since 2007. In 2014–15, about 17% of the 78 696 tows were observed, with a capture rate of 0.93 fur seals per 100 tows, to give an annual mean total of 486 captures (95% c.i.: 299–876) (Table 5.2, Figure 5.3).

Observed and estimated capture rates include animals that are released alive; 13% of 1420 observed trawl captures in the 2002–03 to 2014–15 fishing years were recorded as released alive by the observer.

Ratio estimation was used to calculate total captures in longline fisheries by target fishery fleet and area (Baird 2008) and across all fishing methods (Abraham et al. 2010b). New Zealand fur seal captures in surface-longline fisheries have been generally observed in waters south and west of Fiordland, but also in the Bay of Plenty and off East Cape. Estimated surface-longline captures range from 299 (95% c.i.: 199–428) in 2002–03 to 32 (14–55) in 2006–07 (Table 5.2). These capture rates include animals that are released alive; 5.6% of observed surface-longline captures from 2002–03 to 2014–15 were live releases (Abraham et al. 2017).

Captures of New Zealand fur seals have also been recorded in other fisheries; 39 in set nets, 2 in bottom-longline fisheries and 1 from purse seine fisheries from 2002–03 to 2014–15 (Abraham et al. 2017). Because observer data are too sparse and/or unrepresentative to support the estimation method, capture estimation models are not produced for these fisheries. Captures associated with recreational fishing activities are poorly known (Abraham et al. 2010a)

5.4.2 MANAGING FISHERIES INTERACTIONS

The population level impact of direct fisheries mortalities on the New Zealand fur seal population remains somewhat uncertain. However, fishing interactions are considered unlikely to have adverse consequences for New Zealand fur seals at the scale of the entire New Zealand population on the basis of the following evidence: i) the estimated level of bycatch relative to overall New Zealand fur seal abundance; ii) the apparently increasing population and range at most colonies; and iii) the low threat status assigned to this species by both the New Zealand and IUCN threat classification processes. However, fisheries impact and risk may be higher at the scale of particular colonies, or affecting regional subpopulations.

Management has focused on encouraging vessel operators to alter fishing practices to reduce captures, and monitoring captures via the observer programme. A marine mammal operating procedure (MMOP) has been developed by the deepwater sector to reduce the risk of marine mammal captures and is currently applied to trawlers greater than 28 m LOA.

Table 5.1: Monthly distribution of New Zealand fur seal activity and the main trawl and longline fisheries with observed reports of New Zealand fur seal incidental captures.

<table>
<tr><th>New Zealand fur seals</th><th>Sep</th><th>Oct</th><th>Nov</th><th>Dec</th><th>Jan</th><th>Feb</th><th>Mar</th><th>Apr</th><th>May</th><th>Jun</th><th>Jul</th><th>Aug</th></tr>
<tr><td>Breeding males</td><td>Dispersed at sea or at haulouts</td><td colspan="4">At breeding colony</td><td colspan="7">Dispersed at sea or at haulouts</td></tr>
<tr><td>Breeding females</td><td colspan="2">At sea</td><td colspan="2">At breeding colony</td><td colspan="8">At breeding colony and at-sea foraging and suckling</td></tr>
<tr><td>New pups</td><td colspan="3">At sea</td><td colspan="9">At breeding colony</td></tr>
<tr><td>Non-breeders</td><td colspan="12">Dispersed at sea, at haulouts, or breeding colony periphery</td></tr>
<tr><th>Major fisheries</th><th>Sep</th><th>Oct</th><th>Nov</th><th>Dec</th><th>Jan</th><th>Feb</th><th>Mar</th><th>Apr</th><th>May</th><th>Jun</th><th>Jul</th><th>Aug</th></tr>
<tr><td>Hoki trawl</td><td></td><td colspan="8">Chatham Rise and Stewart-Snares Shelf</td><td colspan="3">Cook Strait, west coast South Island, Puysegur</td></tr>
<tr><td>Squid</td><td colspan="3"></td><td colspan="2">Stewart-Snares Shelf</td><td colspan="6">Auckland Islands and Stewart-Snares Shelf</td><td></td></tr>
<tr><td>Southern blue whiting</td><td colspan="2">Pukaki Rise and Campbell Rise</td><td colspan="9"></td><td>Bounty Islands</td></tr>
<tr><td>Scampi</td><td colspan="12">Mernoo Bank (Chatham Rise) and Auckland Islands</td></tr>
<tr><td>Southern bluefin tuna longline</td><td colspan="6"></td><td colspan="5">South-west South Island</td><td></td></tr>
</table>

