Appendix P Shark effects assessment

Ngāi Tahu Seafood Resources Limited

Hananui Aquaculture Project

Shark Assessment

Evidence of Brittany Finucci regarding *Shark assessment for the proposed fish farm off northern Stewart Island/Rakiura* and the *Shark Management Plan* and Proposed Wildlife and Consent Conditions

Brittany Finucci
11-10-2025

Introduction

My name is Brittany (Brit) Finucci.

My role in relation to the Hananui Aquaculture Project ("**HAP**") has been to provide expert evidence in relation to sharks. I wrote / was the lead author of the *Shark assessment for the proposed fish farm off northern Stewart Island/Rakiura* and the *Shark Management Plan* which are provided within **Appendix P** and **Appendix Y** of the application.

This evidence has been prepared to accompany the application by Ngāi Tahu Seafood Resources Limited ("**NTS**") for approvals required for the HAP under the Fast-track Approvals Act 2024 ("**FTAA**"). It has been prepared on the understanding that the process for determining applications under the FTAA does not require a hearing to be held, and accordingly the purpose of this evidence is to confirm that, relative to my area of expertise, the *Shark assessment for the proposed fish farm off northern Stewart Island/Rakiura* and the *Shark Management Plan* provides an appropriate description of the relevant environment, the proposed activities comprising the effects of the HAP on that environment, and the way those effects are proposed to be managed.

My findings are set out in full in the *Shark assessment for the proposed fish farm off northern Stewart Island/Rakiura* and the *Shark Management Plan* included within **Appendix P** and **Appendix Y** of the application.

While this application is not being considered by the Environment Court, I confirm that I have read the Code of Conduct for expert witnesses contained in the Environment Court of New Zealand Practice Note 2023 and that I have complied with it when preparing this evidence. Other than when I state I am relying on the advice of another person, this evidence is within my area of expertise. I have not omitted to consider material facts known to me that might alter or detract from the opinions that I express.

Qualifications and Experience

I am a fisheries scientist at Earth Sciences New Zealand (previously NIWA).

I graduated from Victoria University of Wellington with a PhD in Marine Biology.

My research has focused mainly on sharks, with an interest in bycatch and data poor species, and fisheries management. I have worked as a fisheries scientist for 8 years in New Zealand and Australia. I currently work at Earth Sciences New Zealand (previously the National Institute of Water and Atmospheric Research, NIWA) in Wellington, New Zealand. I have held this position for 7 years. Prior to this, I worked at Charles Darwin University in Darwin, Australia in 2017–2018 as a Research Associate undertaking research on threatened sharks in river systems. I am affiliated with the Oceania Chondrichthyan Society (current Past President), American Elasmobranch Society, Deep Sea Biology Society, and IUCN Shark Specialist Group (SSG) and am the Chair of the SSG Deepwater Chondrichthyan Working Group.

In providing this evidence in relation to sharks, I have considered the following matters as relevant to that topic:

- The project description provided by NTS as set out in section 6 of the application;
- The description of the existing environment, the effects of the HAP on that environment and their significance, and the proposed management and mitigation measures to manage those effects all as set out in the assessment of environmental effects accompanying the application; and
- A range of data sources, including tagging studies and fisheries data, describing the distribution and known movements of sharks in the region, and published and unpublished information on shark interactions with marine farms within New Zealand and Australia.

Confirmation of Contents of Report and Proposed Conditions

I confirm that in my opinion the *Shark assessment for the proposed fish farm off northern Stewart Island/Rakiura* and the *Shark Management Plan* contain an accurate and appropriate description of the environment, the actual and potential effects of the HAP, and the recommended actions to manage those effects within my area of expertise.

I confirm that in my opinion the contents of the *Shark assessment for the proposed fish farm off northern Stewart Island/Rakiura* and the *Shark Management Plan* may be relied on in making a decision on the approvals sought for the HAP and confirm that provided effects within my area of expertise are managed as proposed in the application those effects will not be unacceptable and will be managed to a standard that I consider meets good practice.

I confirm that I have reviewed the conditions that NTS proposes for the approvals being sought as they relate to my area of expertise. I confirm that in my opinion, those proposed conditions are appropriate.

Brittany Finucci

11-10-2025

Shark assessment for the proposed fish farm off northern Stewart Island/Rakiura

Revised

Prepared for Ngāi Tahu Seafood Resources Limited

June 2025

Climate, Freshwater & Ocean Science

Prepared by:
Brit Finucci

For any information regarding this report please contact:

Brittany Finucci
Fisheries Scientist
Marine Megafauna and Fish Biology
[redacted]

National Institute of Water & Atmospheric Research Ltd
Private Bag 14901
Kilbirnie
Wellington 6241

Phone +64 4 386 0300

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[redacted]	Formatting checked by:	Alex Quigley
[redacted]	Approved for release by:	Alison MacDiarmid

Contents

Executive summary

This report assesses the potential for incidents between sharks and a proposed fish farm situated off northern Rakiura/Stewart Island. The two shark species most likely to interact with the farm are the white shark (*Carcharodon carcharias*), a protected species, and the broadnose sevengill shark (*Notorynchus cepedianus*). The report reviews the known movements of white sharks in the Te Ara a Kiwa/Foveaux Strait and northern Rakiura/Stewart Island area; summarises the spatial and seasonal patterns of white and sevengill shark presence; reviews the distribution of captures of white sharks by commercial fishers; reviews published information on the incidents between sharks and marine farms in Australia; assesses the potential for white sharks to be impacted by the farm; and makes recommendations for mitigating the risks to shark populations.

Satellite fixes from four white sharks tagged at the Titi Islands were distributed through the centre of Te Ara a Kiwa/Foveaux Strait, with few fixes near shore. However, at times white sharks moved into very shallow water. One fix was within the proposed farm boundary and one was just on the southeastern border of the proposed site. Fourteen captures of white sharks were reported by commercial set net and potting fishers in Te Ara a Kiwa/Foveaux Strait and northern Stewart Island/Rakiura between 2010 and 2021. One white shark was caught inside the proposed fish farm boundary, and two others just outside the boundary. The proposed farm overlaps white shark habitat and is only 10 km from a major white shark aggregation site at the Titi Islands. White sharks are present at Stewart Island/Rakiura from late summer to early winter, but they are largely absent during the rest of the year. Sevengill sharks occur throughout New Zealand coastal waters and are abundant around Stewart Island/Rakiura and Te Ara a Kiwa/Foveaux Strait, except in winter when their numbers decline substantially.

