Chapter 7: Common dolphin (*Delphinus delphi delphi*) - Technical Summary

Common dolphin
(*Delphinus delphi delphi*)

Not threatened (Baker et al. 2019)

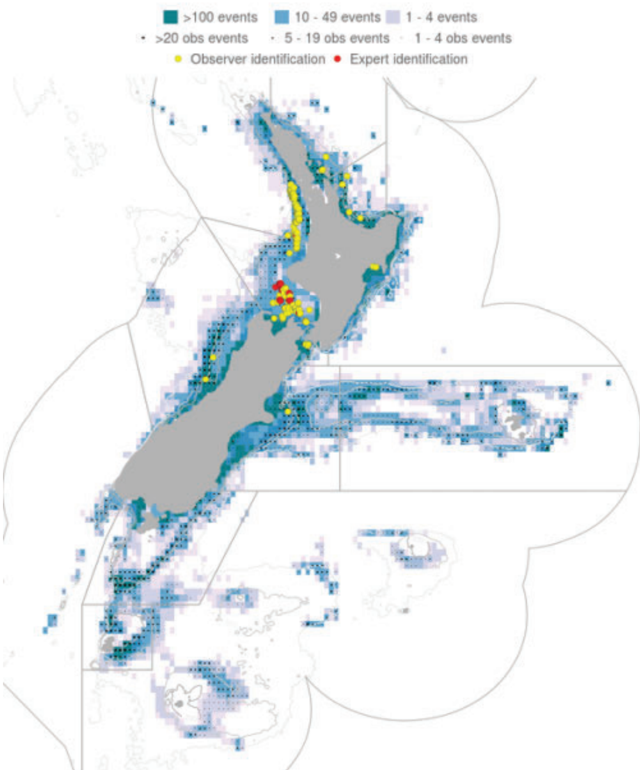
1. THE ISSUE IN BRIEF

- The common dolphin (*Delphinus delphi delphi*) is a marine mammal species with a worldwide distribution
- Common dolphins are abundant and generally not threatened worldwide. They are locally threatened in some areas (e.g., the Mediterranean Sea)
- Like other marine mammals, common dolphins are protected under the Marine Mammals Protection Act 1978 and the Fisheries Act 1996
- Tourism and fisheries are considered two of the greatest potential threats to common dolphin in NZ waters

2. POTENTIAL THREATS

Potential threats to common dolphins include stranding, diseases, natural predation, toxins, habitat loss, ship strikes, tourism-related disturbance, fishing mortality, and negative trophic interactions with fisheries

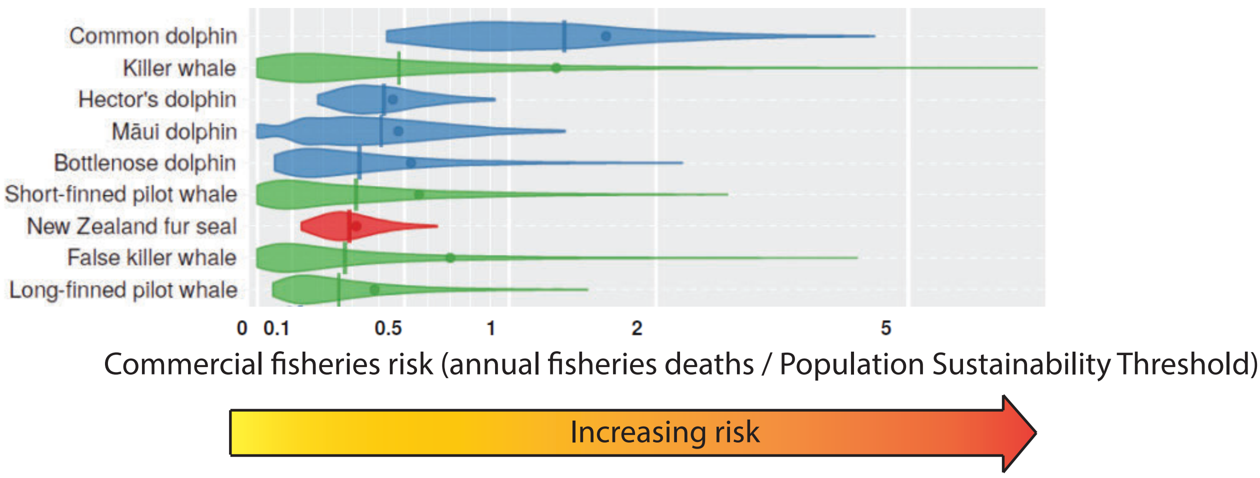
3. INCIDENTAL CAPTURES - LOCATION



- Between 2002–03 and 2017–18, there were 214 observed incidental captures of common dolphins in trawl fisheries, two in surface longline fisheries, and six in set net fisheries
- The main trawl fisheries contributing to incidental captures of common dolphins are jack mackerel, as well as inshore and midwater (mainly hoki) trawls. The jack mackerel midwater trawl fishery contributed the most, and captures mostly resulted in fatal events
- The most common location for incidental captures has been the west coast of the North Island, with a hotspot in the Taranaki Bight
- Observations are limited due to the complexity of the inshore trawl fishery therefore we are uncertain about capture levels

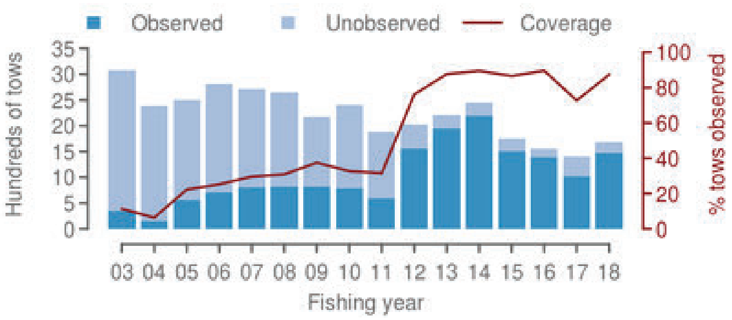
Map of common dolphin captures in NZ trawl fisheries between 2002 and 2018. Yellow and red dots indicate common dolphin capture events, reported by observers and experts, respectively. Blue shades represent the trawl fishing effort

4. RISK ASSESSMENT

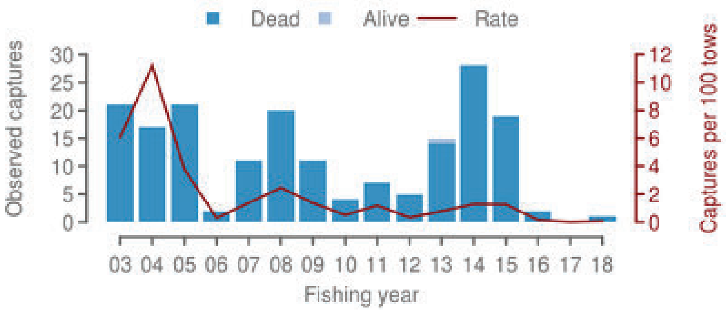


The 2016 multi-species marine mammal risk assessment (MMRA) estimated that commercial fisheries risk to common dolphins may be high, but is highly uncertain, reflecting biological unknowns (uncertain population size and population structure) and low observer coverage in inshore trawl fisheries. The New Zealand threat status for common dolphins is 'not threatened' (Baker et al. 2019). Improved population assessment will reduce this uncertainty and inform a more reliable assessment of commercial fisheries risk to common dolphins.

5. INCIDENTAL CAPTURES - JACK MACKEREL TRAWL FISHERIES



The observer coverage on board of jack mackerel trawl vessels has been steadily increasing since 2003, reaching nearly full coverage in recent years



Captures of common dolphin have been decreasing since 2003–04, due to mitigation measures in fishing operations, and have been negligible in the last 3 years

Fishing effort (above) and observed captures (below) of common dolphin in NZ trawl fisheries

6. ONGOING RESEARCH

- Improved estimates on population size and structure of common dolphin in NZ to inform risk assessment at smaller spatial scales
- Improved models of common dolphin spatial distribution, based on environmental and sighting data

7 COMMON DOLPHIN (*DELPHINUS DELPHIS DELPHIS*)

Status of chapter	This chapter has not been updated for AEBAR 2021.
Scope of chapter	This chapter briefly describes: the biology of short-beaked common dolphins (*Delphinus delphis delphis*); 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	The New Zealand EEZ and Territorial Sea.
Focal localities	Areas where significant fisheries interactions are known to have occurred include waters off the west coast of the North Island (including Taranaki Bight) and to a lesser extent Cook Strait.
Other than the Key issues	Improved means of estimating incidental captures and risk in poorly observed inshore fisheries; improved understanding of population size and structure; improved understanding of common dolphin spatio-temporal distributions affecting interaction rates with fishing effort.
Emerging issues	Improved ability to assess risk and apply risk management solutions on a regional subpopulation basis, or at finer spatial and temporal scales
MPI research (current)	PRO2013-01 *Estimation of Seabird and Marine Mammal Captures*; PRO2014-01 *Improving information on the distribution of seabirds and marine mammals*; PRO2017-08A *Research into the demographic parameters for at-risk marine mammals as identified by the risk assessment (common dolphins).*
NZ government research (current)	DOC Marine Conservation Services Programme (CSP): INT2015-01 *To understand the nature and extent of protected species interactions with New Zealand commercial fishing activities*; INT2015-03 *To determine which marine mammal, turtle and protected fish species are captured in fisheries and their mode of capture*.
Other research	Massey University: Skull morphometrics, growth and reproductive biology, diet and nutritional ecology, fine-scale distribution and abundance, and mother-offspring dynamics of common dolphins in New Zealand. Auckland University: Impacts of tourism on dolphin behaviour examining and the effectiveness of permit changes to the dolphins' responses to swimmers and boats.
Related chapters/issues	Chapter 3: Spatially Explicit Fisheries Risk Assessment (SEFRA); See also the JMA chapter, page 557, of the Fisheries Assessment Plenary Volume 2 (MPI 2017)

7.1 CONTEXT

Short-beaked common dolphins (*Delphinus delphis delphis*) were first described by Linnaeus in 1758 and have a worldwide distribution. In New Zealand waters, this species is protected under the Marine Mammal Protection Act (MMPA) of 1978 and the Fisheries Act (FA) of 1996. All marine mammals are protected under the s.2 (1) of the FA. The ministers for the Department of Conservation (DOC) and the Ministry for Primary Industries (MPI) can jointly approve a population management plan (PMP) for one or more species under s.14F of the Wildlife Act or s.3E of the MMPA. This PMP can include a maximum allowable level of fishing-related mortality of the species in New Zealand waters and recommendations to the Minister of Fisheries on 1) measures to mitigate fishing-related mortality and 2) the standard of information to be collected on fishing-related mortality. Currently, a PMP does not exist for common dolphins.

MPI manages fishing-related mortalities of common dolphins under s.15 (2) of the FA '*to avoid, remedy, or mitigate the effect of fishing-related mortality of any protected species and such measures may include setting a limit on fishing-related mortality.*' The 2005 Conservation General Policy administered by DOC specifies that *'protected marine species should be managed for their long-term viability and recovery throughout their natural range'*. The management of fisheries interactions with common dolphins aligns with the 2030 objective 6 to *'manage impacts of fishing and aquaculture'* and Strategic Action 6.2 to *'set and monitor environmental standards, including for threatened and protected species and seabed impacts'*.

Under the National Deepwater Plan, Objective 2.5 is most relevant to the management of common dolphins in New

Zealand waters: *'manage deepwater and middle-depth fisheries to avoid or minimise adverse effects on the long-term viability of endangered, threatened, and protected species'* (Ministry for Primary Industries 2012). The National Deepwater Plan contains information for fisheries to assess and manage marine mammal interactions with the deepwater fishing activity including a Marine Mammal Operating Procedure (MMOP), which outlines specific mitigation practices and proper handling of incidental marine mammal captures (Ministry for Primary Industries 2012).

Management Objective 7 of the National Fisheries Plan for Highly Migratory Species (HMS) is to 'implement an ecosystem approach to fisheries management, taking into account associated and dependent species' (Ministry of Fisheries 2010). The goals under this objective are as follows:

1. Avoid, remedy, or mitigate the adverse effects of fishing on associated and dependent species, including through maintaining food chain relationships.
2. Minimise unwanted bycatch and maximise survival of incidental catches of protected species in HMS fisheries using a risk management approach.
3. Increase the level and quality of information available on the capture of protected species.

The Draft National Fisheries Plan for Inshore Finfish states that the objectives of all groups is *'to minimise the adverse impact of fishing actives on the aquatic environment, including on biological diversity'* (Ministry of Fisheries 2011).

7.2 BIOLOGY

7.2.1 TAXONOMY

Within the Delphindae family, common dolphin are a member of the subfamily Delphininae (Perrin 1989). Based on genetic and morphological differences, there are two currently recognised species of common dolphins, the short-beaked (*Delphinus delphis*) and the long-beaked (*D. capensis*) (Rosel et al. 1994, Heyning & Perrin 1994). There are two subspecies of the short-beaked common dolphin (*D. d. Delphis* and *D. d. ponticus*), which is found only in the black sea) and two subspecies of long-beaked common dolphin (*D. c. capensis* and a nominal subspecies recognized as *D. c. tropicalis*; Jefferson & Waerebeek 2002). Genetic and morphometric differences between common dolphin populations in the South Pacific and those from other parts of the world have cast uncertainty as to the taxonomic identity of the New Zealand population of common dolphins (Bell et al. 2002, Stockin 2008, Stockin & Visser 2005). Skull morphometry values from Australia and New Zealand common dolphins fall between those reported for short- and long-beaked common dolphins. However, initial evidence suggests that the species in New Zealand waters is a larger form of the short-beaked common dolphin found elsewhere (Jordan et al. 2015, Jordan 2012, Bell et al. 2002). For the remainder of this chapter, 'common dolphin' will refer to the short-beaked species – *D. d. delphis*.