Table 5.2: Fishing effort and observed and estimated New Zealand fur seal captures in trawl and surface-longline fisheries by fishing year in the New Zealand EEZ (Abraham & Berkenbusch 2019, and see MPI data analysis at http://data.dragonfly.co.nz/psc, data version 2019v1). For each fishing year, the table gives the total number of tows or hooks; the observer coverage (the percentage of tows or hooks that were observed); the number of observed captures (both dead and alive); the capture rate (captures per hundred tows or per thousand hooks); the estimation method used (model or ratio); and the mean number of estimated total captures (with 95% confidence interval). For more information on the methods used to prepare the data, see Abraham & Berkenbusch 2019.

Fishing year	Fishing effort	Observed captures		Estimated captures		
	All effort	% observed	Number	Rate	Mean	95% c.i.
Trawl fisheries						
2002–03	130 154	5.3	68	0.994	927	646-1 307
2003–04	120 814	5.4	90	1.375	914	646-1 286
2004–05	120 429	6.4	199	2.580	1 579	1 170-2 123
2005–06	109 934	6.0	143	2.160	1 019	734-1 432
2006–07	103 307	7.7	74	0.935	660	469-916
2007–08	89 531	10.1	142	1.569	737	552-993
2008–09	87 550	11.2	72	0.737	493	353-682
2009–10	92 893	9.7	72	0.798	487	353-668
2010–11	86 079	8.7	73	0.980	551	374-819
2011–12	84 420	11.1	83	0.887	452	323-632
2012–13	83 849	14.8	121	0.976	600	413-904
2013–14	85 111	15.6	159	1.199	379	297-492
2014–15	78 765	17.2	127	0.936	479	352-653
2015–16	78 029	16.6	109	0.840	375	275-521
2016–17	78 173	17.6	79	0.576	–	–
2017–18	74 207	20.1	80	0.536	–	–
Surface-longline fisheries						
2002–03	10 770 038	20.4	56	0.026	408	289-556
2003–04	7 386 059	21.8	40	0.025	177	127-242
2004–05	3 682 895	21.3	20	0.026	88	58-125
2005–06	3 692 109	19.1	12	0.017	58	33-91
2006–07	3 739 882	27.8	10	0.010	34	19-52
2007–08	2 245 589	18.8	10	0.024	44	25-67
2008–09	3 115 633	30.1	22	0.023	66	45-94
2009–10	2 995 264	22.1	19	0.029	93	60-135
2010–11	3 188 179	21.2	17	0.025	76	48-112
2011–12	3 100 227	23.5	40	0.055	174	127-231
2012–13	2 876 782	19.5	21	0.037	130	82-192
2013–14	2 549 764	30.7	57	0.073	204	156-262
2014–15	2 412 336	30.1	37	0.051	151	109-202
2015–16	2 358 541	13.7	3	0.009	24	8-49
2016–17	2 094 236	16.5	32	0.093	–	–
2017–18	2 288 051	12.9	12	0.041	–	–

Figure 5.3. Observed captures of New Zealand fur seals (dead and alive) in trawl fisheries, the capture rate (per hundred tows), and the amount of total and observed effort by fishing year for regions with more than 50 observed captures since 2002–03: (a) New Zealand's EEZ; (b) the Cook Strait area; (c) the East Coast South Island area; (d) the Stewart-Snares Shelf area; and (e) the subantarctic area; and (f) the West Coast South Island area (Abraham et al. 2017, and see MPI data analysis at http://data.dragonfly.co.nz/psc, data version v2018001). Percentage effort included in the estimation is shown when it was less than 100%. For more information on the methods used to prepare the data, see Abraham and Thompson (2011).

It includes a number of mitigation measures supported by annual training, these include managing offal discharge, refraining from shooting the gear when New Zealand fur seals are congregating around the vessel and the introduction of 'trigger' points whereby if two fur seals are captured within 24 hours, or five seals over seven days, then the following procedure is triggered:

1. Advise vessel manager
2. Record capture event including location of capture in ship's log
3. Ensure gear failures are addressed with the gear either onboard or at a depth >50m
4. Report capture to Deepwater Group either directly or via shore management.