In Australia, the main incidents of sharks with marine farms involve bronze whaler sharks (*Carcharhinus brachyurus*), but some incidents with white sharks also occur. The white shark was perceived to be the greater concern because of its protected status and its size, which makes handling and removal of intruders more difficult. Successful live releases involved either lowering the headline around part of the net's perimeter to create a channel through which the shark could escape; or cutting open a flap in the side of the net and drawing it into the centre of the net to create a visual barrier that diverted the swimming shark out through the hole. Many if not all of the reported white shark incidents occurred in nets that did not have a predator exclusion net around the outside. Acoustic tracking of white sharks near fish farms in South Australia found that they were usually deeper than 20 m.

It is inevitable that white and sevengill sharks will be attracted to the proposed farm, although evidence from South Australia suggests that white sharks at least will be transient and not become resident near them. Incidents of white sharks with the farm will probably be restricted to summer, autumn, and early winter. The greatest incidents of sevengill sharks are expected to occur during the warmer months of the year.

Recommendations for reducing or mitigating incidents between sharks and the proposed fish farm include: use a net design that minimises the chances of shark incidents and incursions into the net; inspect nets daily for sharks, and for holes and gaps; ensure animal husbandry is of the highest possible standard to reduce fish mortality; monitor shark activity near the farm with underwater video cameras; maintain greatest vigilance from summer to early winter when sharks are expected to be most abundant; develop an action plan in conjunction with the Department of Conservation to describe the procedures to be followed in the event of a white shark being trapped or killed; train

staff in the removal of sharks from the nets; and develop and implement a shark management plan. If sufficient mitigation action to reduce shark incidents are implemented, then adverse effects on sharks should be relatively low.

1 Introduction

Large predators, particularly sharks, may be attracted to fish farms because they provide the opportunity for a meal (Papastamatiou et al. 2010, Loiseau et al. 2016). Predators may cause damage to farms while trying to access the fish, and they may themselves be injured or killed if they are trapped by or in the net, or in the process of being removed from the net by staff.

In this report, the potential for incidents between sharks and a proposed fish farm situated off northern Rakiura/Stewart Island is assessed. The two shark species most likely to interact with a farm in that location are the great white shark (*Carcharodon carcharias*) and the broadnose sevengill shark (*Notorynchus cepedianus*). Hereafter these sharks are referred to as white shark and sevengill shark respectively. Other shark species occurring in the area (e.g., mako shark *Isurus oxyrinchus*, school shark *Galeorhinus galeus*, blue shark *Prionace glauca*) are not considered here because they are considered too small (school shark) or too uncommon in the area (mako and blue sharks) to be a problem or are not known to interact significantly with fish farms elsewhere.

The objectives of this study were:

1. Review and describe the known movements of great white sharks in the Te Ara a Kiwa/Foveaux Strait/northern Rakiura/Stewart Island area based on previous tagging work at the Titi Islands. The spatial and seasonal patterns of shark presence will be summarised.
2. Review the distribution of captures of white sharks reported by commercial fishing vessels and fishery observers in the same region.
3. Review published information on the incidents between great white sharks and marine farms elsewhere, with emphasis on salmon and tuna aquaculture facilities and holding nets in Australia.
4. Consider the potential for impacts on other shark species in the region, such as sevengill shark.
5. Prepare a report summarising the above investigations, and assessing the potential for white sharks to be meshed/entangled in the marine farm's nets in northern Rakiura/Stewart Island.
6. Make recommendations for mitigating any identified major risks to shark populations.

The information and results reported here did not involve any field work or collection and analysis of new data. This report summarises information available in existing documents and provides updates from previous reports provided to Ngāi Tahu Seafood Limited (Francis 2019, Lyon 2020), as well as an independent expert peer-review of the original resource consent application (Huveneers 2021).`

2 Methods

2.1 Terminology

For clarity, definitions for the following terms frequently used in this document are provided below:

TERM	DEFINTION
Mitigation	Any action that alleviates or moderates the severity of an impact caused by something. Actions that mitigate impacts may also minimise those effects.
Incident	Any physical contact an individual (person), boat, or gear has with a shark species that causes, or may cause death, injury, or stress to an animal. This includes entrapment and entanglement.

2.2 Species occurring in Te Ara a Kiwa/Foveaux Strait

At least 21 species of sharks and their relatives (rays and chimaeras, herein referred to as sharks) have been identified from the Te Ara a Kiwa/Foveaux Strait area. Information on species distribution was described from research trawl surveys (largely off Southland, including the Stewart Island shelf in the summer months of 1994, 1995, and 1996; see Hurst and Bagley 1997), directed research studies (see Sections 2.3, 2.5), and public observations reported on iNaturalist (iNaturalist 2025). Species are listed in Appendix 1.

The two shark species most likely to interact directly with the finfish farm are white shark (*Carcharodon carcharias*) and sevengill shark (*Notorynchus cepedianus*) (Francis 2019). Spiny dogfish (*Squalus acanthias*), school shark (*Galeorhinus galeus*), elephantfish (*Callorhinchus milii*) and carpet shark (*Cephaloscyllium isabellum*) are relatively abundant in the area, with nearly 1290 tonnes (t), 559 t, 518 t, and 75 t of the species, respectively, reported from commercial fisheries operating in Foveaux Strait (statistical area 025) between 2011 and 2020 (Taylor & Dempster 2021). These species, and others are not anticipated to have a direct incident with the finfish farm is low or unlikely because of their small size, are relatively uncommon in the area, or are not known to interact significantly with fish farms elsewhere. Some of these species occupy offshore or deepwater habitats (mostly at depths greater than 200m) and are unlikely to have any incidents with the finfish farm.

2.2.1 Compliance with Wildlife Act 1953

White shark and basking shark are protected under Schedule 7A of the Wildlife Act 1953. It is illegal to hunt, kill, or harm white sharks and basking sharks within New Zealand's Territorial Sea and Exclusive Economic Zone (200 nautical mile limit around New Zealand).