7.2.2 DISTRIBUTION

Common dolphins are found worldwide in tropical, subtropical, and temperate waters of the Pacific and Atlantic oceans (Hammond et al. 2008, Evans 1994) (Figure 7.1). This species also occurs in confined seas such as the Sea of Okhotsk and Sea of Japan as well as in small subpopulations in places such as the Mediterranean and Black Seas (Hammond et al. 2008). New Zealand waters represent the southern-most limit of common dolphins. Common dolphins are found around both the North and South Island (Brager & Schnieder 1998, Gaskin 1968, Berkenbusch et al. 2013, Constantine & Baker 1997) (Figures 1.2 and 1.3). However, Gaskin (1968) suggests that the distribution of common dolphins in New Zealand waters is constrained to warmer waters (greater than ca. 14°C) and is limited by the subtropical East Cape Current in the north and the subtropical convergence in the south.

Common dolphins are frequently observed along the northern and eastern coast of the North Island in the Bay of Islands, Hauraki Gulf, Mercury Bay, and in small groups, outside Wellington Harbour (Gaskin 1968, Constantine & Baker 1997, Neumann & Orams 2005, O'Callaghan & Baker 2002). Similar to other populations, common dolphins in New Zealand waters exhibit inshore and offshore daily and seasonal movements (Meynier et al. 2008, Neumann 2001c, Stockin 2008). The seasonal distribution of common dolphins is largely determined by the behaviour of their prey. Common dolphins are known to forage on small schooling fish that are strongly linked to sea surface temperature (SST). As a result, both common dolphins and their prey are found close to shore in the spring and summer when SST is high and further offshore in the autumn when SST drops (Neumann 2001, Stockin 2008, Neumann 2001). This species is also known to adjust their seasonal movements to take advantage of warmer water during a La Niña event (Neumann 2001).

Common dolphins are encountered in single and large multi-species groups with both seabirds and other marine mammals (hundreds to thousands) and found in waters both nearshore and thousands of kilometres offshore, in pelagic waters (Evans 1994). In New Zealand waters, they are known to form large aggregations with approximately 10 seabird and seven cetacean species. Of the seabird species, common dolphins are most often associated with the Australasian gannet (*Morus serrator*). Associations with other cetaceans include: bottlenose dolphins (*Tursiops truncatus*), striped dolphins (*Stenella coeruleoaba*), Hector's dolphin (*Cephalorhynchus hectori hectori*), Dusky dolphin (*Lagenorhynchus obscurus*), Minke whale (*Balaenoptera acutorostrata*), Sei whale (*Balaenoptera borealis*), and Bryde's whales (*Balaenoptera brydei*) (Stockin 2009).

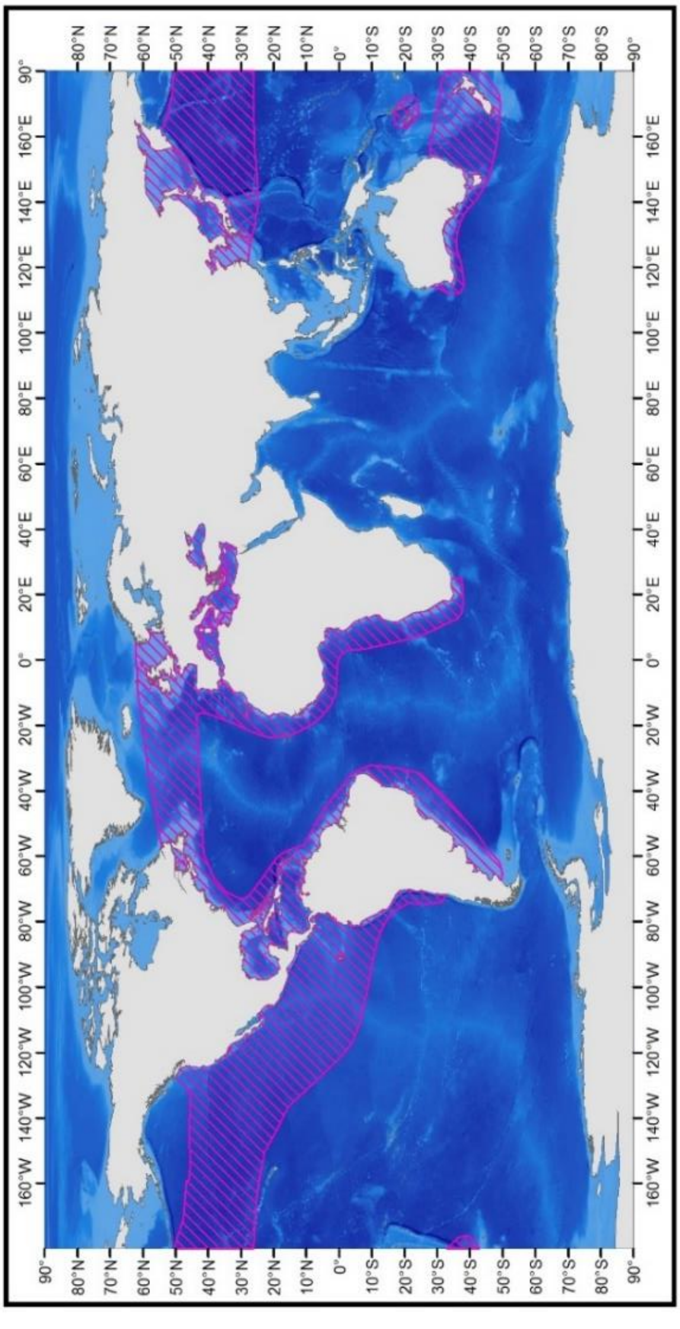


Figure 7.1: Worldwide distribution of short-beaked common dolphins (*Delphinus delphis delphis*) provided by the International Union for the Conservation of Nature (IUCN) (Hammond et al. 2008). Magenta hatched areas indicate range.

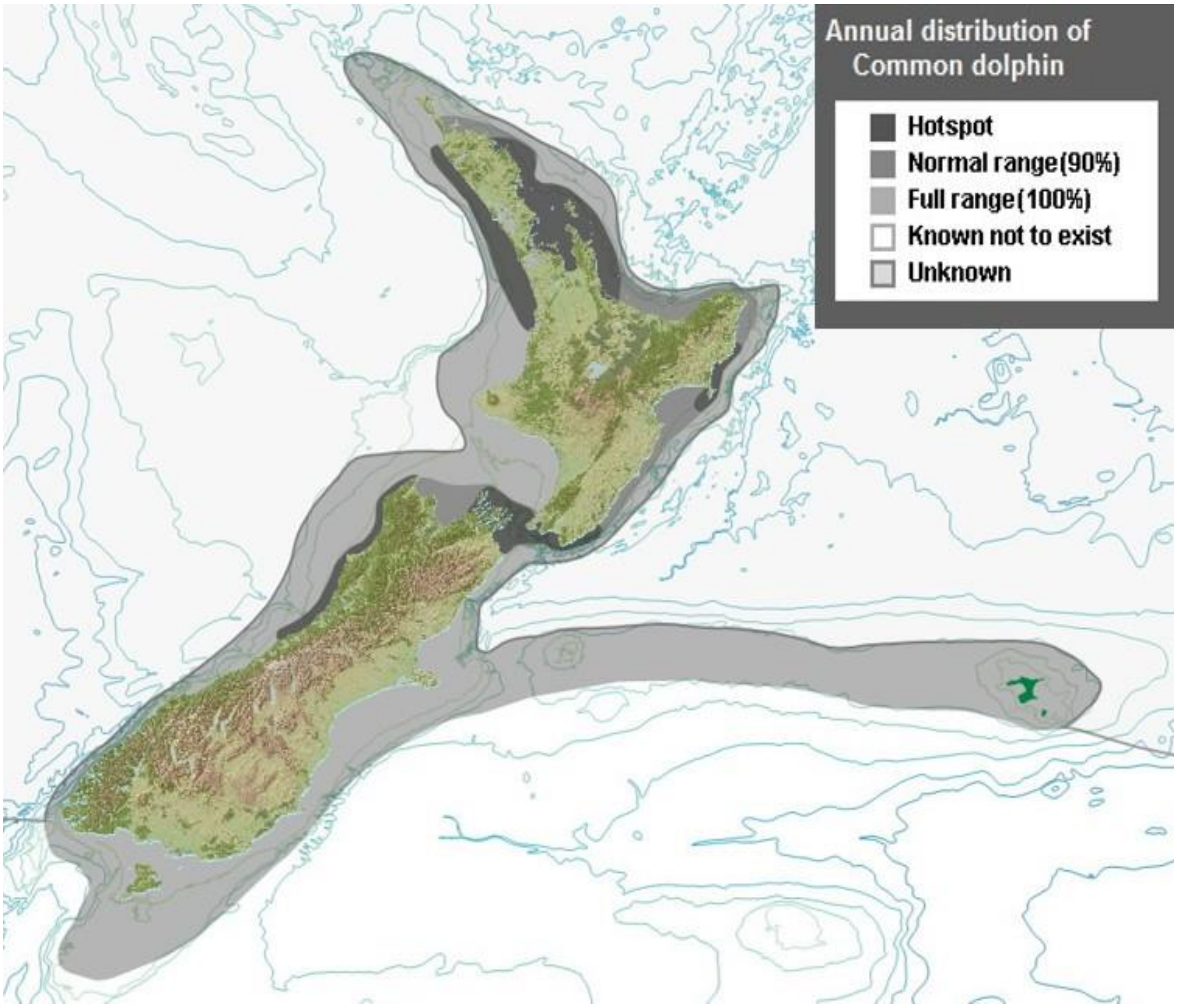


Figure 7.2: Distribution of short-beaked common dolphins (*Delphinus delphis delphis*) in New Zealand waters (from www.nabis.govt.nz).

7.2.3 FORAGING ECOLOGY

The diet of common dolphins has primarily been assessed from the stomach contents of stranded and incidentally captured animals. Studies on common dolphins worldwide have documented the primary prey items as small schooling epipelagic and mesopelagic fish such as mackerel, sardines, and anchovies, as well as squid (Hammond et al. 2008, Young & Cockcroft 1994, Silva 1999, Bearzi et al. 2003, Pusineri et al. 2007, Overholtz 1991, Morizur et al. 1999). While there is abundant information on the diet of common dolphins for many populations, there is relatively little information for common dolphins in New Zealand waters.

Although research has specifically identified the Hauraki Gulf as an area extensively used for feeding, common dolphins forage in waters all around New Zealand (Stockin et al. 2009a). In one study, common dolphins off the east coast of the North Island were observed foraging on schools of jack mackerel (*Trachurus novaezelandiae*), schools of juvenile kahawai (*Arripis trutta),* yellow-eyed mullet (*Aldrichetta forsteri*), flying fish (*Cypselurus lineatus*), and, on one occasion, a school of parore (*Girella tricuspidata*), and garfish (*Hyporamphus ihi*) (Neumann & Orams 2003). The prevalent prey species from the stomach contents of animals stranded around the New Zealand coastline (n=27) and animals incidentally captured in the jack mackerel fishery off the west coast of the North Island (n=10) included arrow squid (*Nototodarus* sp.), anchovy (*Engraulis australis*), jack mackerel (*Trachurus* spp.) (Meynier et al. 2008). In another study, pilchard (*Sardinops neopilchardus*), and garfish (*Hyporhamphus ihi*) were the predominant prey items found in the stomachs of nine New Zealand common dolphin carcasses (n=9) classified as 'entanglement' (Stockin et al. 2009b).