The major focus of the MMOP is to reduce the time gear is at or near the surface when it poses the greatest risk. MPI, via observers, monitors and audits vessel performance against this procedure (see the MPI National Deepwater Plan for further details). Research into methods to minimise or mitigate New Zealand fur seal captures in commercial fisheries has focused on fisheries in which New Zealand fur seals are more likely to be captured (trawl fisheries; see Clement and Associates 2009). Finding ways to mitigate captures has proved difficult because the animals are free swimming, can easily dive to the depths of the net when it is being deployed, hauled, or brought to the surface during a turn, and are known to actively and deliberately enter nets to feed. Further, any measures also need to ensure that the catch is not greatly compromised, either in terms of the amount of fish or their condition. Possible fish loss is one potential drawback of using seal exclusion devices (see Rowe 2007). Adhering to current risk mitigation methods (e.g., MMOP) will help to minimise the level of impacts, however bycatch rates are still expected to fluctuate depending on fleet deployment, New Zealand fur seal abundance and local feeding conditions.

5.4.3 MODELLING POPULATION-LEVEL IMPACTS OF FISHERIES INTERACTIONS

Uncertainty about the size of the New Zealand fur seal population limits our ability to estimate the effects of direct fisheries mortalities on sea lions at the scale of the New Zealand population. Potential impacts on specific colonies are best addressed via spatially explicit methods (below). The provenance of New Zealand fur seals caught during fishing is presently unknown. Improved research to understand foraging distributions in relation to colony locations is in progress (PMM2018-04A). In addition, genetics research may help to assign bycaught animals to a specific colony (Robertson & Gemmell 2005).

5.4.4 MULTI-SPECIES MARINE MAMMAL RISK ASSESSMENT

In 2017, the first iteration of a New Zealand Marine Mammal Risk Assessment (NZMMRA) was complete (Abraham et al. 2017) applying a partial implementation of the Spatially Explicit Fisheries Risk Assessment (SEFRA) method formerly applied for New Zealand seabirds and described in Chapter 3.

In the risk assessment outputs fur seals are the seventh-highest at-risk species of marine mammal from New Zealand commercial fisheries. Fisheries risk to fur seals is attributable primarily to 'other trawl' fisheries (i.e., primarily targeting hoki and southern blue whiting), and secondarily to set net fisheries. Estimated annual potential fishery-related deaths for fur seals by fishery group are shown in Figure 5.5.

The estimated cumulative fisheries risk score for fur seals ranges from approximately 0.2 to 0.6 (Figure 5.4), consistent with colony observations indicating a general trend of increasing population size in recent years. Note that unlike the NZSRA, the NZMMRA does not utilise population monitoring results directly in the risk assessment to inform or constrain total fishery related deaths to be consistent with observed adult survival rates. Introducing this constraint is a priority when a full implementation of the SEFRA framework is delivered for all marine mammal species (PMM2018-07).

An independent external review of the SEFRA method (Lonergan et al. 2017) noted that the reliability and specific applicability of the previous NZMMRA is limited by its reliance on species spatial distributions derived from expert knowledge in which animal densities are assigned to discrete spatial blocks using a Delphi approach. The reviewers recommended that the MMRA should be updated using more reliable species spatial distributions as these become available. Input data layers reflecting finer-scale spatial and seasonal patterns are likely to be especially important for coastal and/or colony-associated species such as fur seals. Where sightings or satellite telemetry data are available, it is likely that these can be used to parameterise predictive spatial foraging models fitted to continuous environmental variables using multivariate statistical approaches, to estimate spatio-temporal species distributions in a more rigorous way. This work has recently been completed to improve available distribution models for cetaceans (under contract PRO2014-01) and for Māui and Hector's dolphins (PRO2017-12). This work is in progress for Auckland Island sea lions (PRO2017-09), for Stewart Island/ South Island sea lions (PMM2018-04B); and for New Zealand fur seals (PMM2018-04A). Because fur seals show sex-specific movement patterns, it is likely that this work will consider male and female distributions and mortalities separately, given that male and female deaths are likely to have very different implications for the population response of harem-breeding mammals