2.2.2 Compliance with the New Zealand Coastal Policy Statement 2010 (NZCPS) Policy 11

The objective of the NZCPS-Policy 11 is to protect indigenous biological diversity in the coastal environment. Policy 11 of the NZCPS lists species and habitats for which adverse effects should be avoided (Policy 11(a)) and areas and habitats where significant adverse effects should be avoided and all other adverse effects should be avoided, remedied or mitigated (Policy 11(b)). Policy 11(a) is applicable to white shark, broadnose sevengill shark, school shark, spiny dogfish, basking shark, mako, porbeagle, and thresher shark which are listed as threatened species under either the New

Zealand Threat Classification System (NZTCS) or IUCN Red List of Threatened Species (see Appendix 1[1]). White shark and basking shark considered threatened by both classification systems.

Policy 11(b)(v) is applicable to white sharks which used Te Ara a Kiwa/Foveaux Strait during their annual migrations. The region may also be used by broadnose sevengill shark as they are suspected to move seasonally between the South Island and Rakiura/Stewart Island, but movements of this species have not been quantified.

Should either death or injury of a species meeting the NZCPS Policy 11 threshold occur because of an incident, this event would represent an 'adverse effect' and would trigger clauses (a)(i) and (a)(ii) of Policy 11. Of the species most likely to interact with the farm (i.e., white shark and sevengill shark), the death of a single individual is unlikely to be a significant adverse effect at the population level. The size of the shared New Zealand and eastern Australia white shark population is estimated to be up to 650 individuals (Hillary et al. 2018). While the population size of sevengill shark is unknown, it is likely to be larger than white sharks.

2.3 White shark distribution from tag location

Between 2007 and 2015, the National Institute of Water and Atmospheric Research (NIWA) and the Department of Conservation (DOC) carried out a research project on the distribution, abundance and behaviour of white sharks around northern Rakiura/Stewart Island (Duffy et al. 2012, Francis et al. 2012, 2015). The main focus of that study was the Titi Islands group, the nearest of which (Edwards and Bench islands) are situated about 9.7 km southeast of the proposed farm location. The white shark study involved the deployment of 81 electronic tags on more than 60 sharks (some sharks were tagged with more than one tag, or tagged multiple times).

Three types of electronic tags were used, as follows (summarised from Francis et al. 2015):

1. Vemco acoustic tags. These tags emit a coded train of sound pings at random intervals. Tags were detected by a network of Vemco acoustic receivers having an estimated range of 300−500 m. Receivers were placed at Titi Island and Te Ara a Kiwa/Foveaux Strait stations near major fur seal colonies, or at headlands or rocky islands that may be way-points for travelling sharks. Receivers were mounted ca 5 m above the seabed on a mooring rope. Receivers were deployed in March 2011 and retrieved, downloaded and re-deployed at 2−5 month intervals until they were finally removed in July 2013. The nearest receiver to the proposed farm site was at northwest Edwards Island, 9.7 km away.

2. Wildlife Computers Ltd and Microwave Telemetry Ltd pop-up archival transmitting (PAT) tags. PAT tags record light levels, depth and temperature, and archive the data in memory until the tags release themselves and float to the surface on a programmed date, and transmit summarised data to orbiting Argos satellites. Approximate daily positions can be determined from the estimated times of dawn, dusk and midday.

3. Wildlife Computers Ltd smart position or temperature transmitting (SPOT) tags. SPOT tags do not archive raw data, but instead communicate with satellites whenever the

[1] School shark, spiny dogfish, blue shark, mako, and porbeagle are managed under the Quota Management System (QMS). See the Shark Management Plan for more details.

aerial breaks the water surface, and obtain accurate position fixes (often to less than 2 km accuracy).

Acoustic and PAT tags were deployed using a hand-held tagging pole on free-swimming sharks that were attracted to a research vessel with a chum of minced tuna and fish oil, and whole tuna baits. Tag anchors were injected into the dorsal musculature below the first dorsal fin. SPOT tags were attached to the dorsal fins of four captured white sharks using stainless steel bolts, washers and locknuts. Further details of the tagging methods were described by Francis et al. (2015).

PAT tag location estimates may have errors of one degree or more, especially for latitude around the equinoxes. They are therefore not suitable for describing the location and movements of sharks at small spatial scales. Similarly, acoustic tags record shark presence only within a few hundred metres of fixed listening stations, so they do not tell us anything about the presence of white sharks in the region of the proposed farm. We therefore restricted the spatial analysis below to SPOT tag fixes received from four sharks 3.3–3.7 m total length tagged at the Titi Islands in 2007–2014. The small number of SPOT tags deployed by the study reflects the difficulty of catching sharks to attach these tags.

The seasonal presence of white sharks in the northern Rakiura/Stewart Island region was assessed using data collected from all three tag types (Francis et al. 2015).

2.4 Commercial fisher white shark capture locations

White shark captures were analysed and summarised by Francis (2017) and Finucci et al. (2022). Records of white shark captures by commercial fishers in the Te Ara a Kiwa/Foveaux Strait region were obtained from two Ministry for Primary Industries' databases: the Centralised Observer Database which contains data collected by observers on fishing vessels; and the Non Fish and Protected Species Catch Returns (NFPS), which were introduced in 2008 for fishers to report catches of protected fish species.

2.5 Sevengill shark distribution and seasonality

The University of Otago had a research programme on sevengill sharks in the Otago- Rakiura/Stewart Island region. Studies completed are reviewed here for information on the distribution and seasonality of sevengill sharks (Edwards 2018, Housiaux et al. 2019, Lewis et al. 2020, Lewis et al. 2023).

2.6 Incidents of sharks with fish farms

Searches for publications on shark incidents with fish farms or aquaculture facilities were made using scientific abstracting services (Web of Science, Science Direct) and the Google search engine.

