Marine Mammals and Salmon Farms

REPORT

prepared for

The New Zealand King Salmon Co. Ltd.

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2. Marine mammals (pinnipeds and cetaceans) are common throughout Cook Strait and the Marlborough Sounds.

3. The New Zealand fur seal is the one species likely to have greatest impact on salmon farms through attacks on the salmon cages with the potential for net damage, loss of stock through escape, stress and/or physical damage to the fish.

4. Four species of dolphins are common throughout the Marlborough Sounds. They are: killer whale, Hector's dolphin, dusky dolphin and the bottlenose dolphin.

5. Two endangered species of large whales, southern right whales and humpback whales, are frequent visitors to the Sounds area.

6. It is highly unlikely that either the above dolphins or the large whales will be adversely affected by the farm operations or vice versa.

7. The methods used by NZ King Salmon to mitigate seal attacks have been very successful and should be continued, these include continual improvements to protection netting, and farm maintenance practices.

8. Because blue whales, fin whales, sei whales, minke whales, sperm whales and beaked whales have not been known to enter the Marlborough Sounds, the Species Accounts for these whales can be found in Appendix 1.

2. Introduction

Marine aquaculture accounts for about 35% of the world aquaculture production. Finfish production makes up about 8% of the total (Kemper, 2003) and is rapidly growing in importance as increasing pressure is applied to wild fish stocks. In New Zealand, finfish aquaculture (primarily for King salmon *Oncorynchus tshawytscha*) began in 1981 and increased rapidly since about 1990. Salmon are farmed in Stewart Island, and the Marlborough Sounds where New Zealand King Salmon Ltd (hereafter NZ King Salmon) currently produce about 60% (7,500mt) of the total national salmon production of approximately 12,000mt from five sea farms occupying a total area of about 5ha at the surface. NZ King Salmon plans to seek new marine farm space in the Marlborough Sounds to achieve potential growth and plan for future development. Cetaceans (whales and dolphins) and pinnipeds (almost always fur seals and sea lions in the Southern Hemisphere) are responsible for most interactions with farm operations, including damage to gear and fish stocks. Adverse effects to marine mammals from fish farming can include fatal and non-fatal entanglements, injuries, habitat loss or disturbance, alterations to predator distribution and diet. All marine mammals in New Zealand waters are protected under the Marine Mammals Protection Act 1978 and all marine farming operations impinging on marine mammals are conducted under permits issued by the Department of Conservation which administers the MMPA.

NZ King Salmon commissioned Cawthorn & Associates to provide independent advice focusing on possible direct and indirect effects on marine mammals from proposed farm expansion within the Marlborough Sounds including such management measures that could be used to avoid, remedy or mitigate adverse effects.

2.1. Scope of Report

This report briefly examines the Marlborough Sounds/Cook Strait physical and marine environment, comments on NZ King Salmon's proposed development and the possible effects this may have on marine mammals in the area. It describes the species of marine

mammals found in the Cook Strait/ Marlborough Sounds area, concentrating on those which are known to enter the Marlborough Sounds, their status, biology, seasonal movements and interactions with different types of fishing gear generally and aquaculture farms particularly. Interaction mitigation methods are discussed and comments on the efficacy of some of these in limiting predation. It concludes by noting which marine mammal species are of most concern and the positive or negative effects of farm development on these species.

2.2. Relevant experience

I have had 45 years specialist marine mammal research (whales and seals), including the following positions:

- 1962–66 Technical Officer (marine mammals) NZ Marine Department Research Division.
- 1966-71 Scientist, Whaling Section, Fisheries Research Board of Canada, Arctic Biological Station, Montreal, Quebec, Canada.
- 1976-87 Scientist (Marine Mammals/Deepwater Fisheries) MAF Fisheries Research Division.
- 1987-92 Senior Scientist (Marine Mammals) Department of Conservation.
- 1992 – established Cawthorn & Associates. Consultants specialising in marine mammals and fisheries and marine industrial interactions.
- Adjunct Lecturer, Institute of Veterinary and Biological Studies, Massey University.