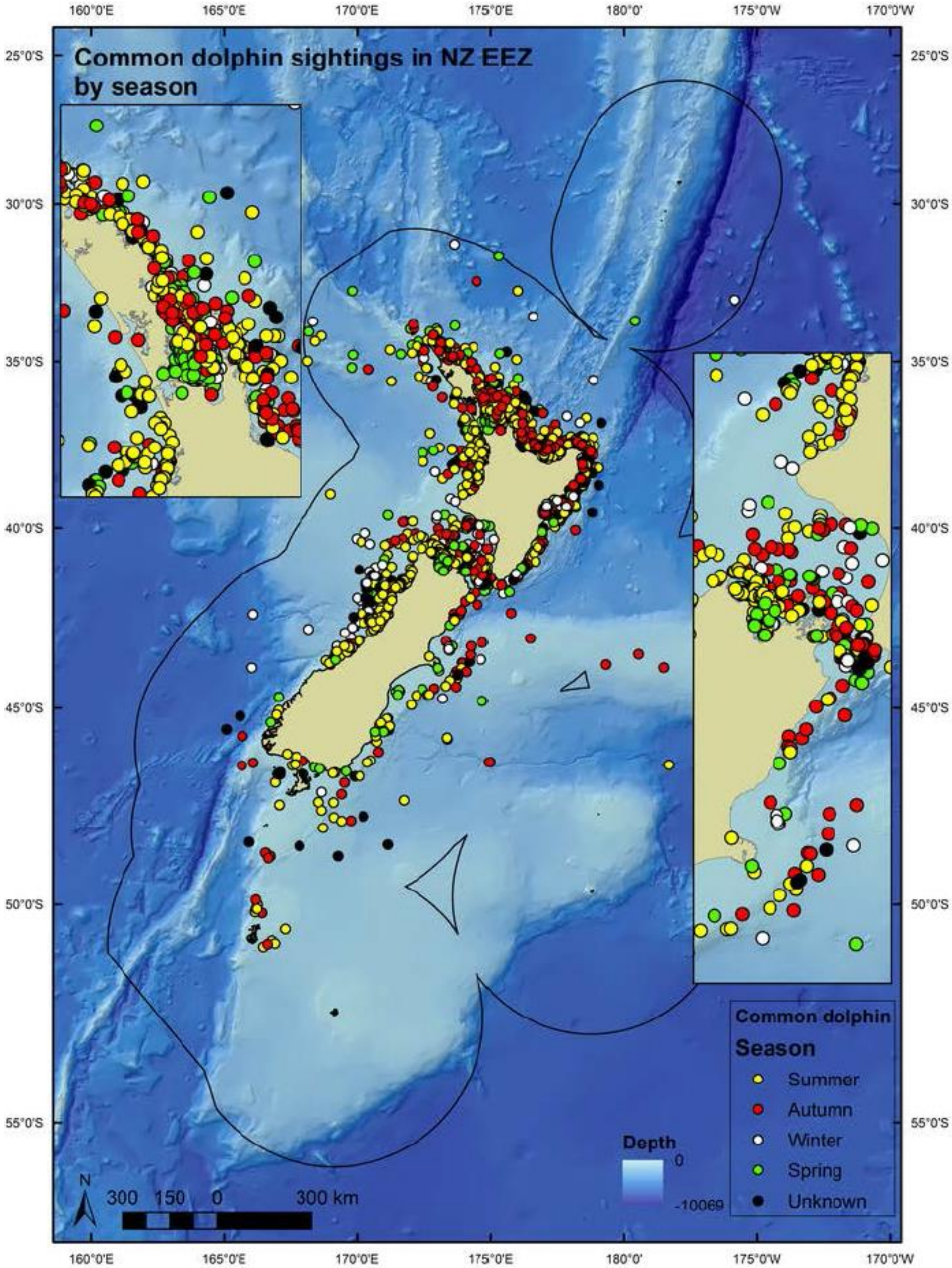


Figure 7.3: Systematic and opportunistic sightings of short-beaked common dolphins (*Delphinus delphis delphis*) in New Zealand waters between 1970 and 2013. Data sources include Department of Conservation (DOC), Cawthorn (2009), opportunistic at-sea sightings (NIWA), and the Centralised Observer Database (COD). (Sightings are indicative of the distribution only). Figure from Berkenbusch et al. (2013).

The similarity in prey items found in the stomachs of coastal and offshore animals provides further support that common dolphins in New Zealand make daily excursions between nearshore and offshore environments (Meynier et al. 2008). In addition, many of the prey species (e.g., squid) found in the stomachs of common dolphins are found in the deep scattering layer, which migrates towards the surface at night (Hammond et al. 2008, Neumann & Orams 2003). Neumann & Orams (2003) cite personal communication with S. Morrison in which common dolphin were sighted by crew members of squid boats during nocturnal fishing in Mercury Bay suggesting that time of day may provide important foraging opportunities for this species. The ability of common dolphins to feed on small schooling fish in shallow coastal waters during the day and on prey in the deep scattering layer in pelagic waters at night may indicate foraging plasticity (Neumann 2001). Acoustic research in New Zealand waters showed that during the day the mesopelagic layer occupied waters deeper than 200 m, then rapidly ascended to close to the surface after sunset; throughout the night, this layer dispersed downwards but remained in depths of less than 200 m until dawn when the it descended to day depths (McClatchie & Dunford 2003, O'Driscoll et al. 2009). O'Driscoll et al. (2013) found that schools of jack mackerel ascended and dispersed at night and were seen in depths of 10–30 m before dawn.

To exploit a large range of prey species, common dolphins exhibit a variety of foraging strategies. In New Zealand waters, both individual and coordinated feeding strategies have been documented (Neumann & Orams 2003). Individual foraging strategies include four types of behaviour: high-speed pursuit (traveling at high velocity in a zig-zag erratic fashion), fish-whacking (fish whacked with tail-fluke) and kerplunking (rapid tail-fluke movement in shallow water) (Neumann & Orams 2003, Constantine & Baker 1997). Furthermore, coordinated foraging strategies include: wall formation (driving fish into shallower water), carouseling (herding fish against the water surface), and bubble-blowing (startling herded fish).

Common dolphins are often observed foraging in association with other species (Neumann & Orams 2003). Rather than initiating feeding as a multi-species group, research indicates that birds and cetaceans may alert one another to prey by their presence and behaviour (Neumann & Orams 2003).

7.2.4 REPRODUCTIVE BIOLOGY

Despite their global distribution, relatively little information exists on the reproductive biology of common dolphins. Most of the existing information comes from studies on common dolphin populations in the North Pacific, Eastern Tropical Pacific, or North Atlantic and may or may not be applicable to the population of animals in New Zealand waters. Male and female age of sexual maturity for common dolphins in the North Pacific is 10.5 years for males and 8.0 years for females with lengths ranging 179–182 cm and 170.7–172.8 cm, respectively (Ferrero & Walker 1995). In the North Atlantic population, males reach sexual maturity at 9.5 years and 213 cm and females at 8.3 years and 200 cm (Westgate & Read 2007). A later age of sexual maturity for males may be the result of delayed breeding until the testes are large enough to compete with other males (Westgate & Read 2007).

Testes weight of sexually mature males ranges from 273.2 to 1190 g (Ferrero & Walker 1995). Male common dolphins in the North Atlantic exhibit seasonal changes in testes size with largest testes occurring in mid-July and smallest in October (Westgate & Read 2007). The peak in testes size corresponds with the timing of ovulation, conception and parturition and changes five-fold between maximum expansion and retraction. In mature males, testes comprised 2.2–3% of their total body mass (Westgate & Read 2007). Results from Westgate & Read (2007) suggest common dolphins in the North Atlantic engage in sperm competition as evidences by the seasonal change in testes size. The slight sexual dimorphism between sexes, in addition to seasonal changes in testes size, indicate that males compete for access to oestrous females and that females likely mate with many males (Westgate & Read 2007). Given that many common dolphins in temperate environments exhibit reproductive seasonality, it is likely that the New Zealand population of animals also exhibits a peak in reproduction that may correspond to seasonally abundant prey or optimal water temperatures.

Although gestation time for common dolphins in New Zealand waters is unknown, the length of gestation for this species is about 11 months for the North Pacific population, 11–12 months for the North Atlantic population, and 11 months for the Black Sea population (Westgate & Read 2007, Ferrero & Walker 1995, Gaskin 1972). Like all odontecetes, common dolphins give birth to a single calf, though one occurrence of a twin birth was reported off the coast of Spain (Gonzalez et al. 1999). At parturition, Westgate & Read (2007) estimated the length of neonate common dolphins in the North Atlantic at 93.2 cm. Neonates nurse for approximately six months and begin foraging at three to six months of age (Brophy et al. 2009). Common dolphins in the North Atlantic were found to have a minimum inter-birth interval of two years (Westgate & Read 2007).

In New Zealand waters, calves are seen year-round in the Hauraki Gulf, however, peak numbers are recorded in late spring and early summer months of December and January (Stockin et al. 2008). Common dolphins are considered a social species, showing non-random associations with other individuals. Sexual segregation in which animals divide into 'bachelor' (adult males), and 'nursery' (adult females and calves) groups has been observed in common dolphins in New Zealand waters (Neumann 2001, Neumann et al. 2002, Viricel et al. 2008). Mixed-sex groups also occur though they are usually associated with mating activities. The lack of stability in group composition is known as a 'fission-fusion' society in which group composition changes almost daily (Connor et al. 2000, Neumann 2001).

7.2.5 POPULATION BIOLOGY

The abundance of common dolphins is estimated at 4 000 000 worldwide with population estimates existing for many regions: 370 000 in the western US; 3 000 000 in the Eastern Tropical Pacific; 30 000 off the eastern US; 96 000 in the Black Sea; 60 000 on the eastern Atlantic continental shelf; 14 700 in the Alboran Sea; 75 000 in the Celtic Sea Shelf; and 19 400 in the western Mediterranean Sea (Jefferson et al. 2011, Hammond et al. 2008).

Although there is currently no abundance estimate for common dolphins in New Zealand waters, they are considered the most abundant and widespread cetacean recorded in the Hauraki Gulf, an important foraging and nursery area, in the summer (O'Callaghan & Baker 2002). Unlike common dolphins in other areas of New Zealand waters, in the Hauraki Gulf, this species exhibits high site fidelity (Stockin et al. 2008, 2014).

The maximum age of short-beaked common dolphins in western North Atlantic teeth was estimated at over 30 years using teeth samples from 204 bycaught and stranded animals (Westgate & Read 2007). Similarly, growth layers of teeth collected from 206 common dolphins in New Zealand waters that were stranded or bycaught in the midwater trawl fishery for jack mackerel (*T. novaezelandiae*) estimated maximum age at over 20 years and 29 years for males and females, respectively (Stockin et al. 2011, Murphy et al. 2014). Seven common dolphins incidentally caught by New Zealand fisheries and returned for autopsy were aged between 4 and 11 years (based on dentinel growth layers) (Duignan et al. 2003, 2004, Duignan & Jones 2005).

Microsatellite analyses of nearshore and offshore New Zealand common dolphins suggest that these animals have recently diverged (Stockin et al. 2014). In addition, the presence of high genetic variation at the southern limit of their distribution suggests that the overall population in New Zealand waters may be expanding and that there are fine-scale population level differences (Stockin et al. 2014).

Common dolphin populations are subject to many natural and anthropogenic threats that include but are not limited to: stranding, disease, predation, toxins, habitat loss, vessel-strike, recreational and commercial fishing and tourism-based activities. The cumulative impact of these threats on common dolphin populations has not been assessed. Drivers of common dolphin mortality include seasonal environmental variation, commercial fisheries interactions, habitat degradation, high-intensity acoustic disturbance, and disease (Murphy et al. 2013).

The Mediterranean Sea population of common dolphins was greatly reduced due to five main factors: 1) habitat loss, 2) prey depletion, 3) incidental captures by fisheries, and 4) immuno-suppression caused by chemical contamination, and 5) environmental fluctuations (Bearzi et al. 2003). In addition, at least 840 000 animals were removed from the Black Sea by hunters between 1946 and 1983, after which the population further declined due to disease and overfishing of prey species (Hammond et al. 2008).

In the absence of a population estimate for common dolphins in New Zealand waters, the impact of natural and human-induced effects cannot be accurately determined. Two of the main known threats to common dolphins in New Zealand waters are incidental capture by fisheries and tourism-related impacts (Thompson et al.

2013, Neumann & Orams 2005, Meissner et al. 2015, Constantine & Baker 1997, Stockin 2009). Fisheries-related threats are discussed in detail in the Sections 7.3 and 7.4.

7.2.6 CONSERVATION BIOLOGY AND THREAT CLASSIFICATION

Common dolphins are currently listed as a species of least concern under the International Union for the Conservation of Nature (IUCN) Red List of Threatened species with the exception of the Mediterranean subpopulation, which is listed as 'endangered' (Hammond et al. 2008).

In 2010, the conservation status of New Zealand marine mammals was reassessed using the 2008 version of the New Zealand Threat Classification system (Baker 2010). Based on several levels of criteria, common dolphins were classified as 'not threatened' with the qualifiers that the information was considered 'data poor', that the species was 'secure overseas', and that some subpopulations were 'threatened overseas'.

7.3 GLOBAL UNDERSTANDING OF FISHERIES INTERACTIONS

Interactions between cetaceans and fisheries occur worldwide. Cetaceans have been incidentally captured by numerous types of fishing gear including trawl nets, purse seine nets, and static nets such as driftnets or gillnets (Reeves et al. 2005). Hall et al. (2000) state that cetaceans are at greater risk of capture by midwater trawls, which are towed faster than bottom trawls and usually target fish and squid. As a result, cetaceans may be captured when foraging in areas where fisheries using such gear also operate.

Due to their high global abundance, interactions between common dolphins and fisheries are not unusual. The highest rates of interactions are associated with fisheries that use trawl, purse seine, and drift nets. Outside New Zealand, perhaps the most well-known interaction occurs in the Eastern Tropical Pacific where common dolphins are found in association with yellowfin tuna (*Thunnus albacares*). In the 1960s, about 350 000 common dolphins were estimated to have been taken by this purse seine fishery (Joseph 1994). However, due to mitigation measures introduced in the 1970s, the rate of dolphin captures has been greatly reduced and is no longer a conservation concern (Reeves 2003).

In addition to the Eastern Tropical Pacific, interactions between common dolphins and fisheries are known to occur in the north and south Atlantic and Pacific oceans. Common dolphins were the most commonly caught cetacean in the US shark and swordfish gillnet fishery with an estimated mortality of 861 dolphins between 1996 and 2002 (Carretta et al. 2005). In the UK and the French pelagic trawl fishery for bass, ca. 800 common dolphins were taken annually (Hammond et al. 2008). In addition, the pelagic pair-trawl fishery off southwest England captured approximately 200 common dolphins per annum, with most animals being captured at night (de Boer et al. 2012). Male dolphins were at a greater risk of capture in pair-trawls offshore whereas females and calves were more vulnerable to gillnets close to shore (de Boer et al. 2012). Other areas where interactions between common dolphins and fisheries are known to occur include:

- The North Sea, predominantly in gillnets (Reijnders & Lankester 1990).
- Off the coast of Africa, predominantly in gillnet and purse seine fisheries (Maigret 1994, Jefferson et al. 1997).
- Off the south coast of Australia, mostly in gillnets or anti-shark netting (Kemper et al. 2005).
- Off the coast of Portugal, where 59% of 124 bycaught common dolphins were bycaught in primarily gill and seine nets between 1975 and 1998 and where fisheries interactions were responsible for up to 44% of strandings (Silva & Sequeira 2003).
- The Mediterranean Sea, where dolphins have a moderate (6–30% of sightings) or strong (35–50% of sightings) association with foreign purse seine tuna fishing, dolphin fish fishing activities, and illegal drift nets for swordfish offshore (Vella 2005, Tudela et al. 2005, Bearzi et al. 2008).
- The Black Sea, in pelagic trawl nets (Hammond et al. 2008, Reeves & Notarbartolo di Sciara 2006).