3 Spatial and seasonal distribution of white sharks

The distribution of SPOT tag fixes from four white sharks tagged in 2007–2014 at the Titi Islands, northern Rakiura/Stewart Island, is shown in Figure 3-1. Many of the SPOT locations were low quality fixes, with accuracy estimates of 5–10 km. Such locations are not useful for identifying fine-scale spatial distribution, and were discounted (note that some of these fixes were apparently on land). High quality fixes (accurate to within 2 km) showed that all four white sharks moved widely around Te Ara a Kiwa/Foveaux Strait and northern Rakiura/Stewart Island. Most of the high-quality fixes were distributed through the centre of Te Ara a Kiwa/Foveaux Strait, with relatively few fixes near

shore. However, some of the latter were very close to shore, indicating that at times white sharks moved into very shallow water. One fix was within the proposed farm boundary and one was just on the southeastern border.

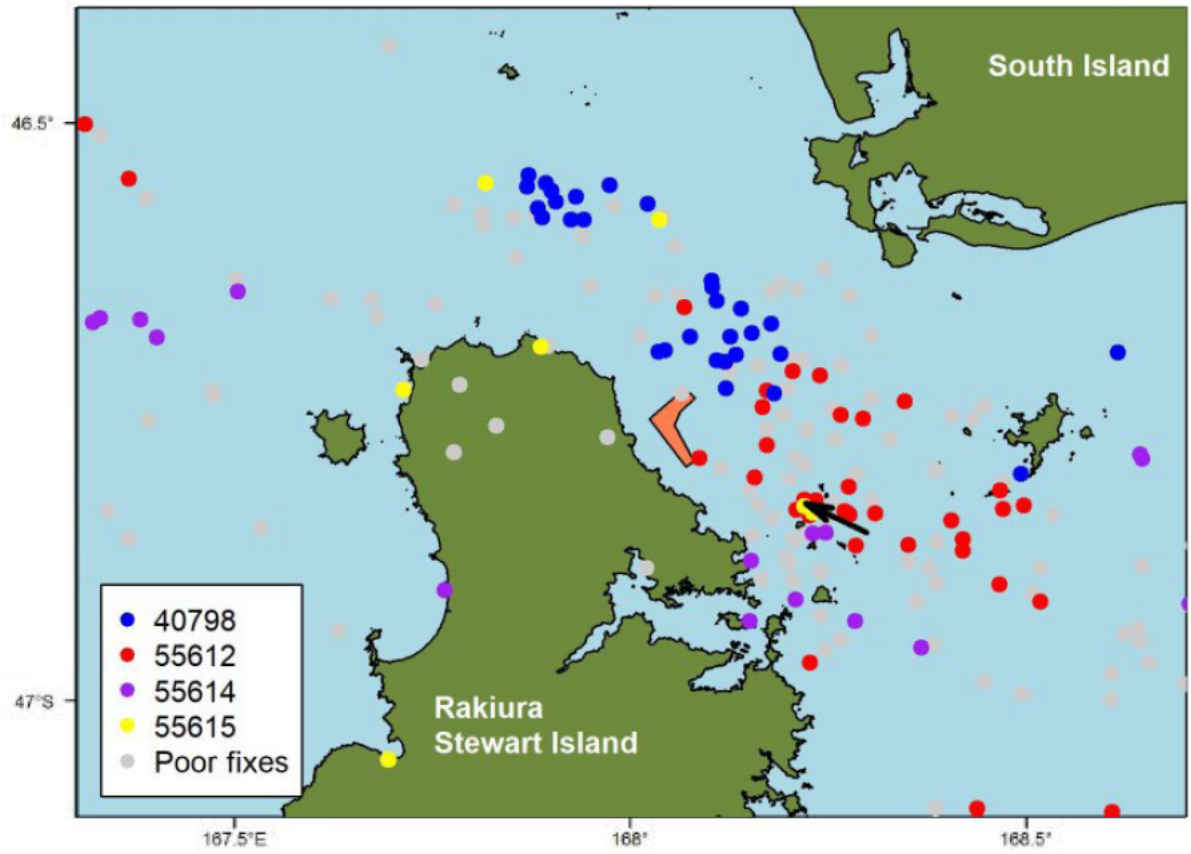

Figure 3-1: Distribution of SPOT tag fixes for four white sharks tagged at the Titi Islands, northern Rakiura/Stewart Island. Coloured dots indicate the locations of high-quality fixes (accuracy < 2 km) for each shark individually, and grey dots indicate low quality fixes (accuracy 5–10 km) for all sharks combined. The location of the proposed fish farm is shown by the brown polygon, and Edwards Island, a major white shark aggregation site, is indicated by the black arrow.**Fourteen captures of white sharks in thirteen events were reported by commercial fishers on NFPS forms around Te Ara a Kiwa/Foveaux Strait and northern Rakiura/Stewart Island between 2010 and 2021 (Figure 3-2). Twelve sharks were caught in set nets and two sharks were caught in one potting event. Most captures were distributed along the northern coast of Rakiura/Stewart Island and in Te Ara a Kiwa/Foveaux Strait. One white shark was caught inside the proposed fish farm boundary, and two others just outside the boundary. Only three fishery captures, in set nets, have been reported from the region by MPI observers (Francis 2017, Finucci et al. 2022). This low rate reflects the very low observer coverage of small inshore fishing vessels.**