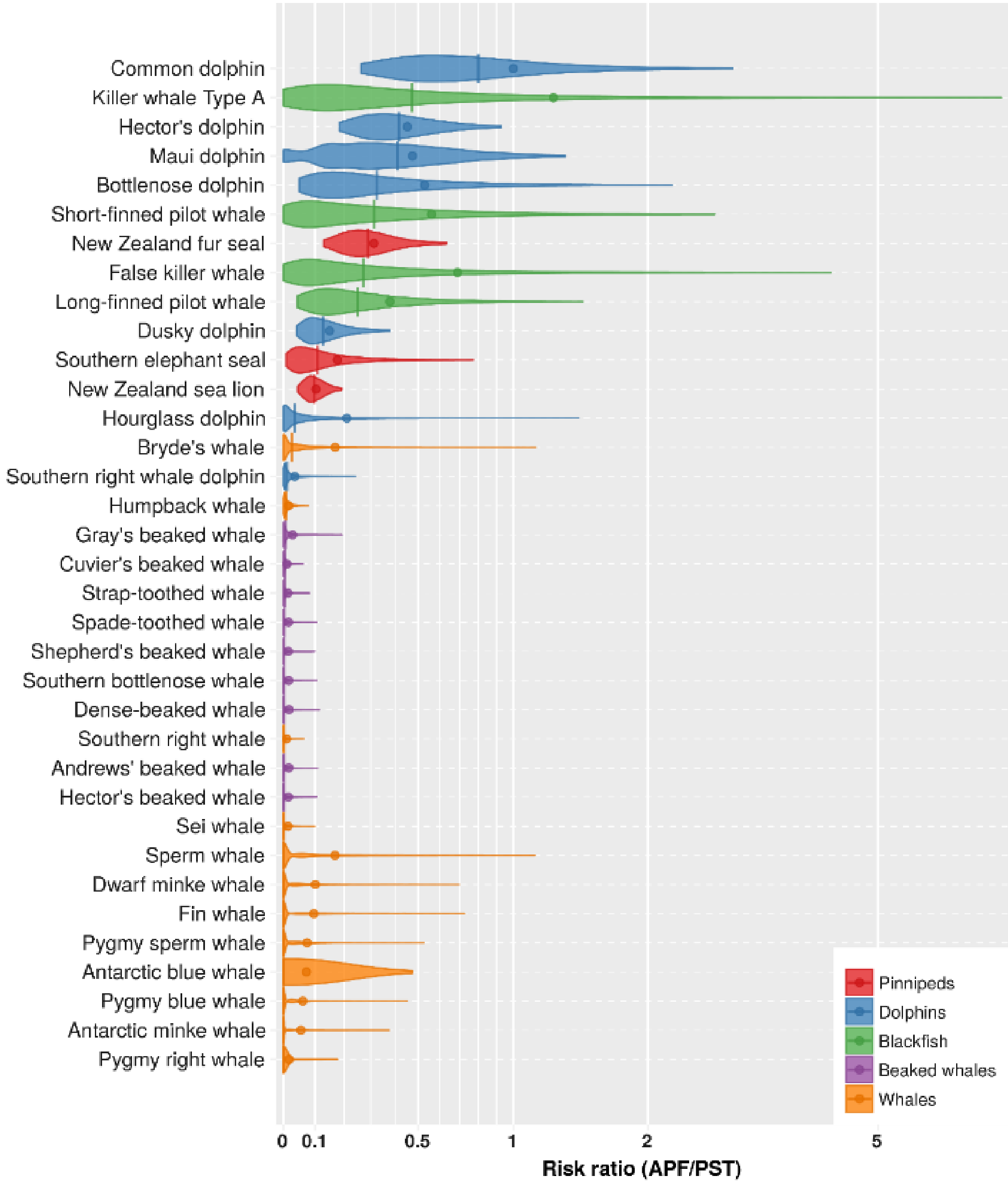


Figure 5.4: Cumulative fishery risk across all fishery groups as estimated by the 2016 New Zealand Marine Mammal Risk Assessment (NZMMRA; Abraham et al. 2017). Species groups are colour coded.