My experience has included work in New Zealand, South West Pacific and Polynesia,

Eastern Tropical Pacific, Central and South America, South Atlantic, Southern Indian Ocean, Southern Ocean/Antarctic, Western North Atlantic, Canadian Arctic, Norwegian Sea.

I have been a member of the Scientific Committee of the International Whaling Commission since 1977, a Charter Member of the Society for Marine Mammalogy since 1984, am a member of IUCN Species Survival Commission's Specialist Groups on Whales and Seals, recipient of the NZ Antarctic Society Conservation Award (1984) for work on Hooker's sea lion and Antarctic minke whales. I was an instigator and co-author of the Marine Mammal Protection Act 1978. I was principal author of the Australian Fisheries Management Authority Code of Fishing Practice for the South East Trawl Fishery. I have been the recipient of 19 research grants from international and NZ sources.

I have provided consultancy services to Australian, Canadian, Japanese, New Zealand, Norwegian and Tongan government agencies, and most recently to the UK government's Department of Environment Fisheries and Rural Affairs(2002-3) and the Australian Fisheries Management Authority (2008).

In New Zealand, since 1992, I have provided consultancy services to private aquaculture and marine industrial enterprises and attended at least 14 resource consent hearings before both the Environment Court and Regional and District Councils regarding the potential effects of marine farms and marine structures on marine mammals.

3. Methodology

The data used to compile this document have been drawn from the existing literature, personal records, historical stranding reports and incidental sightings databases. Systematically gathered data from aerial sightings surveys have been used alongside observations collected regularly by the two main commercial marine mammal watching companies in the area. Other sources have been the Department of Conservation Sounds Area office marine mammal database, information collected from King Salmon farm staff on site, and a very recently published summary of the current knowledge of New Zealand fur seals.

4. Description of Environment

The Marlborough Sounds is a large area of deeply interdigitated, relatively shallow, drowned river valleys opening onto Cook Strait. The northern shore of the Marlborough Sounds is steeply cliffed and drops away into Cook Strait which is shallowest at the western end falling quickly into the Cook Strait Canyon and on into the Hikurangi Trench. The Pacific high tide occurs 5 hours before that at the western end in the Tasman Sea producing very strong currents and upwellings within Cook Strait resulting in high biological productivity in areas such as Clifford and Cloudy Bays and Palliser Bay. Narrow passages such as Tory Channel are affected by the strong tidal flows in the Strait with tidal streams running up to 7 knots at the entrance and about 4 knots inside the Channel. Depths throughout Queen Charlotte Sound range from about 30m-50m with 'scour holes' of as much as 70m indicating increased water movement off rocky points such as Dieffenbach Pt. and off the western side of Blumine Island. Despite the rapid currents in Tory Channel, depths throughout range from 20m-60m decreasing at the heads of bays and inlets. The general bathymetry in Pelorus Sound is similar to Queen Charlotte Sound. There are general depths of 18m – 90m decreasing at the heads of bays and inlets. The general nature of the seafloor is muddy sand with rocky outcrops and reefs off points (New Zealand Pilot 1971).

5. Description of Proposal

NZ King Salmon currently operates five salmon farms within the Marlborough Sounds and has recently purchased two small salmon farms in Crail Bay, Pelorus Sound. It is investigating the feasibility of expanding its production into eight new sites, covering a total of about 11ha of surface marine farm structures in the mid to outer Marlborough Sounds.

5.1. Farm Sites

Most of the existing Marlborough Sounds farm sites are over water about 35m deep. All farm cages, many of which can be subject to strong current flows, have 20 – 30 anchors securing them in position in a generally muddy sand substrate. The cages are connected to the anchors by 14mm polypropylene rope made fast to 24mm galvanised chain shackled to 'screw anchors' buried in the seabed sediment. The recently acquired Crail Bay farms use concrete block anchors. The total length of most anchor warps is about 100m from floating structure to the screw anchors (M.Preece, NZ King Salmon, pers. comm.). The length allows for good holding and accommodates the rise and fall of tide. Generally, anchor warps are continuously taut.