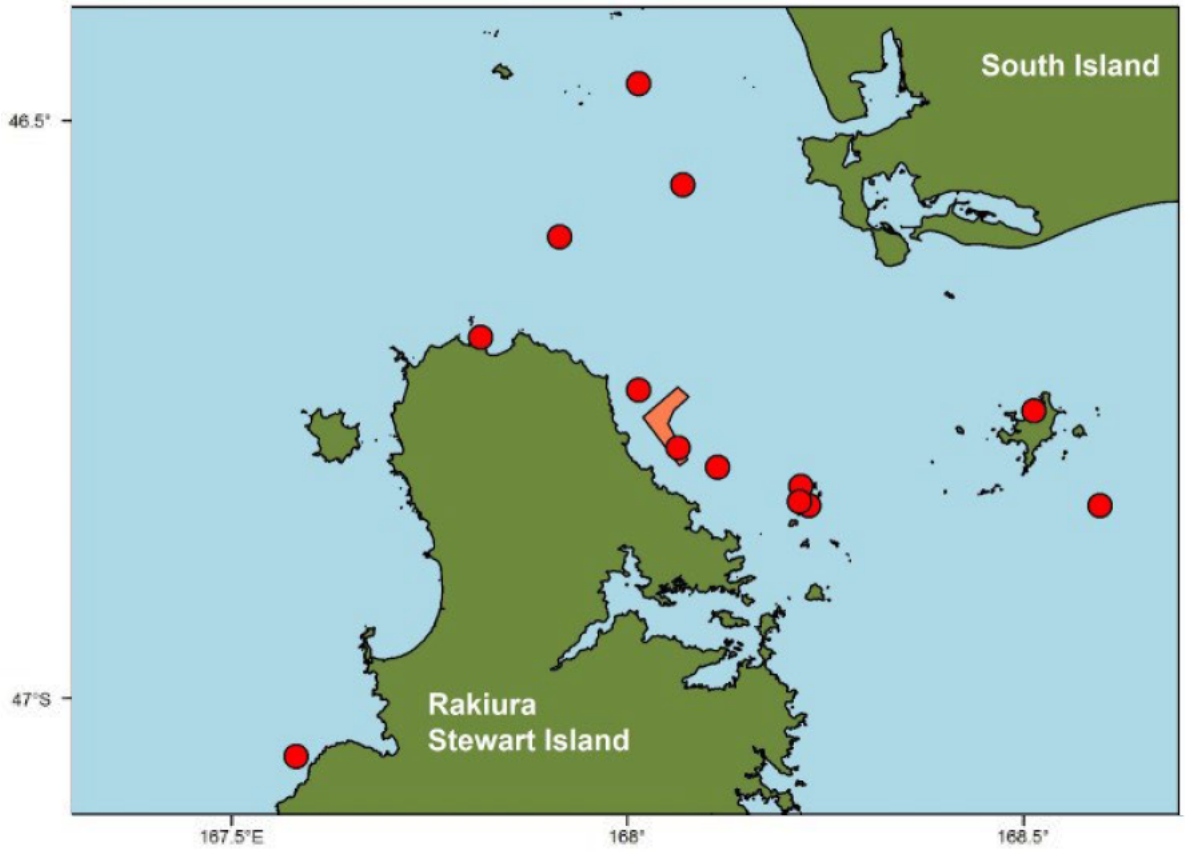

Figure 3-2: White shark capture locations reported by fishers on Non Fish Protected Species forms in 2010–2021. The location of the proposed fish farm is shown by the brown polygon.

The NIWA/DOC tagging programme found that Rakiura/Stewart Island white sharks migrate annually between there and the tropical islands of the South Pacific and eastern Australia (Duffy et al. 2012, Francis et al. 2015). Sharks mainly departed from Rakiura/Stewart Island on their migrations in March–September (peaking in May–July) and returned in December–May (peaking in December–March) (Figure 3-3, Francis et al. 2015). The mean residency period of white sharks at the Titi Islands was estimated to be 4.3 months. Thus, white sharks were present at Rakiura/Stewart Island almost continuously from late summer to early winter, peaking in autumn (March–June), but largely absent during the rest of the year. Only one tagged white shark is known to have remained in the Te Ara a Kiwa/Foveaux Strait region throughout winter–spring (Francis et al. 2015). In 2024, white sharks were tagged off Rakiura/Stewart Island, but this work is still ongoing, and movement patterns are not known at this time.