5.4.5 SOURCES OF UNCERTAINTY

Any measure of the effect of New Zealand fur seal mortality from commercial fisheries on New Zealand fur seal populations requires adequate information on the size of the populations at different colonies. Although there is reasonable information about where the main New Zealand fur seal breeding colonies occur, colony size and population dynamics are poorly understood. At present, the main sources of uncertainty are the lack of consistent data on: abundance by colony and in total; population demographic parameters; and at-sea distribution (which would ideally be available at the level of a colony or wider geographic area where several colonies are close together) (Baird 2011). Collation and analysis of existing data, such as that for the west coast South Island, would fill some of these gaps; there is a 20-year time series of pup production from three west coast South Island colonies, a reasonably long data series from the Otago Peninsula, and another from Kaikoura. Maximum benefit could be gained through the use of all available data, as shown by the monitoring of certain colonies of New Zealand fur seals in Australia to provide a measure of overall population stability (see Shaughnessy et al. 1994, Goldsworthy et al. 2003).

Fur seals may forage in waters near a colony or haulout, or may range widely, depending on the sex, age, and individual preferences of the animal (Baird 2011). It is not known whether the New Zealand fur seals around a fishing vessel are from colonies nearby. Some genetic work is proposed to test the potential to differentiate between colonies so that in the future New Zealand fur seals drowned by fishing gear may be identified as being from a certain colony (Robertson & Gemmell 2005).

The low to moderate levels of observer coverage in some fishery-area strata add uncertainty to the total estimated captures. However, the main source of uncertainty in the level of bycatch is the paucity of information from the inshore fishing fleets, which use a variety of gears and methods. Recent increases in observer coverage enabled fur seal capture estimates to include inshore fishing effort. Further increases in coverage, particularly for inshore fisheries, would provide better data on the life stage, sex, and size of captured animals, as well as samples for fatty acid or stable isotope analysis to assess diet and to determine provenance. Information on the aspects of fishing operations that lead to capture in inshore fisheries would also be useful as input to designing mitigation measures.

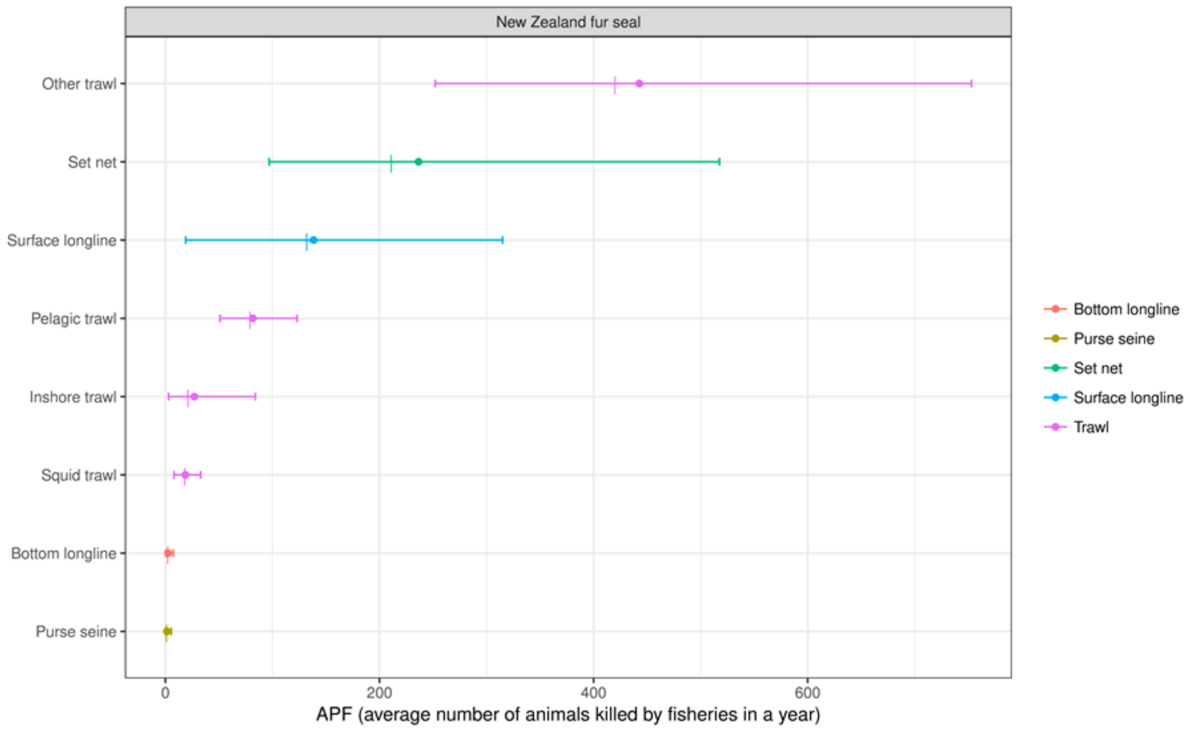
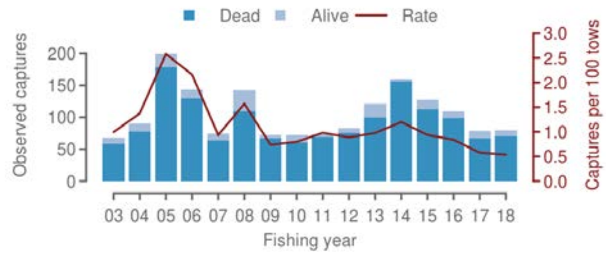
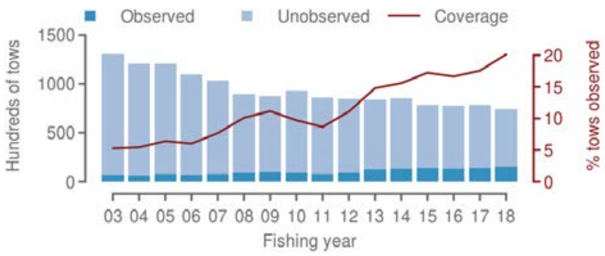