The Mediterranean Sea subpopulation of common dolphins has been declining since the 1960s and has been subjected to the effects of illegal drift-netting and other anthropogenic impacts (Reeves 2003, Forcada & Hammond 1998, Piroddi et al. 2011). It is believed that overfishing in the Mediterranean Sea has outcompeted common dolphins for prey (Bearzi et al. 2003). Bearzi et al. (2008) found that 10 active purse seine vessels were responsible for removing 33% of the biomass and suggested that they had the largest impact on dolphin prey species.

To reduce mortality from incidental captures, many countries have put implemented monitoring programmes to mitigate direct fisheries impacts to common dolphins. For example, after the creation of the US Marine Mammal Protection Act in 1972, observer coverage in the purse seine fishery was increased to 100% to ensure compliance. The European Union has also introduced legislation to establish observer programmes for most fisheries (Hammond et al. 2008). Other measures to reduce unwanted bycatch include: modification of fishing gear and methods (acoustic deterrents), input and output controls (limiting fishing effort or capacity), compensatory mitigation (investing in conservation projects), establishment of Marine Protected Areas (MPAs), fleet communication (reporting real-time observation of unpredictable bycatch hotspots), industry self-policing (peer pressure from within the industry), handling and release practices (backing down and hand rescue procedures to release dolphins), and changing gear (using alternative fishing methods that results in lower bycatch) (Gilman & Lundin 2009).

7.4 STATE OF KNOWLEDGE IN NEW ZEALAND

Common dolphins and fisheries in New Zealand waters often target the same fish species in the same areas. Early reports to the International Whaling Commission suggested that during June 1979 and April 1992, common dolphins were captured in trawl nets, crayfish pots, and purse seine nets (see Berkenbusch et al. 2013). Scientific observer data show that the primary fishery in New Zealand waters that is responsible for common dolphin mortality has been the midwater trawl fishery for jack mackerel species. Evidence from the early 1990s, after the establishment of the government observer programme, indicated that single and multiple captures of common dolphins occurred in the trawl nets of foreign-chartered trawlers targeting jack mackerel species off the west coast of New Zealand, in Quota Management Areas 7, 8 and 9 (61 animals between 1989–90 and 1992–93; see Baird 1994). This fishery operated offshore in the north and south Taranaki Bight waters, mainly in the summer months of November to April. During these years, observers reported a change in this fleet from the use of bottom trawls with headline heights of 5.2–9.8 m to midwater trawls with headline heights of 20–45 m (MPI unpublished observer data). The midwater trawls could be towed near the bottom during the day and in the water column at night and thus follow the movement of the jack mackerel schools. Alternatively, both gear types were used, alternating according to time of day.

Midwater nets were towed for 4–6 hrs and nets hauled between 2330 and 0615 h were responsible for almost all the dolphin captures, particularly in south Taranaki Bight in 70–130 m depths (Baird 1994). These mortalities resulted in the development of voluntary Codes of Practice (COPs) by the company operating the vessels, which aims to outline best practices to remedy, mitigate, or avoid incidental captures (Rowe 2007) (see Baird 1994, Appendix 9). The COPs addressed several aspects of the fishing operation thought to increase the likelihood of capture, mainly: the practice of undertaking a U-turn with the trawl doors up but the net in the water near the surface; the timing of setting; and the vessel lighting during night fishing activities. In addition, the codes may include recommendation for gear modifications and voluntary area closures (Rowe 2007). The government response led to increased observer coverage and provision for the necropsy of captured animals. MPI observer data shows that 10 common dolphins have been autopsied since 1994 (see also Duignan et al. 2003, 2004, Duignan & Jones 2005). However, capture incidents continued to occur until this fleet of vessels ceased fishing in New Zealand waters in the mid–late 1990s (Baird 1996).

Subsequently, midwater trawling for jack mackerels has remained the main method and target fishery responsible for common dolphin captures (based on observer data) (see Abraham & Thompson 2011). However, since the late 1990s, the observed common dolphin captures have been almost entirely from a different fleet of large foreign-charted trawlers operating mainly off the west coast of the North Island during summer months (Thompson et al. 2013a).

These vessels use midwater nets with headline heights of 30–60 m in depths of less than 200 m. The largest capture event in this fishery caught nine dolphins in one tow (Thompson et al. 2013a). Observer coverage between 1995–96 and 2010–11 was at least 20% for most fishing years but fluctuated considerably between 7 and 70% (Thompson et al. 2013a). The vessels are required to follow Operational Procedures for mitigating incidental captures of marine mammals as agreed by quota owners (see Section 7.4.2 for a fuller explanation).

Headline depth of trawl nets (distance from the headline to the surface) was found to be an important factor in explaining common dolphin captures in this fishery (Thompson et al. 2013). The majority of dolphin captures occurred when headline depth was between 10 and 40 m; however, 50% of observed capture events and 54% of common dolphins captured in large vessel mackerel fishery occurred on the 10% of the observed trawls that had a headline depth shallower than 30 m (Figure 7.4) (Thompson et al. 2010). Thompson et al. (2013, 2010) estimated that an increase of 21 m in headline depth may reduce the number of common dolphin captures by half. Longer tows caught more dolphins, as did tows in darkness, and tows conducted in the waters off the north Taranaki Bight. Of all shallow trawl tows (headline depths shallower than 40 m), 69% occurred at night when the fish migrate to the surface (Thompson et al. 2013). Common dolphins are known to follow diel migrating prey, which likely explains higher captures rates in shallow waters at night. Table 7.1 shows common dolphin captures in the jack mackerel fishery from 1989–90 to 1994–95. Most common dolphin captures occurred when conducting midwater trawls at night. The number of captures between 1995–96 and 2001–02 fishing years ranged between zero and 31 animals (Thompson et al. 2013). Captures have also been reported occasionally from observed trawl fisheries that targeted other middle depth species such as barracouta, hoki and arrow squid, as well as trawl nets targeting inshore species such as trevally and tarakihi (MPI unpublished data). The distributions of the fishing effort and observed captures for 2002–03 to 2015–16 are shown for all trawl fisheries (Figure 7.5) and for jack mackerel fisheries (Figure 7.6). During this time period there were 150 observed captures of common dolphins in trawl fisheries, 134 of which occurred in the jack mackerel fishery (see Section 7.4.1, Tables 7.2 and Table 7.3).

There were no observed common dolphin captures by the following New Zealand fisheries between 2002–03 and 2015–16: trawl (all except jack mackerel, hoki, middle depth and inshore); surface longline (southern bluefin, albacore and swordfish); bottom longline (ling, snapper); set net (flatfish and mullet); and purse seine (mackerel and skipjack tuna). There was a single common dolphin observed caught in the bigeye surface-longline fishery, in 2014–15. It should be noted that the proportion of the commercial effort covered by observers is highest in deepwater trawl fisheries, with relatively small amounts of effort observed for inshore trawl fisheries and fisheries using other types of fishing gear (see Abraham & Thompson 2011). Between 1995–96 and 2011–12 fishing years, observer effort in the middle-depth, inshore, and flatfish trawl fisheries was 3.4%, 0.5% and 0.3%, respectively (Berkenbusch et al. 2013).

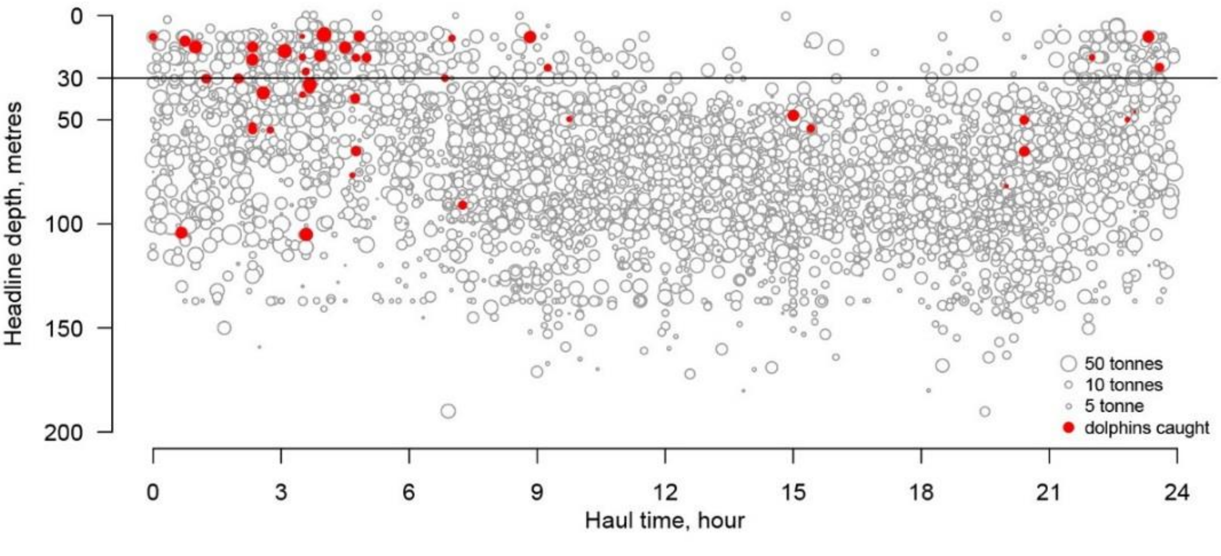


Figure 7.4: Headline depth versus the haul time for observed trawls in the large-vessel jack mackerel fishery. The catch weight is indicated by the size of the circles. Tows where an observed common dolphin capture event occurred are filled (from Thompson et al. 2010).

Table 7.1: Total and observed numbers of tows, observed number of dolphin mortalities and the number of events (tows) that incidentally caught dolphins in the jack mackerel fishery around the North (NT) and South (ST) Taranaki Bights by gear type (MW: midwater and BT: Bottom Tow), and time of day (D: Day and N: Night) for fishing years 1989–90 to 1994–95. Red bold numbers indicate that the species was confirmed as common dolphin (*Delphinus delphis delphis*). Table reproduced from Baird (1994, 1996). [Continued on next page]

Fishing year	Region	Gear	Time of day	Effort		Observed captures	
				Fishing tows	% observed	Mortality	Events
1989–90	NT	BT	D	1191	48	0	0
	NT	MW	D	41	0	0	0
	NT	BT	N	173	6	0	0
	NT	MW	N	28	1	0	0
	ST	BT	D	1418	139	0	0
	ST	MW	D	15	6	0	0
	ST	BT	N	186	6	0	0
	ST	MW	N	105	90	**23**	10
1990–91	NT	BT	D	603	2	0	0
	NT	MW	D	53	0	0	0
	NT	MT	N	72	0	0	0
	NT	MW	N	63	0	0	0
	ST	BT	D	676	47	0	0
	ST	MW	D	147	110	0	0
	ST	BT	N	84	12	0	0
	ST	MW	N	146	73	0	0
1991–92	NT	BT	D	1523	101	0	0
	NT	MW	D	361	4	0	0
	NT	BT	N	279	36	**2**	2
	NT	MW	N	500	3	**5**	3
	ST	BT	D	618	74	**1**	1
	ST	MW	D	151	3	0	0
	ST	BT	N	95	7	**5**	1
	ST	MW	N	146	15	16	5
1992–93	NT	BT	D	1759	135	0	0
	NT	MW	D	21	3	0	0
	NT	BT	N	438	22	0	0
	NT	MW	N	156	16	0	0
	ST	BT	D	588	112	0	0
	ST	MW	D	51	0	0	0
1992–93	ST	BT	N	48	6	0	0
	ST	MW	N	305	28	**9**	3
1993–94	NT	BT	D	1494	78	0	0
	NT	BT	D	219	19	0	0
	NT	MT	N	309	13	0	0
	NT	MW	N	300	28	0	0
	ST	BT	D	645	155	0	0
	ST	MW	D	120	20	0	0
	ST	BT	N	35	14	0	0
	ST	MW	N	279	71	8	5
1994–95	NT	BT	D	391	17	0	0
	NT	MW	D	399	80	0	0
	NT	BT	N	93	9	0	0
	NT	MW	N	258	74	0	0
	ST	BT	D	198	41	0	0
	ST	MW	D	228	73	6	3
	ST	BT	N	27	13	0	0
	ST	MW	N	147	74	15	3

Table 7.2: Fishing and observed effort (number of tows), the number and rate of observed captures, and estimated mean from statistical models of common dolphin (*Delphinus delphis delphis*) captures by all trawl fisheries by fishing year in the New Zealand EEZ (see MPI data analysis at https://protectedspeciescaptures.nz/PSCv6/, data version v11). For each fishing year, the table gives the total number of fishing tows, the percentage of tows that were observed; the number of observed captures (both dead and alive); the capture rate (captures per hundred tows); and the mean number of estimated total captures (with 95% confidence interval). For more information on the methods used to prepare the data, see Thompson et al. 2010 and 2013).