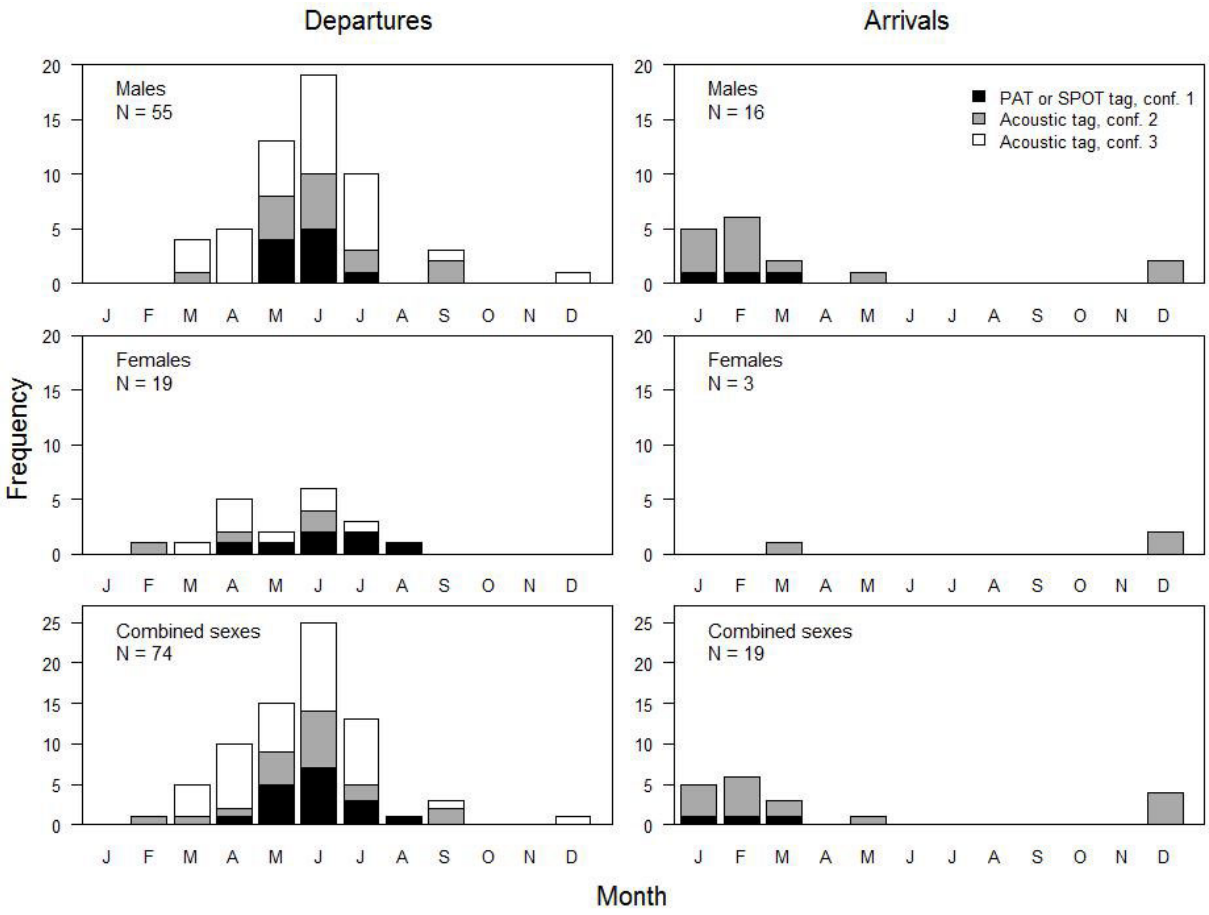

Figure 3-3: Seasonal distribution of white shark departures from and arrivals at Titi Islands, northern Rakiura/Stewart Island, by sex and for both sexes combined. Data are classified by the confidence level of the departure and arrival dates, ranging from black (highest confidence) to white (lowest confidence). Reproduced from Francis et al. (2015).

4 Spatial and seasonal distribution of sevengill sharks

Sevengill sharks occur throughout New Zealand coastal waters, including all around Rakiura/Stewart Island and Te Ara a Kiwa/Foveaux Strait. A study at Paterson Inlet (Te Whaka ā Te Wera) in 2013–2015 found that sevengill sharks were present all year round, but that numbers declined in winter: sharks were encountered on 71–79% of sampling trips in spring–autumn, but the rate declined to 33% in winter (Housiaux 2016, Housiaux et al. 2019, Lewis et al. 2023). Females appeared to be more resident than males. A decline in the abundance of sevengill sharks in Paterson Inlet between summer and winter 2018 was also reported by Edwards (2018). Some evidence of annual site fidelity was observed in Sawdust Bay, Rakiura/Stewart Island, using underwater survey observations, however, a longer sampling period was needed to confirm this suspicion (Lewis et al. 2020). Housiaux (2016) found that sevengill sharks were absent from Otago (Ōtākou) Harbour during winter. Thus, there appears to be a migration away from southern New Zealand in winter. Such a migration is consistent with what is known about the movements of sevengill sharks in Australia, where males migrate up to 1,000 km northwards from Tasmania to New South Wales in winter (Barnett et al. 2011).

5 Interaction of sharks with fish farms in Australia

There is limited information on shark incidents with fish farms globally. The presence of fish farms may affect shark behaviour, attracting sharks to the area and increasing their residency around infrastructure (Papastamatiou et al. 2010, Loiseau et al. 2016). Sharks may cause damage to farms while trying to access the fish, and they may themselves be injured or killed if they are trapped by or in the net, or in the process of being removed from the net by staff. Sharks have been documented as being attracted to fish farm operations elsewhere (e.g., Pacific Northwest, Nash et al. 2005; Latin America, Rojas et al. 2007), however, there is limited data to understand the incidents between sharks and the fish farms, and if the presence of these farms has induced any behavioural or ecological changes.

In 2003, a workshop was held in South Australia on the incidents between sharks and aquaculture operations (Murray-Jones 2004). The workshop focussed on incidents of white sharks and bronze whaler sharks with bluefin tuna pens, because those sharks and that type of farm were the most important in South Australian waters (de Jong & Tanner 2004). Participants stated that the greatest incidents occurred between bronze whalers and the pens while the latter were being towed through open water (stationary farms were not often involved in incidents). At those times, dead tuna ('morts') accumulated at the lower rear corner of the net which bowed out under water pressure. White sharks were regarded as relatively unimportant, having been involved in incidents with only a few farms, and always involved a single shark (a 'loner'), whereas bronze whalers usually aggregated in packs. However, the white shark was perceived to be the greater concern because of its protected status and also its size, making handling and removal of intruders slower and more difficult. Sharks that entered nets usually caused minimal losses to tuna, with only a few reportedly eaten; however the tuna were frequently stressed and that was seen as a greater problem than predation.

The removal of several white sharks from fish farm nets has been described (Malcolm et al. 2001, Murray-Jones 2004, Jones 2008). Successful live releases involved either (a) lowering the headline around part of the net's perimeter to create a channel through which the shark could escape; or (b) cutting open a flap in the side of the net and drawing it into the centre of the net to create a visual barrier that diverted the swimming shark out through the hole. In all cases there was no or minimal loss of fish. There have been other reports of white sharks being found dead in the nets, and sharks being shot to facilitate their removal. Obviously, the latter is not a legal option for a protected species. A key observation is that many if not all the reported white shark incidents occurred in nets that did not have an additional predator exclusion net around the outside.

The development of ocean sea cages for southern bluefin tuna (*Thunnus maccoyii*) aquaculture in South Australia has resulted in a number of studies of their incidents with sharks, particularly white sharks and bronze whaler sharks (*Carcharhinus brachyurus*) (Malcolm et al. 2001, de Jong & Tanner 2004, Murray-Jones 2004, Tanner 2007, Jones 2008). The residency and abundance of sharks was monitored over a five-year period around Granite Island (South Australia) where aquaculture pens of southern bluefin tuna are established for the purpose of wildlife tourism (Huveneers et al. 2022). Acoustic receivers were deployed for a period of 59 months (March 2016–April 2021), including 16 months prior to the pen being installed, 33 months while the pen was present and with southern bluefin tuna, and 12 months after southern bluefin tuna were removed. A total of 117 bronze whalers and 129 white sharks were acoustically tagged prior to or during the study period for other research projects throughout southern Australia.

There was no clear evidence of the pen attracting either shark species, either in terms of number of sharks detected or number of detections. Only 14 bronze whalers (12% of tagged individuals) and nine white sharks (1% of tagged individuals) were detected by the acoustic array deployed around Granite Island. Five of the six white sharks detected in the region while the pen was deployed were not detected by the receiver near the pen, nor were they detected for prolonged periods of time (1–2 days), showing that the white sharks were not attracted to, or resided near, the pen. The low number of shark incidents with the pen was suspected to be due to a combination of factors, including low fish biomass, pen installed in a shallow location, local shark species being migratory species, and good husbandry practices (Huveneers et al. 2022).