Figure 5.5: Preliminary estimates of annual potential fishery-related deaths of fur seals by fishery group, as estimated by the 2016 New Zealand Marine Mammal Risk Assessment (NZMMRA; Abraham et al. 2017).

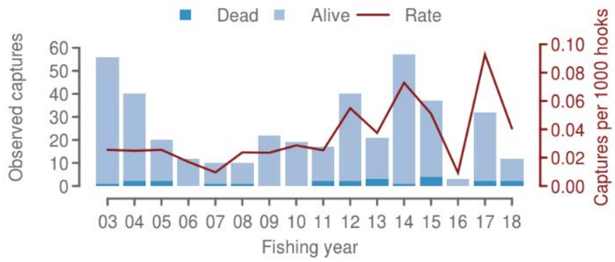
5.5 INDICATORS AND TRENDS

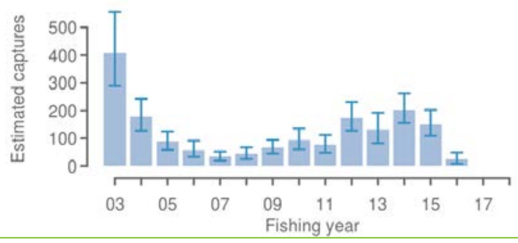
<table>
<tr><td>Population size</td><td>Unknown, but potentially ~100 000 in the New Zealand EEZ.[2]</td></tr>
<tr><td>Population trend</td><td>Increasing at some mainland colonies but unknown for offshore island colonies. Range is thought to be increasing.</td></tr>
<tr><td>Threat status</td><td>New Zealand: Not Threatened, Increasing, Secure Overseas, in 2013.[3]
IUCN: Least Concern, in 2015.[4]</td></tr>
<tr><td>Number of interactions</td><td>375 estimated captures (95% c.i.: 275–521) in trawl fisheries in 2015–16[6]
24 estimated captures (95% c.i.: 8–49) in surface-longline fisheries in 2015–16[6]
80 observed captures in trawl fisheries in 2017–18[6]
12 observed captures in surface-longline fisheries in 2017–18[6]
949.3 estimated annual potential fatalities (APF) (95% c.i.: 949.3–1 406.5) [7]</td></tr>
<tr><td>Tends in interactions[6]</td><td>Trawl fisheries:





Surface-longline fisheries:





</td></tr>
</table>

[2]Taylor (1990), Harcourt (2001).

[3] Baker et al. (2016).

[4] Chilvers & Goldsworthy (2015).

[6] For more information, see: http://data.dragonfly.co.nz/psc.

[7] Abraham et al. (2017).

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