Fishing year	Effort		Observed captures		Estimated captures	
	Fishing tows	% observed	Number	Rate	Mean	95% c.i.
2002–03	130 119	5.3	21	0.31	271	146–440
2003–04	120 819	5.4	17	0.26	239	129–396
2004–05	120 430	6.4	22	0.29	221	123–367
2005–06	109 944	6.0	4	0.06	125	52–242
2006–07	103 314	7.7	11	0.14	178	87–315
2007–08	89 531	10.1	20	0.22	143	71–250
2008–09	87 549	11.2	20	0.20	135	64–248
2009–10	92 893	9.7	4	0.04	137	55–266
2010–11	86 078	8.7	9	0.12	155	75–274
2011–12	84 418	11.1	5	0.05	108	41–210
2012–13	83 837	14.8	17	0.14	116	52–218
2013–14	85 110	15.6	30	0.23	118	61–208
2014–15	78 765	17.2	21	0.15	104	50–190
2015–16	78 029	16.6	7	0.05	3	2–7
2016–17	78 173	17.6	1	0.01	1	0–5
2017–18	74 243	20.1	1	0.01	0	0–4
2018–19	70 924	19.6	0	0.00	–	–
2019–20	65 994	23.6	0	0.00	–	–

Table 7.3: Fishing and observed effort (number of tows) and the number, rate, and estimated mean for common dolphin (*Delphinus delphis delphis*) captures by jack mackerel fisheries by fishing year in the New Zealand EEZ (see MPI data analysis at https://protectedspeciescaptures.nz/PSCv6/, data version v11). For each fishing year, the table gives the total number of trawl tows, the number of tows observed and the percentage of tows that were observed; the number of observed captures (both dead and alive); the capture rate (captures per hundred tows); and the mean number of estimated total captures (with 95% confidence interval). For more information on the methods used to prepare the data, see Thompson et al. 2010 and 2013.

Fishing year	Effort		Observed captures		Estimated captures	
	Fishing tows	% Observed	Number	Rate	Mean	95% c.i.
2002–03	3 067	11.3	21	6.07	141	60–259
2003–04	2 383	6.4	17	11.18	99	45–181
2004–05	2 509	22.2	21	3.76	85	46–139
2005–06	2 809	25.2	2	0.28	12	2–33
2006–07	2 711	29.6	11	1.37	55	23–102
2007–08	2 652	30.8	20	2.44	42	24–70
2008–09	2 169	37.5	11	1.35	23	11–43
2009–10	2 406	32.7	4	0.51	17	4–42
2010–11	1 882	31.5	7	1.18	53	18–108
2011–12	2 032	76.2	5	0.32	7	5–13
2012–13	2 213	87.7	15	0.77	16	15–20
2013–14	2 447	89.4	28	1.28	29	28–35
2014–15	1 750	86.4	19	1.26	21	19–28
2015–16	1 544	89.6	2	0.14	3	2–7
2016–17	1 407	72.8	0	0	1	0–5
2017–18	1 688	87.3	0	0	0	0–4
2018–19	1 627	78.5	0	0	–	–
2019–20	1 747	77.4	0	0	–	–

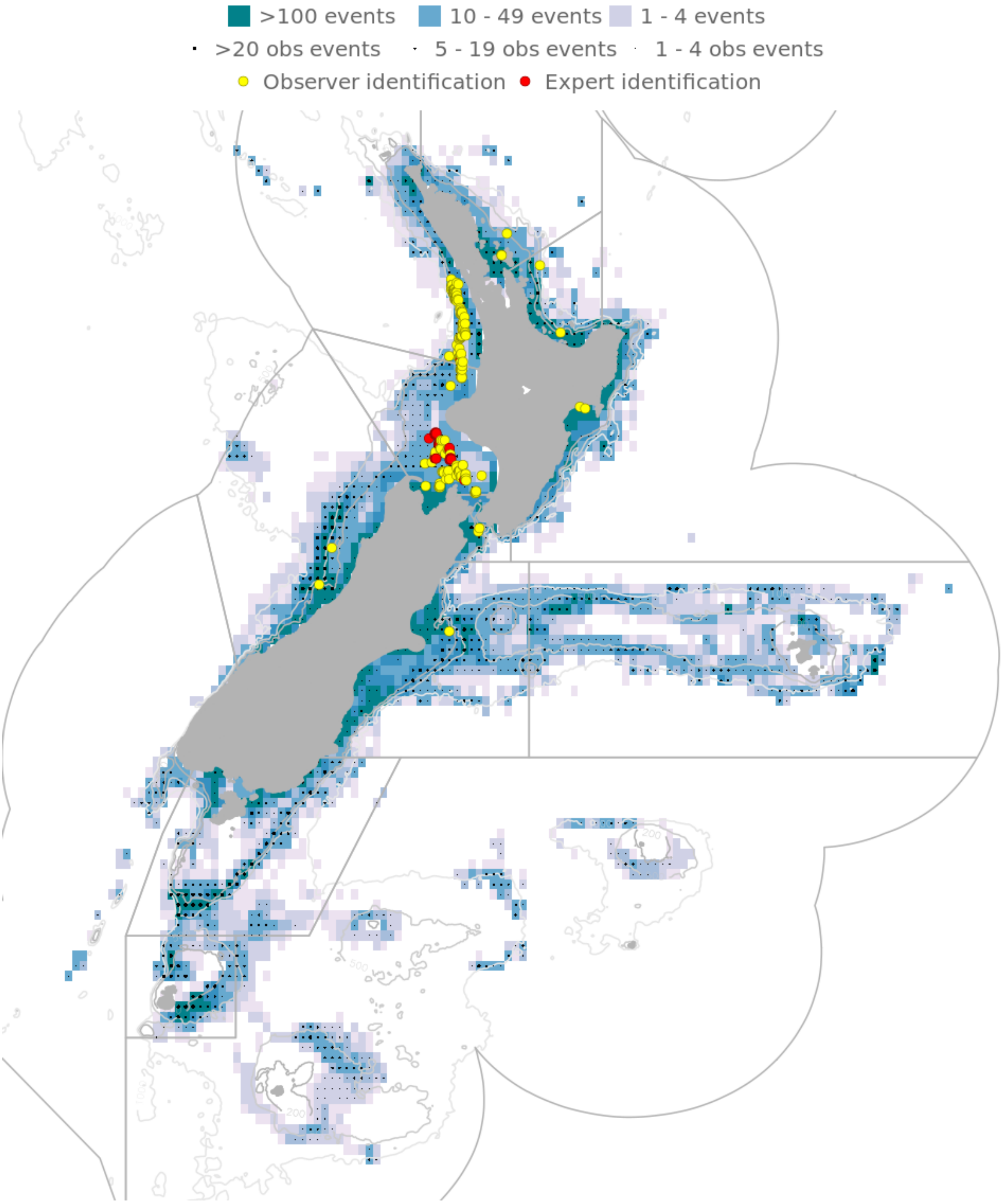


Figure 7.5: Distribution of all trawl fishing effort and observed common dolphin (*Delphinus delphis delphis*) captures, 2002–03 to 2019–20 (for more information see MPI data analysis at https://protectedspeciescaptures.nz/PSCv6/, data version v11). Fishing effort is mapped into 0.2-degree cells, coloured to represent the number of tows. Observed fishing events are indicated by black dots, and observed capture events 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.

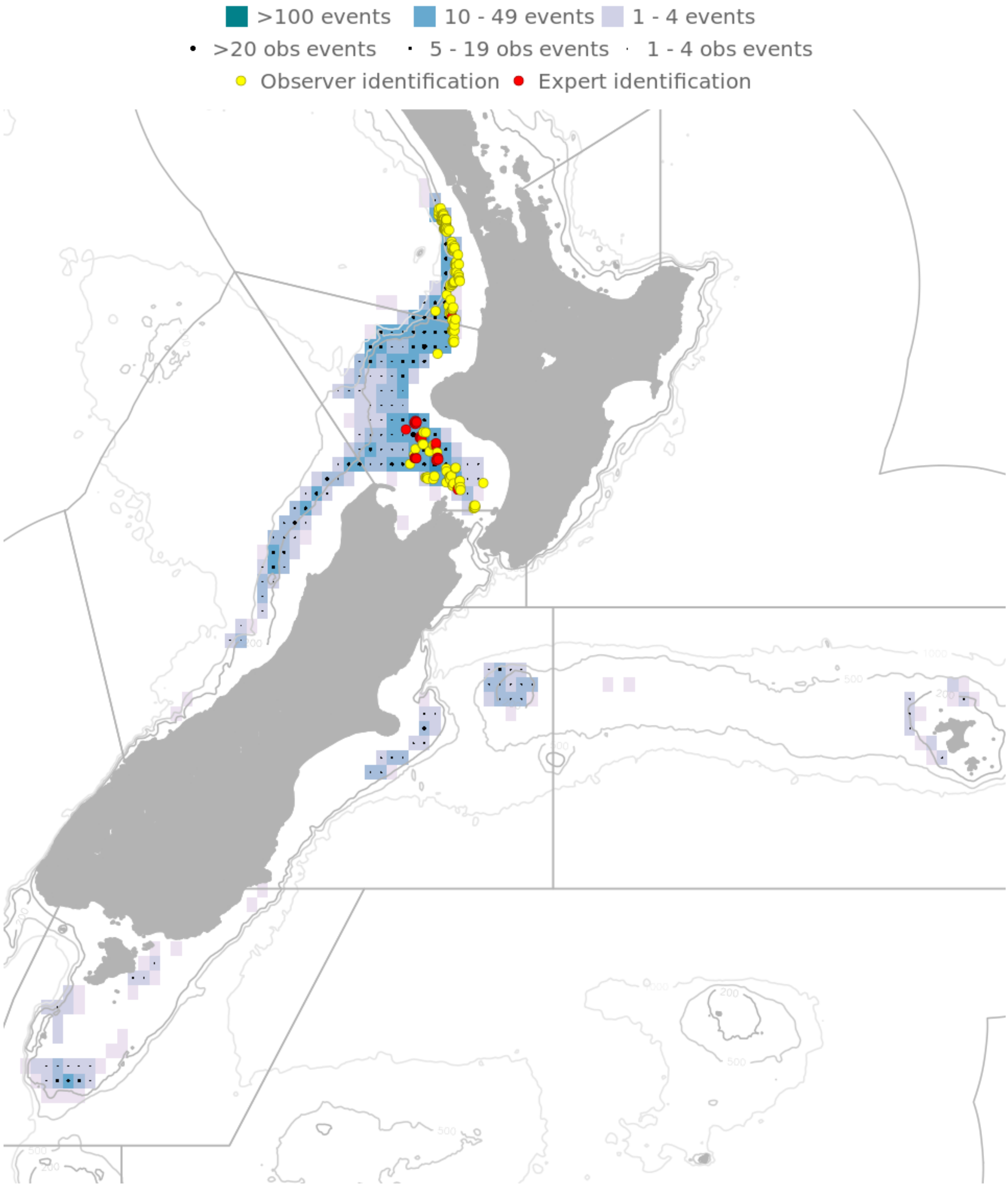


Figure 7.6: Distribution of trawl fishing effort for jack mackerel and observed common dolphin (*Delphinus delphis delphis*) captures, 2002–03 to 2019–20 (for more information see MPI data analysis at https://protectedspeciescaptures.nz/PSCv6/, data version v11). Fishing effort is mapped into 0.2-degree cells, coloured to represent the number of tows. Observed fishing events are indicated by black dots, and observed captures are indicated by red and yellow dots. Fishing effort is shown for all tows with latitude and longitude data, where three or more vessels fished within a cell.

7.4.1 QUANTIFYING FISHERIES INTERACTIONS

Bayesian models have been applied to fishing effort and observer data collected from trawl fisheries to estimate the number of common dolphin captures within New Zealand's EEZ (Abraham & Thompson 2011) (Figure 7.7). Note that while there were a small number of live captures, most capture events resulted in dolphin mortality. A separate two-step Bayesian hurdle model was developed by Thompson et al. (2010) to estimate the number of captures by the jack mackerel trawl fishery off the west coast of the North Island (Figure 7.8). The first part of the model estimated the presence of a capture event and the second part estimated how many capture events occurred if a capture event was estimated to have been present. Because no captures were recorded from smaller vessels, this analysis only included data from vessels over 90 m in length (Thompson et al. 2010). However, observer coverage of these vessels was limited to 0–0.5% for the years analysed (Thompson et al. 2010). Model-based capture estimates have been created for fishing years since 1995–96 (Thompson et al. 2013) and updated estimates to 2015–16 are presented in Table 7.2.

During the 2002–03 and 2015–16 fishing seasons, less than 3% of the total trawl effort (number of tows) occurred in the jack mackerel fishery, yet 90% of the 206 common dolphin captures recorded by observers occurred in this fishery (Tables 7.2 and 7.3).

7.4.2 MANAGING FISHERIES INTERACTIONS

Because little is known about the population of common dolphins in New Zealand, the level of fisheries impact and population level risk cannot be estimated with certainty. Given the large numbers of common dolphins worldwide, it is unlikely that the interaction between common dolphins and fisheries will have an adverse effect at the scale of the global population. However, there is still debate regarding the taxonomy of common dolphins found in New Zealand waters and whether a unique subpopulation inhabits New Zealand's EEZ. New research is currently underway to investigate population size and structure of common dolphins, to enable assessment of fisheries impacts and risk at the scale of regional subpopulations (if any).