A similar project in Spencer Gulf (South Australia) also showed that satellite tagged white sharks had limited incidents with existing finfish aquaculture sites (situated at 12–25 m depth) (Rogers & Drew 2018). However, it is important to note that these conclusions are inferred from smart position or temperature transmitting (SPOT) tags, which can only provide location data when sharks are at the surface and with limited accurate position fixes (often to less than 2 km accuracy). The authors suggested that marine farms should avoid areas deeper than 20 m to minimise white shark incidents.

Salmon farms in Tasmania also have incidents with sharks, particularly sevengill sharks. Sevengill sharks are commonly reported to interact with salmon farms, and divers maintaining farm infrastructure have reported possible aggressive behaviour (Keane & Semmens 2016). There has been little evidence to suggest sharks have taken up residency near the farms. A single record of a shark (species unknown) breach into a salmon pen was observed at a marine farm off Tasmania (Petuna 2017).

6 Potential for shark incidents with Rakiura/Stewart Island fish farms

Little information is available on the incidents between sharks and fish farms in New Zealand. NZ King Salmon farms in the Marlborough Sounds reported the most common species observed around their fish farms was spiny dogfish, which appeared in large numbers during the autumn (March–May) and spring months. Bronze whalers (*Carcharhinus brachyurus*), blue sharks, and sevengill sharks were also observed (Duffy 2010, Taylor & Dempster 2016). There is anecdotal evidence of sevengill sharks interacting with salmon farms elsewhere, including Akaroa Harbour (Rosa Edward, Seafood New Zealand, pers. comm. 2024). At Big Glory Bay near Stewart Island (owned by Sanford Ltd), sevengill sharks have also been reported to interact with the salmon farm operations (Alison Undorf-Lay, Sanford Ltd., pers. comm. 2024). Sevengill sharks have attempted to bite through the base of the farm net only when dead fish have accumulated. However, dead fish are collected regularly from the bottom of pens, and dead stock are removed through the water column via a fully enclosed and automated piping system. There are no reports of any sharks interacting with staff. White sharks have been but are rarely observed in the area but there is only one reported incident of a white shark approaching the farm in 2016. However, while white sharks could be observed at any time throughout the year around Stewart Island there seems to be a seasonal presence in observations.

White sharks aggregate at the Titi islands, which are less than 10 km away from the proposed farm site, to feed on New Zealand fur seals (*Arctocephalus forsteri*), which form large colonies there. The emerging breeding colony of New Zealand sea lions (*Phocarctos hookeri*) around Rakiura/Stewart Island may also be attractive to white sharks. Tagging studies and captures in set nets show that white sharks move throughout Te Ara a Kiwa/Foveaux Strait, and at least occasionally pass through the proposed farm site, although shallower coastal waters may be visited less often than the deeper

central strait. It is, however, inevitable that white sharks will be attracted to the farm, although evidence from South Australia suggests that they will be transient and not take up residence near them. White sharks tagged near the Titi Islands almost all migrated to tropical regions north and north-west of New Zealand during winter–spring, so any incidents with the farm will probably be restricted to summer, autumn and early winter. Similarly, sevengill shark numbers decline in the Rakiura/Stewart Island region during winter so the greatest incidents are expected to occur during the warmer months of the year.

7 Potential impacts on sharks and recommended avoidance and mitigation measures

Adverse effects from finfish farms on sharks can arise from risk factors such as the physical presence of the aquaculture gear, vessel movements, and fish farming activities. Based on a literature review of the best available scientific data as well as documented information on the adverse interactions of marine fauna with marine aquaculture, the primary adverse effect identified to have an impact on sharks are:

- Entanglement and entrapment (fatal or non-fatal)

While there is little, if any, information available on other impacts, such as from noise and lighting during the farm development, these impacts are unlikely to have any long-term adverse effects on sharks in the region. Cumulative impacts on sharks caused by multiple effects of finfish farms may arise, however, there are no available data and are not considered at this time. Such information may become available with routine monitoring and reporting. A summary of potential effects of the proposed finfish farm is presented in Table 7-1.

Table 7-1: Summary of potential effects on sharks of the proposed finfish farm on sharks.

Potential effect	Spatial scale of effect	Duration of effect	Consequence for sharks	Likelihood of effect	Significance level of effect (unmitigated)	Mitigation measure
Entanglement/ entrapment	Medium to Large	Persistent	Individual to Regional Level: Death or injury of threatened[2] or non-threatened species	Low to Moderate	Less than Minor to More than Minor	Continuous monitoring of operations, regular inspections of nets and conduct repairs immediately Use predator resistant net material with appropriate mesh size Ensure animal husbandry is kept to a high standard (e.g., fish mortalities regularly collected) Keep all lines under tension and avoid overlap or crossing of warp lines between pens Shield power cables to avoid attraction to electromagnetic fields
Habitat exclusion/ displacement	Small to Medium	Persistent	Individual to Regional Level: Attraction or avoidance of farm site	Attraction: Moderate Avoidance Low	Less than Minor to More than Minor	Record and report shark incidents to build a local presence/ absence database Use monitoring data to reassess disturbance between stages of development and operations Carry out tagging studies for species where no data exists to understand habitat use in the area pre-development and during operations
Change in diet, habitat quality	Small to Medium	Short to Persistent	Individual to Regional Level: Attraction to feed on stock or fish feed; avoidance of natural foraging opportunities	Low to Moderate	Less than Minor	Ensure proper site placement Ensure water and benthic standards are met Ensure animal husbandry is kept to a high standard (e.g., fish mortalities regularly collected)
Underwater sound	Small	Short to Persistent	Individual Level: Attraction or avoidance of farm site	Low	Negligible	Minimise underwater noise to reduce attraction or exclusion to the site
Underwater lighting	Small	Short to Persistent	Individual Level: Attraction or avoidance of farm site	Low	Negligible	Minimise underwater lighting to reduce attraction or exclusion to the site

[2] Should either death or injury occur, such event would represent an 'adverse effect' and would trigger clauses (a)(i) and (a)(ii) of NZCPS Policy 11. See Section 2.2.2 for a list of species applicable here.