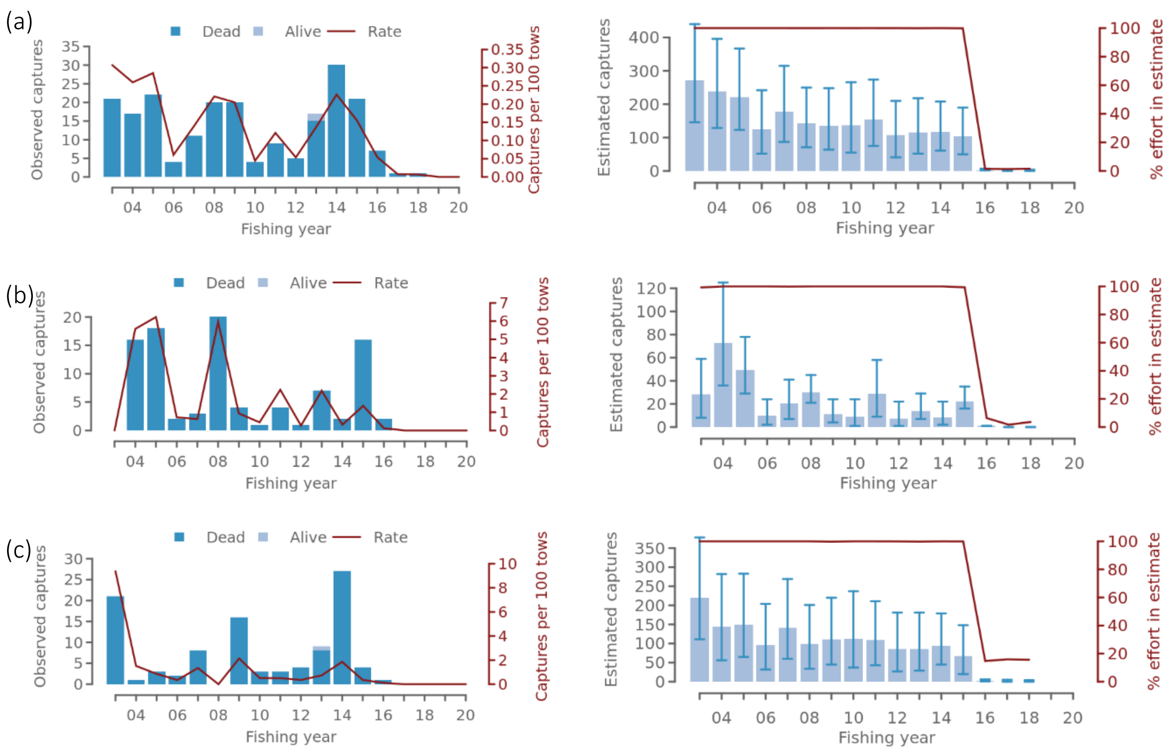


Figure 7.7: Observed captures of common dolphins (*Delphinus delphis delphis*) (dead and alive) in all trawl fisheries, the capture rate (captures per hundred tows) and the mean number of estimated total captures (with 95% confidence interval) by fishing years from 2002–03 to 2019–20, inclusive of three regions: (a) New Zealand's EEZ; (b) West coast of North Island; and (c) the Taranaki region (MPI data analysis at https://protectedspeciescaptures.nz/PSCv6/, data version v11). 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 Thompson el al. 2010 and 2013.

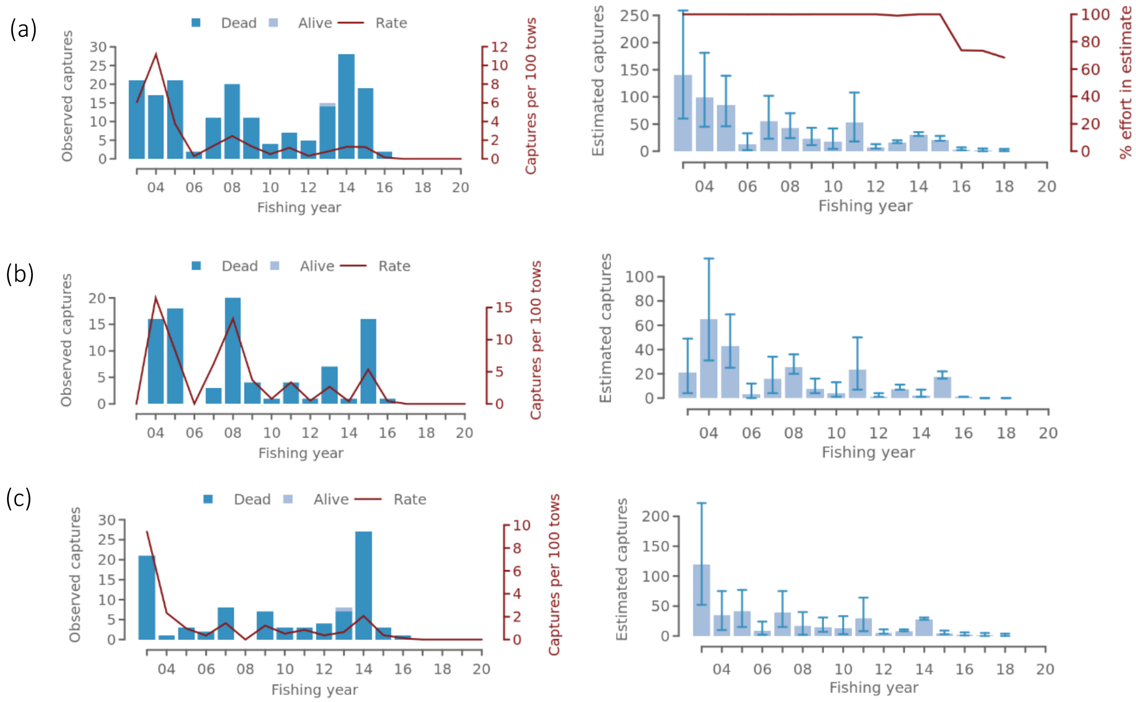


Figure 7.8: Observed captures of common dolphins (*Delphinus delphis delphis*) (dead and alive) in the jack mackerel trawl fisheries, the capture rate (captures per hundred tows) and the mean number of estimated total captures (with 95% confidence interval) by fishing years from 2002–03 to 2019–20 for three regions: (a) New Zealand's EEZ; (b) West coast of North Island; and (c) the Taranaki region (MPI data analysis at https://protectedspeciescaptures.nz/PSCv6/, data version v11). 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 Thompson el al. 2010 and 2013.

MPI monitors interactions between fishing vessels and marine mammals primarily via the observer programme. In addition, MPI and the deepwater quota owners and trawl operators have developed a Marine Mammal Operating Procedure (MMOP) that specifies how skippers of trawlers greater than 28 m in length are expected to provide reports to the government of all marine mammal interactions, and specifies what fishers should do reduce capture rates and fisheries risk. Observer reviews provide information that contributes to managing interaction of the deepwater fleet. Specific risk management actions are identified for implementation in all JMA trawl fisheries, and there are additional requirements north of latitude 40° 30' S where most interactions occur.

Vessel practices required under the MMOP include: refraining from deploying fishing gear when dolphins are present; assigning an officer on watch and deck to report all sightings; ensuring trawl gear is closed during turns, by keeping doors at or above surface; using acoustic dissuasive devices attached to net on night-time tows for jack mackerel species; and (in the northern area) refraining from deploying trawl gear between 0230 and 0430 h. Additionally, under the MMOP all vessel officers are briefed annually on the risk factors regarding common dolphin captures especially area, depth and temporal factors. The full requirements can be seen at http://deepwatergroup.org/wp-content/uploads/2016/11/Marine-Mammals-Operational-Procedures-2016-17.pdf.

Vessels are required to report any captures to all vessels in the vicinity (by VHF radio) and must also notify the DeepWater Group (DWG) within a 24 hour period, and record captures in the ship's log, any time a common dolphin is caught (see Annual Review Report for Deepwater Fisheries, http://www.mpi.govt.nz/document-vault/4090, for more information).

7.4.3 MODELLING POPULATION-LEVEL IMPACTS OF FISHERIES INTERACTIONS

Because common dolphins are abundant and widespread, fisheries interactions are not considered a threat to the population at a global scale. However, small subpopulations of common dolphins such as the

Mediterranean Sea population have been significantly impacted by fishing.

The number of common dolphins captured in deepwater trawl fisheries is known with high certainty, due to high levels of observer coverage. Capture rates in poorly observed inshore fisheries are far less certain. Regardless of captures, the level of fisheries risk to common dolphins is estimated very poorly, in large part due to unknown population structure, such that there is no clear understanding of what size population these impacts should be considered against. New MPI research (PRO2017-08A) is underway applying genetic analyses to better understand common dolphin population structure and population size for potentially impacted populations, to improve estimates of fisheries risk. Other research is also in progress to estimate spatial distributions for New Zealand cetacean species (PRO2014-01), including common dolphins. Outputs from this work will inform spatially explicit estimates of encounter rate and capture rate in fisheries, which can then be applied to estimate population level risk at any spatial scale, applying the SEFRA method (Chapter 3, and below).

Total estimated captures per year varied between 0.15 (95% c.i.: 0.00–1.74) and 6.27 (95% c.i.: 2.49–12.27) captures per 100 tows over this 16-year period between the 1995–96 and 2011–12 fishing years (Thompson et al. 2013, Berkenbusch et al. 2013, Abraham & Berkenbusch 2017). The majority of observed common dolphin bycatch events in New Zealand waters have been in trawl fisheries targeting jack mackerel (*Trachurus declivis, T. murphyi* and *T. novaezelandiae*) on the west coast of the North Island.

7.4.4 MULTI-SPECIES MARINE MAMMAL RISK ASSESSMENT

In 2017, a New Zealand Marine Mammal Risk Assessment (MMRA) was completed (Abraham et al. 2017) applying a modification of the SEFRA method described in Chapter 3. Outputs of the MMRA suggest that common dolphins are the species potentially most at risk from New Zealand commercial fisheries. Fisheries risk to common dolphins is attributed primarily to pelagic trawl fisheries, for which historically observed captures are sufficient to estimate vulnerability and risk with some confidence, and also to inshore trawl and set-net fisheries, for which species vulnerability (hence total captures) is very poorly estimated (due to very low levels of historical observer coverage). Furthermore, as previously noted, estimates of biological population size are highly uncertain due to unknown population structure. As a consequence, cumulative fisheries risk for common dolphins remains highly uncertain, with an estimated risk score that may be less than half the Population Sustainability Threshold (PST) or may exceed the PST by a factor of two (Figure 7.9). (Note that the particular definition of PST used in the multi-species MMRA represents a number of anthropogenic deaths that would allow population recovery to, or stabilisation at, 50% of K with 90% certainty. Other species-specific risk assessments may adopt other population reference outcomes in the definition of PST, reflecting policy choices.)

Estimated fishery-related deaths for common dolphins in each fishery group, as estimated in the MMRA, are shown in Figure 7.10.

In 2017 an independent expert review of the SEFRA method and its implementations, including the (at that time unpublished) MMRA, made recommendations to improve this and future implementations of the MMRA (Lonergan et al. 2017). Of particular relevance to common dolphins, the review cautioned against uncritical use of Delphi-derived spatial species distribution layers as inputs. Research is currently in progress to estimate common dolphin distributions empirically on a finer spatial scale, using habitat suitability models informed by sightings data (PRO2014-01). When outputs of this work is available, it is expected that these will be combined with improved population estimates (from PRO2017-08A) in an updated marine mammal risk assessment.

7.4.5 SOURCES OF UNCERTAINTY

While there is an abundance of knowledge on common dolphins worldwide, relatively little is known about this species in New Zealand waters. The latest research suggests that common dolphins in New Zealand waters are a larger form of the short-beaked common dolphin found elsewhere; however further work is needed to verify this conclusion, which is based on a study with small sample size (Jordan 2012). As identified above, there is considerable uncertainty regarding population size and/or subpopulation structure of common dolphins around New Zealand. MPI project PRO2017-08A will address this uncertainty.

Due to historically low levels of observer coverage incidental captures of common dolphins by inshore fisheries are only poorly estimated. Improved observer coverage or monitoring by other means may help to address this uncertainty. Where captures are observed, improved understanding of factors affecting capture rates in different parts of the fishing event (i.e., setting, towing, or hauling) may be useful to inform management strategies or mitigation options to reduce captures.

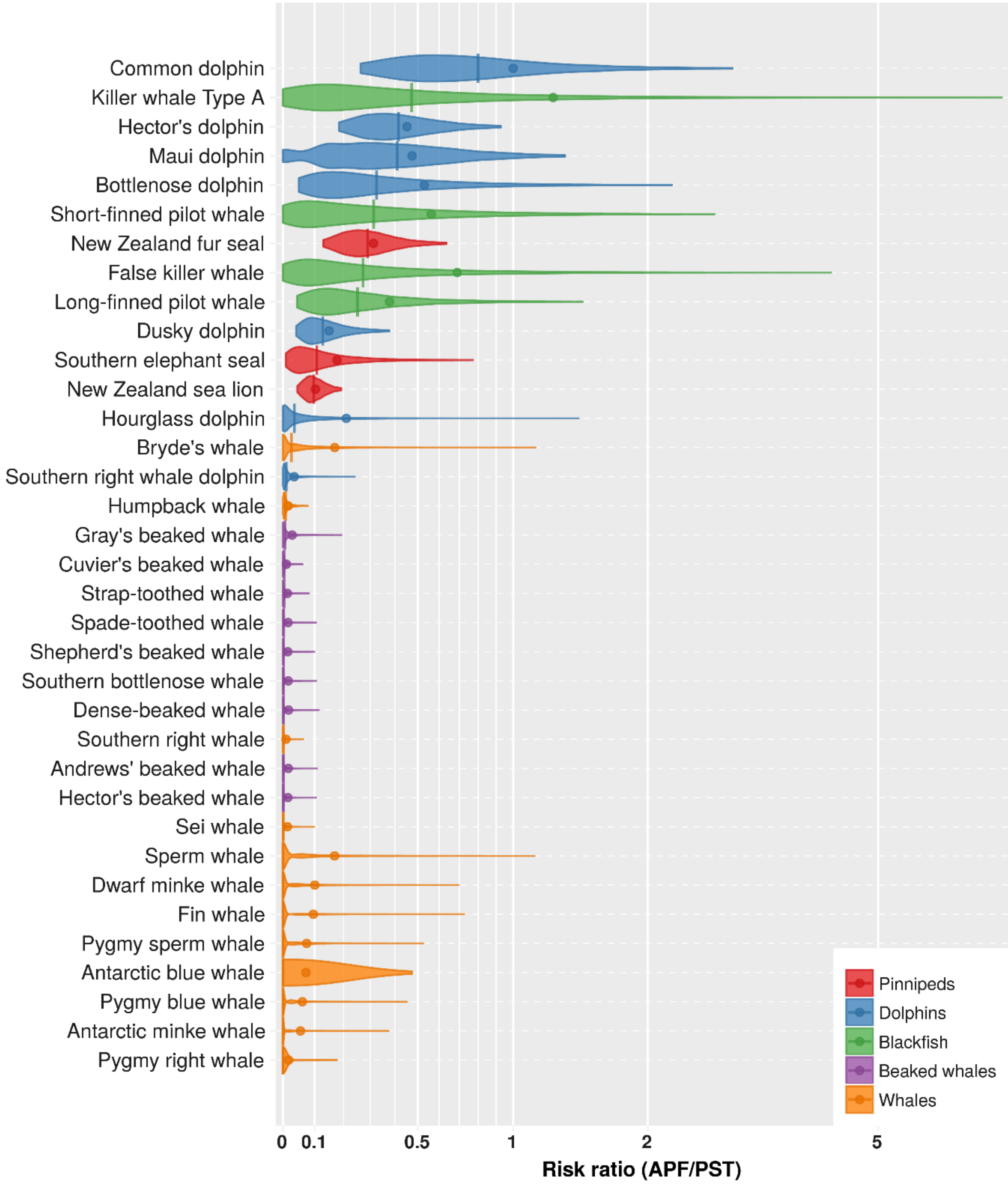


Figure 7.9: Cumulative fishery risk across all fishery groups as estimated by the 2016 New Zealand Marine Mammal Risk Assessment (NZMMRA; Abraham et al. 2017). Species groups are colour coded.

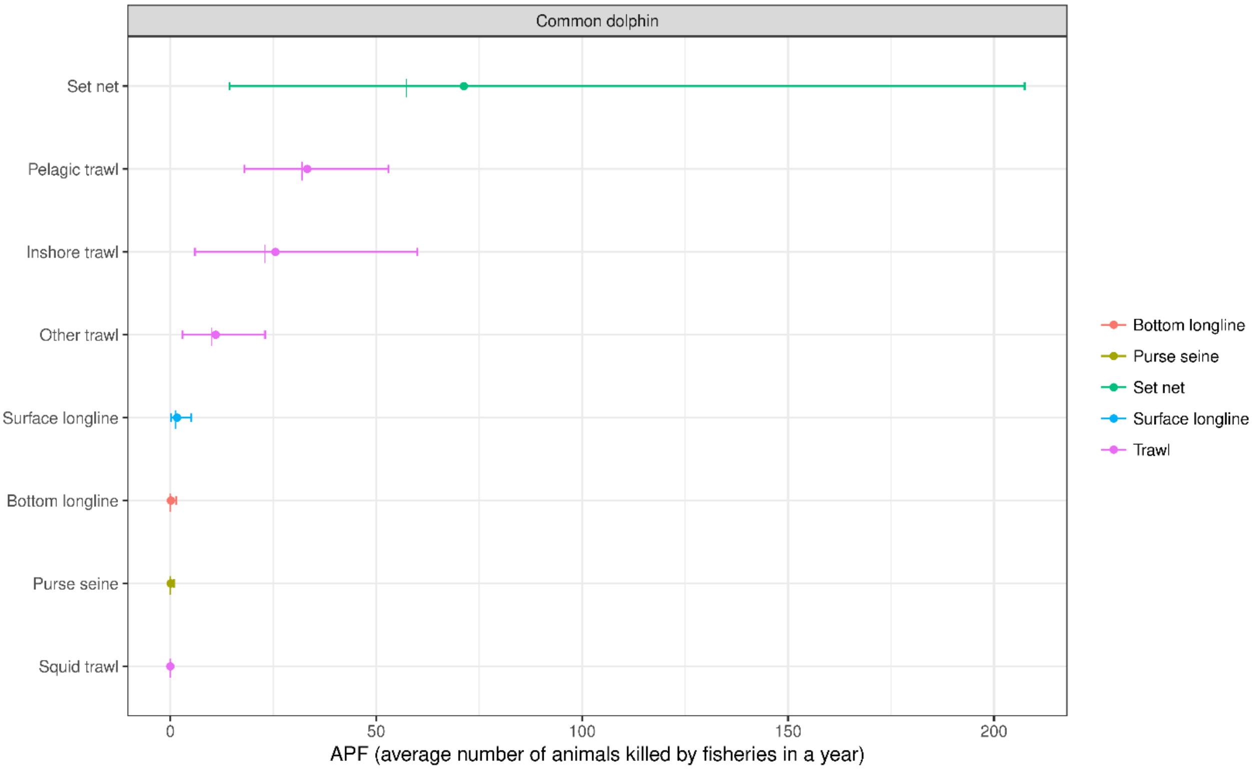
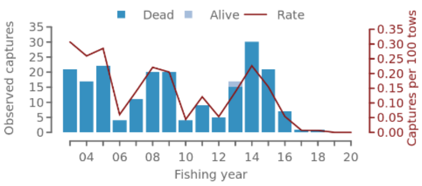
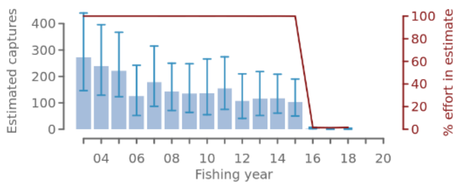


Figure 7.10: Annual fishery-related deaths of common dolphins in each fishery group, as estimated by the 2017 New Zealand Marine Mammal Risk Assessment (NZMMRA; Abraham et al. 2017).

7.5 INDICATORS AND TRENDS

Population size	Unknown in New Zealand EEZ, but approximately 4 000 000 worldwide.[1]
Population trend	Unknown.
Threat status	New Zealand: Not Threatened; Data Poor, and Secure Overseas in 2013.[2] IUCN: Least Concern, in 2008.[3]
Number of interactions[4]	104 estimated captures (95% c.i.: 50–189) in modelled trawl fisheries in 2014–15[4] 1 observed captures in trawl fisheries in 2017–18[4] 21 estimated captures (95% c.i.: 19–28) in the jack mackerel trawl fisheries in 2014–15[4] 0 observed captures in the jack mackerel trawl fisheries in 2017–18[4] 0 observed captures in the jack mackerel trawl fisheries in 2016–17[4] 142.7 estimated annual potential fatalities (APF) (95% c.i.: 70.7–285.1)[5]
Trends in interactions[4]	Trawl fisheries:  

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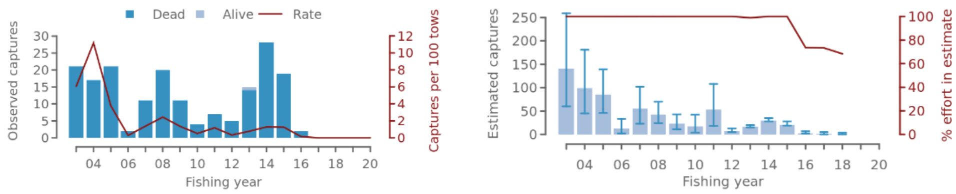
[1] Hammond et al. (2008).
[2] Baker et al. (2016).
[3] Hammond et al. (2008).
[4] For more information, see: https://protectedspeciescaptures.nz/PSCv6/
[5] Abraham & Berkenbusch 2017.

Jack mackerel trawl fishery:



7.6 REFERENCES

Abraham, E R; Berkenbusch, K (2017) Estimated captures of New Zealand fur seal, New Zealand sea lion, common dolphin, and turtles in New Zealand commercial fisheries, 1995–96 to 2014–15. *New Zealand Aquatic Environment and Biodiversity Report No. 188*. 66 p.

Abraham, E R; Berkenbusch, K; Neubauer, P; Richard, Y (2017) Assessment of the risk to New Zealand marine mammals from commercial fisheries. *New Zealand Aquatic Environment and Biodiversity Report No. 189*. 123 p.

Abraham, E R; Thompson, F N (2011) Summary of the capture of seabirds, marine mammals, and turtles in New Zealand commercial fisheries, 1998-99 to 2008-09. Final research report prepared for Ministry of Fisheries project PRO2007/01. 170 p.

Baird, S (1994) Nonfish species and fisheries interactions working group report 94/1. 27 p.

Baird, S (1996) Nonfish species and fisheries interactions working group report 96/1. 27 p.

Baker, C S; Chilvers, B L; Childerhouse, S; Constantine, R; Currey, R; Mattlin, R; van Helden, A; Hitchmough, R; Rolfe, J (2016) Conservation status of New Zealand marine mammals, 2013. *New Zealand Threat Classification Series 14*. Department of Conservation, Wellington. 18 p.

Bearzi, G; Agazzi, S; Gonzalvo, J; Costa, M; Bonizzoni, S; Politi, E; Piroddi, C; Reeves, R R (2008) Overfishing and the disappearance of short-beaked common dolphins from western Greece. *Endangered Species Research 5 (1)*: 1–12.

Bearzi, G; Reeves, R R; Notarbartolo-di Sciara, G; Politi, E; Canadas, A; Frantzis, A; Mussi, B (2003) Ecology, status and conservation of short-beaked common dolphins *Delphinus delphis* in the Mediterranean Sea. *Mammal Review 33 (3–4)*: 224–252.

Bell, C; Kemper, C; Conran , J (2002) Common dolphins (*Delphinus delphis*) in southern Australia: A morphometric study. *Australian Mammalogy 24 (1)*: 1–10.

Berkenbusch, K; Abraham, E R; Torres, L (2013) New Zealand marine mammals and commercial fisheries. *New Zealand Aquatic Environment and Biodiveristy Report No. 119*. 110 p.

Brager, S; Schneider, K (1998) Near-shore distribution and abundance of dolphins along the West Coast of the South Island, New Zealand. *New Zealand Journal of Marine and Freshwater Research 32 (1)*: 105–112.

Brophy, J; Murphy, S; Rogan, E (2009) The diet and feeding ecology of the short-beaked common dolphin (*Delphinus delphis*) in the northeast Atlantic. International Whaling Commission Scientific Committee paper SC/61/SM 14.

Carretta, J; Price, T; Peterson, D; Rear, R (2005) Estimates of marine mammals, sea turtle, and seabird mortality in the California drift gillnet fishery for swordfish and thresher shark, 1996-2002. *Marine Fisheries Review 66*: 21–30.

Cawthorn, M (2009) Incidental cetacean sighting records by transiting ships between New Zealand and overseas ports. Cawthorn & Associates, Plimmerton, New Zealand.

Connor, R C; Wells, R S; Mann, J; Read, A J (2000) The bottlenose dolphin: social relationships in a fission-fusion society. *In*: Mann, J; Connor, R C; Tyack, P; Whitehead, H, Cetacean Societies: field studies of dolphins and whales. pp 91–125. University of Chicago Press, Chicago.

Constantine, R; Baker, C S (1997) Monitoring the commercial swim-with-dolphin operations in the Bay of Islands. Department of Conservation, New Zealand. 59 p.

de Boer, M N; Saulino, J T; Leopold, M F; Reijnders, P J; Simmonds, M P (2012) Interactions Between Short-Beaked Common Dolphin (*Delphinus delphis*) and the Winter Pelagic Pair-Trawl Fishery off Southwest England (UK). *International Journal of Biodiversity and Conservation 4 (13)*: 481–499.

Deepwater Group (2016) 2014/15 Marine Mammal Operating Procedures, updated September 2016. Retrieved from http://deepwatergroup.org/wp-content/uploads/2016/11/Marine-Mammals-Operational-Procedures-2016-17.pdf.

Duignan, P J; Gibbs, N J; Jones, G W (2003) Autopsy of cetaceans incidentally caught in fishing operations 1997/98, 1999/2000, and 2000/01. *DOC Science Internal Series No. 119*. 66 p.

Duignan, P J; Gibbs, N J; Jones, G W (2004) Autopsy of cetaceans incidentally caught in commercial fisheries, and all beachcast specimens of Hector's dolphins, 2001/02. *DOC Science Internal Series No. 176*. 28 p.

Duignan, P J; Jones, G W (2005) Autopsy of cetaceans including those incidentally caught in commercial fisheries, 2002/03. *DOC Science Internal Series No. 195*. 22 p.

Evans, W E (1994) Common dolphin, white-bellied porpoise *Delphinus delphis* Linnaeus, 1758. *Handbook of Marine Mammals.*

Ferrero, R; Walker, W (1995) Growth and reproduction of the common dolphin, *Delphinus delphis* Linnaeus, in the offshore waters of the North Pacific Ocean. *Fishery Bulletin 93 (3)*: 483–494.

Forcada, J; Hammond, P (1998) Geographical variation in abundance of striped and common dolphins of the western Mediterranean. *Journal of Sea Research 39 (3)*: 313–325.

Gaskin, D E (1968) Distribution of Delphinidae (Cetacea) in relation to sea surface temperatures off eastern and southern New Zealand. *New Zealand Journal of Marine and Freshwater Research 2 (3)*: 527–534.

Gaskin, D E (1972) Whales, dolphins, and seals: with special reference to the New Zealand region. Heiemann Educational Books. 200 p.