Terms in the table:

- Spatial scale of effect: Small (tens of metres), Medium (hundreds of metres), Large (> 1 km)
- Duration of effect: Short (days to weeks), Moderate (weeks to months), Persistent (years or more)
- Consequence for sharks: Individual, Regional, Population level
- Likelihood of effect: Not Applicable (NA), Low (< 25%), Moderate (25‑75%), High (> 75%)
- Significance level of effect: Nil (no effects), Negligible (effect too small to be discernible or of concern), Less than Minor (discernible effect but too small to affect other animals), Minor (noticeable effect but will not cause any significant adverse effects), More than Minor (noticeable effect that may cause adverse impact but could be mitigated), Significant (noticeable effect that will have serious adverse impact but could be potential for mitigation).

Shark incidents with finfish farms may be reduced with adequate planning and management, and good husbandry practices, including the removal of dead stock, avoiding over-feeding, and installing farms in shallow locations (Huveneers et al. 2022). The following recommendations are made to reduce or mitigate incidents between sharks and the proposed fish farm:

1. Use a single net system with an underwater mesh size less than 40mm and predator resistant net materials (e.g., semi-rigid or core stiffened nets resistant, or heavy monofilament to provide resistance to easy tearing, i.e., from chewing).
2. Nets should be inspected daily for incursions of sharks, and for holes and gaps. The net should be maintained to a high standard so that it is effective at excluding sharks.
3. Animal husbandry should be of the highest possible standard to reduce fish mortality. Dead fish should be removed from the nets at least daily. In Australia, dead fish have been consistently identified as the prime shark attractant to fish farms. Dead fish must be disposed of in a way that does not attract sharks to the farm.
4. Shark activity near the farm should be monitored with appropriate measures. This may include routine visual surveys for at/near-surface dwelling species, or with passive acoustic tracking for benthic species (e.g., Huveneers et al. 2022).
5. Greatest vigilance should be maintained between summer and early winter when white sharks are expected to be most present in the area, and when sevengill sharks are most abundant.
6. An action plan should be developed in conjunction with the Department of Conservation to describe the procedures to be followed in the event of a white shark being trapped or killed (see the accompanying Shark Management Plan).
7. Staff should be trained in the removal of sharks from the nets.

8. A shark management plan should be developed and implemented. Detailed operating procedures should be described, and staff should be trained in their application. The plan should describe a range of different scenarios for dealing with trapped sharks[3].

All the above mitigation measures would contribute to reducing the risks to sharks. The recommended mitigation measures 1 to 3 would be essential, represent international best practice and would have a considerable and direct effect in reducing risk to sharks. Recommendations 4 to 7 would be supportive of recommendations 1 to 3 and could be considered as providing additional information. Recommendation 8 would ensure best practices are met and revised, where necessary, and provide an operating framework in which the benefits of recommendations 1 to 3 could be maximised. If recommendations 1 to 3 were implemented, then further recommendations may reduce shark incidents further, although perhaps not significantly, but would ensure the farm is not any long-lasting adverse effects of sharks, particularly those most likely to interact with the farm (i.e., white shark and sevengill shark).

[3] A Shark Management Plan (SMP) has been drafted and will be lodged with the application. The SMP represents the current best practice for mitigating shark incidents. The SMP will be routinely reviewed by appropriate experts at defined intervals, or shorter if an incident with a protected species occurs. See the accompanying SMP for more details.

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Appendix 1

Table 9-1: Shark species recorded from the Te Ara a Kiwa/Foveaux Strait area. Size category, depth range, New Zealand distribution, and occurrence of fish in their diet are summarised from Roberts et al. (2015).

Common name	Scientific name	Size	Depth range (m)	Distribution	Fish Diet	Threat Status
Elephant fish	*Callorhinchus milii*	small	0–200	SI+	N	NoT/LC
Pale ghost shark	*Hydrolagus bemisi*	small	400–1100	NZ	N	NoT/LC
Dark ghost shark	*Hydrolagus novaezealandiae*	small	200–500	NZ	N	NoT/LC
Thresher shark	*Alopias vulpinus*	large	50–250	NZ	Y	NoT/**VU**
Basking shark	*Cetorhinus maximus*	large	0–1000	NZ	?	**Thr/EN**
White shark	*Carcharodon carcharias*	large	0–1000	NZ	Y	**Thr/VU**
Mako	*Isurus oxyrinchus*	large	0–550	NZ	Y	NoT/**EN**
Porbeagle	*Lamna nasus*	large	0–715	NZ	Y	NoT/**VU**
Carpet shark	*Cephaloscyllium isabellum*	small	0–400	NZ	Y	NoT/LC
School shark	*Galeorhinus galeus*	medium	0–1100	NZ	Y	NoT/**CR**
Rig	*Mustelus lenticulatus*	small	0–250	NZ	N	NoT/LC
Blue shark	*Prionace glauca*	large	0–1000	NZ	Y	NoT/NT
Broadnose sevengill shark	*Notorynchus cepedianus*	large	0–200	NZ	Y	NoT/**VU**
Spiny dogfish	*Squalus acanthias*	small	0–1446	NZ	Y	NoT/**VU**
Seal shark	*Dalatias licha*	medium	400–1000	NZ	Y	NoT/**VU**
Electric ray	*Torpedo fairchildi*	small	0–1135	NZ	Y	NoT/LC
Blind electric ray	*Typhlonarke* spp	small	60–880	NZ	Y	NoT/LC
Smooth skate	*Dipturus innominatus*	medium	0–500	NZ	Y	NoT/LC
Rough skate	*Zearaja nasuta*	small	17–600	NZ	Y	NoT/LC
Shorttail stingray	*Bathytoshia brevicaudata*	large	0–200	NZ	Y	NoT/LC
Eagle ray	*Myliobatis tenuicaudatus*	small	0–75	NZ	N	NoT/LC

Size: Small < 1.5m total length; Medium = 1.6 – 2.5m; Large > 2.6m

Distribution: NZ = distributed throughout New Zealand; + = South Island plus lower North Island

Diet: Y = Yes; N = No; ? = unknown diet

Threat Status (NZTCS/IUCN Red List, bold=threat category in either system): NoT = Not Threatened or Thr = Threatened (NZTCS); LC = Least Concern; NT = Near Threatened; VU = Vulnerable; EN = Endangered; CR = Critically Endangered (IUCN Red List)