Gilman, E L; Lundin, C G (2009) Minimizing bycatch of sensitive species groups in marine capture fisheries: lessons from tuna fisheries. *In*: Grafton, Q; Hillborn, R; Squires, D; Tait, M; Williams, M (Eds.), Handbook of Marine Fisheries Conservation and Management. pp 150. Oxford University Press, Oxford.

Gonzalez, A F; López, A; Benavente, P (1999) A multiple gestation in a *Delphinus delphis* stranded on the north-western Spanish coast. *Journal of the Marine Biological Association of the UK 79 (06)*: 1147–1148.

Hall, M A; Alverson, D L; Metuzals, K I (2000) By-catch: problems and solutions. *Marine Pollution Bulletin 41 (1)*: 204–219.

Hammond, P S; Bearzi, G; Bjørge, A; Forney, K; Karczmarski, L; Kasuya, T; Perrin, W F; Scott, M D; Wang, J Y; Wells, R S; Wilson, B (2008) *Delphinus delphis*. The IUCN Red List of Threatened Species. Retrieved from http://www.iucnredlist.org.

Heyning, J E; Perrin, W F (1994) Evidence for two species of common dolphins (genus *Delphinus*) from the eastern North Pacific. *Contributions in Science, Serial Publications of the Natural History Museum of Los Angeles County 442*: 1–35.

Jefferson, T; Curry, B; Leatherwood, S; Powell, J (1997) Dolphins and porpoises of West Africa: a review of records (Cetacea: Delphinidae, Phocoenidae). *Mammalia 61 (1)*: 87–108.

Jefferson, T A; Waerebeek, K V (2002) The taxonomic status of the nominal dolphin species *Delphinus tropicalis* van Bree, 1971. *Marine Mammal Science 18 (4)*: 787–818.

Jefferson, T A; Webber, M A; Pitman, R L (2011) Marine Mammals of the World: A Comprehensive Guide to Their Identification. Academic Press. 573 p.

Jordan, F (2012) Skull morphometry of the common dolphin, *Delphinus* sp., from New Zealand waters. Master's Thesis, Massey University, Auckland, New Zealand. 242 p.

Jordan, F F; Murphy, S; Martinez, E; Amiot, C; Helden, A; Stockin, K A (2015) Criteria for assessing maturity of skulls in the common dolphin, *Delphinus* sp., from New Zealand waters. *Marine Mammal Science 31 (3)*: 1077–1097.

Joseph, J (1994) The tuna-dolphin controversy in the eastern pacific ocean: Biological, economic, and political impacts. *Ocean Development & International Law 25 (1)*: 1–30.

Kemper, C; Flaherty, A; Gibbs, S; Hill, M; Long, M; Byard, R (2005) Cetacean captures, strandings and mortalities in South Australia 1881-2000, with special reference to human interactions. *Australian Mammalogy 27 (1)*: 37–47.

Lonergan, M E; Phillips, R A; Thomson, R B; Zhou, S (2017) Independent review of New Zealand's Spatially Explicit Fisheries Risk Assessment approach – 2017. *New Zealand Fisheries Science Review 2017/2*. 36 p.

McClatchie, S; Dunford, A (2003) Estimated biomass of vertically migrating mesopelagic fish off New Zealand. *Deep-Sea Research I 50*: 1263–1281.

Maigret, J (1994) Marine mammals and fisheries along the West African coast. *Rep. Int. Whal. Comm. Spec (15)*: 307–316.

Meissner, A M; Christiansen, F; Martinez, E; Pawley, M; Orams, M B; Stockin, K A (2015) Behavioural Effects of Tourism on Oceanic Common Dolphins, *Delphinus* sp. in New Zealand: The Effects of Markov Analysis Variations and Current Tour Operator Compliance with Regulations. *Plos One 10 (1)*: e0116962.

Meynier, L; Stockin, K; Bando, M; Duignan, P (2008) Stomach contents of common dolphin (*Deiphinus* sp.) from New Zealand waters. *New Zealand Journal of Marine and Freshwater Research 42 (2)*: 257–268.

Ministry of Fisheries (2010) National Fisheries Plan for Highly Migratory Species. 43 p.

Ministry of Fisheries (2011) Draft National Fisheries Plan for Inshore Finfish. 47 p.

Morizur, Y; Berrow, S; Tregenza, N; Couperus, A; Pouvreau, S (1999) Incidental catches of marine-mammals in pelagic trawl fisheries of the northeast Atlantic. *Fisheries Research 41 (3)*: 297–307.

Ministry for Primary Industries (2012) National Operational Plan for Deepwater Fisheries for 2012/13. 71 p.

Ministry for Primary Industries (2015) Fisheries Assessment Plenary, May 2015: stock assessments and stock status. Compiled by the Fisheries Science Group, Ministry for Primary Industries, Wellington, New Zealand.

Murphy, S; Perrott, M; McVee, J; Read, F L; Stockin, K A (2014) Deposition of growth layer groups in dentine tissue of captive common dolphins *Delphinus delphis*. *NAMMCO Scientific Publications 10*.

Murphy, S; Pinn, E H; Jepson, P D (2013) The short-beaked common dolphin (*Delphinus delphis*) in the North-east Atlantic: Distribution, ecology, management, and conservation status. *Oceanography and Marine Biology: An Annual Review 51*: 193–280.

Neumann, D R (2001a) Activity budget of free-ranging common dolphins (*Delphinus delphis*) in the northwestern Bay of Plenty, New Zealand. *Aquatic Mammals 27 (2)*: 121–136.

Neumann, D R (2001b) The behaviour and ecology of short-beaked common dolphins (*Delphinus delphis*) along the east coast of Coromandel Peninsula, North Island, New Zealand: with a note on their interactions with humans. Massey Universtity. 344 p.

Neumann, D R (2001c) Seasonal movements of short-beaked common dolphins (*Delphinus delphis*) in the north-western Bay of Plenty, New Zealand: Influence of sea surface temperature and El Niño/La Niña. *New Zealand Journal of Marine and Freshwater Research 35 (2)*: 371–374.

Neumann, D; Orams, M B (2003) Feeding behaviours of short-beaked common dolphins, *Delphinus delphis*, in New Zealand. *Aquatic Mammals 29 (1)*: 137–149.

Neumann, D R; Orams, M (2005) Behaviour and ecology of common dolphins (*Delphinus delphis*) and the impact of tourism in Mercury Bay, North Island, New Zealand. Science & Technical Publishing, Department of Conservation. 40 p.

Neumann, D R; Russell, K; Orams, M B; Baker, C S; Duignan, P (2002) Identifying sexually mature, male short-beaked common dolphins (*Delphinus delphis*) at sea, based on the presence of a postanal hump. *Aquatic Mammals 28 (2)*: 181–187.

O'Callaghan, T M; Baker, C S (2002) Summer cetacean community, with particular reference to Bryde's whales, in the Hauraki Gulf, New Zealand. *DOC Science Series.* Department of Conservation, Wellington. 18 p.

O’Driscoll, R L; Gauthier, S; Devine, J A (2009) Acoustic estimates of mesopelagic fish: as clear as day and night? *ICES Journal of Marine Science 66*: 1310–1317.

O’Driscoll, R L; Oeffner, J; Ross, O; Dunford, A J; McMillan, P J (2013) Pilot acoustic survey for jack mackerel on the west coast New Zealand (JMA7).. *New Zealand Fisheries Assessment Report 2013/1*. 53 p.

Overholtz, W J (1991) *Delphlnus delphis* in the Mid-Atlantlc Blght during Sprlng 1989. *Fishery Bulletin 89*: 723–728.

Perrin, W (1989) Dolphins, porpoises, and whales. An action plan for the conservation of biological diversity 1988–1992. IUCN, Gland, Switzerland. 27 p.

Piroddi, C; Bearzi, G; Gonzalvo, J; Christensen, V (2011) From common to rare: the case of the Mediterranean common dolphin. *Biological Conservation 144 (10)*: 2490–2498.

Pusineri, C; Magnin, V; Meynier, L; Spitz, J; Hassani, S; Ridoux, V (2007) Food and feeding ecology of the common dolphin (*Delphinus delphis*) in the oceanic Northeast Atlantic and comparison with its diet in neritic areas. *Marine Mammal Science 23 (1)*: 30–47.

Reeves, R R (2003) Dolphins, whales and porpoises: 2002–2010 conservation action plan for the world's cetaceans. IUCN/SSC Cetacean Specialist Group. 139 p.

Reeves, R R; Berggren, P; Crespo, E A; Gales, N; Northridge, S P; di Sciara, G N; Perrin, W F; Read, A J; Rogan, E; Smith, B D (2005) Global priorities for reduction of cetacean bycatch. Report to the World Wildlife Fund for Nature. 28 p.

Reeves, R R; Notarbartolo di Sciara, G (2006) The status and distribution of cetaceans in the Black Sea and Mediterranean Sea. IUCN Centre for Mediterranean Cooperation, Malaga, Spain. 137 p.

Reijnders, P; Lankester, K (1990) Status of marine mammals in the North Sea. *Netherlands Journal of Sea Research 26 (2)*: 427–435.

Rosel, P; Dizon, A; Heyning, J (1994) Genetic analysis of sympatric morphotypes of common dolphins (genus *Delphinus*). *Marine Biology 119 (2)*: 159–167.

Rowe, S J (2007) A review of methodologies for mitigating incidental catch of protected marine mammals. *DOC Research and Development Series No. 283*. 48 p.

Silva, M (1999) Diet of common dolphins, *Delphinus delphis*, off the Portuguese continental coast. *Journal of the Marine Biological Association of the UK 79 (03)*: 531–540.

Silva, M A; Sequeira, M (2003) Patterns in the mortality of common dolphins (*Delphinus delphis*) on the Portuguese coast, using stranding records, 1975-1998. *Aquatic Mammals 29 (1)*: 88–98.

Stockin, K A (2008) The New Zealand common dolphin (*Delphinus* sp.). Massey University. 235 p.

Stockin, K A; Amaral, A R; Latimer, J; Lambert, D M; Natoli, A (2014) Population genetic structure and taxonomy of the common dolphin (*Delphinus* sp.) at its southernmost range limit: New Zealand waters. *Marine Mammal Science 30 (1)*: 44–63.

Stockin, K A; Binedell, V; Wiseman, N; Brunton, D H; Orams, M B (2009a) Behavior of free-ranging common dolphins (*Delphinus* sp.) in the Hauraki Gulf, New Zealand. *Marine Mammal Science 25 (2)*: 283–301.

Stockin, K A; Duignan, P J; Roe, W D; Meynier, L; Alley, M; Fettermann, T (2009b) Causes of mortality in stranded common dolphin (*Delphinus* sp.) from New Zealand waters between 1998 and 2008. *Pacific Conservation Biology 15 (3)*: 217–227.

Stockin, K A; Murphy, S N; Duignan, P J; Perrott, M M; Jones, G W; Roe, W D (2011) Reproductive biology of New Zealand common dolphins (*Delphinus* sp). *In*: 19th Biennial Conference on the Biology of Marine Mammals. pp 283. Tampa, Florida, 27 November-2 December 2011.

Stockin, K; Orams, M (2009) The status of common dolphins (*Delphinus delphis*) within New Zealand waters. *Journal of Cetacean Research Management SC/61/SM20*.

Stockin, K A; Pierce, G J; Binedell, V; Wiseman, N; Orams, M B (2008) Factors affecting the occurrence and demographics of common dolphins (*Delphinus* sp.) in the Hauraki Gulf, New Zealand. *Aquatic Mammals 34 (2)*: 200–211.

Stockin, K A; Visser, I N (2005) Anomalously Pigmented Common Dolphins (*Delphinus* Dolphins sp.) off Northern New Zealand. *Aquatic Mammals 31 (1)*: 43–51.

Thompson, F N; Abraham, E R; Berkenbusch, K (2010) Common dolphin (*Delphinus Delphis*) bycatch in New Zealand mackerel trawl fisheries, 1995-96 to 2008-09. *New Zealand Aquatic Environment and Biodiversity Report No. 63.* 20 p.

Thompson, F N; Abraham, E R; Berkenbusch, K (2013a) Common dolphin (*Delphinus delphis*) bycatch in New Zealand commercial trawl fisheries. *Plos One 8 (5)*: e64438.

Thompson, F N; Abraham, E R; Berkenbusch, K (2013b) Marine Mammal Bycatch in New Zealand Trawl Fisheries, 1995-96 to 2010-11. *New Zealand Aquatic Environment and Biodiversity Report No. 105.* 73 p.

Tudela, S; Kai, A K; Maynou, F; El Andalossi, M; Guglielmi, P (2005) Driftnet fishing and biodiversity conservation: the case study of the large-scale Moroccan driftnet fleet operating in the Alboran Sea (SW Mediterranean). *Biological Conservation 121 (1)*: 65–78.

Vella, A (2005) Proceedings of the workshop on Common dolphins: current research, threats and issues. *European Cetacean Society Newsletter Special Issue No. 45.* 39 p.

Viricel, A; Strand, A E; Rosel, P E; Ridoux, V; Garcia, P (2008) Insights on common dolphin (*Delphinus delphis*) social organization from genetic analysis of a mass-stranded pod. *Behavioral Ecology and Sociobiology 63 (2)*: 173–185.

Westgate, A J; Read, A J (2007) Reproduction in short-beaked common dolphins (*Delphinus delphis*) from the western North Atlantic. *Marine Biology 150 (5)*: 1011–1024.

Young, D D; Cockcroft, V (1994) Diet of common dolphins (*Delphinus delphis*) off the south-east coast of southern Africa: opportunism or specialization? *Journal of Zoology 234 (1)*: 41–53.