5.2. Farm structures

Generally, the farm structures include both the cages and a 20mx13m two storey /office and feed barge with accommodation facilities for four staff who live on site and rotate every 7 days. However, the Crail Bay farms rely on a mobile servicing barge which remains on site overnight.

5.3. Nets

Fish cages range from 20x20m – 30mx30m. The oldest farms are individual 42mx42m structures containing 4 nets, there may be up to 7 of these on a farm. The latest design is for a single rectangular structure incorporating a paired row of 40mx40m nets where each net is approx. 20m deep. Flotation is provided by steel tubes of up to 1m diameter between which the nets are suspended. Salmon holding nets are protected from seal attack by tensioned protection nets of 240 mm stretched mesh which enclose the whole farm structure and extend over 2m above water level. Protection nets are coated with copper-based antifouling paint. Bird nets are slung across the top of every salmon cage to prevent access by shags and gulls and also mat serve to exclude seals which may have climbed the predator nets. Polar Circle type nets are located at Crail Bay and proposed for the Papatua site.

5.4. Feeding

Fish are fed pelletised food currently sourced from either Chile or Tasmania. King Salmon is currently feeding diets with 15% fishmeal but proposes to change diets of growing fish to 10% fishmeal. Feed delivery to the cages is computer controlled. Each site has a maximum level of feed discharge set as a condition of the farm Resource Consent.

Automatic feeding of pelletised food and uptake by fish is a major source of concern in any operation of this type as unconsumed food pellets fall to the seafloor and degrade the benthic environment. All feeding occurs in the top 5m. NZ King Salmon has installed video cameras about 5m-7m beneath the feeders to monitor pellet fall. If a single pellet passes through the field of view of the camera the feeder is automatically closed off preventing the accumulation of excess organic material on the seabed below and down-current from the salmon cages, and subsequent degradation of the benthos. Food loss is monitored and, through continuous refinement of management practices, loss of unconsumed pellets is $\leq 0.1\%$ (M.Preece, NZ King Salmon, pers comm..)

5.5. Cleaning

To ensure optimum water flow through the nets, the predator nets and larger grower nets are cleaned in the water but on older farm structures the nets are lifted from the water for pressure washing.

5.6. Dead fish disposal

Fish that die and sink to the floor of the cages, are removed either by airlift or by divers and stored on the farm for later disposal in the Blenheim landfill.

5.7. Noise

Operational noise around the farm sites is limited to some degree by constraints imposed on operations by the Marlborough Sounds Resource Management Plan (Clauses 35.1.1.4 Noise; and 34.1.1.4.1 Limits). Clause 35.1.1.4.2 exceptions, however, provides that the rules above do not apply to: …"noise generated by ships underway; noise ordinarily generated by commercial fishing activities including marine farm servicing and harvesting in Coastal Marine Zones 1 & 2". NZ King Salmon has a committed 15m dive vessel for the NZ King Salmon dive team and three 8m commuter vessels which visit the farms five times per week. Farm crews are changed weekly. All farms are serviced by barges from Picton or Havelock.

5.8. Lights

NZ King Salmon has recently installed underwater lighting systems in two of the cages at its Clay Point farm. These lights are suspended at depths of 5m and 10m and are designed to increase production and inhibit maturation of salmon before harvesting. This lighting system is described in more detail in the Cawthron report, *"Assessment of the Environmental Effects of Submerged Artificial Lighting associated with Salmon Farming*" (Cornelisen C. 2011), attached to King Salmon's application.

6. Potential effects on marine mammals

Large whales do most of their foraging in cold, productive, high latitude waters and generally fast when migrating. It is most unlikely large whales would choose to feed near salmon farms or within the Sounds. Migration is a time of social cohesion for humpback whales and, generally, it is very rare for single animals to abandon the main pods in transit, hence the small numbers of humpback whales which are recorded within the Sounds.

Right whales and humpbacks in the Sounds are usually seen as singletons, or as a female with a calf. They often travel very close to shore and have been recorded in the vicinity of mussel farms. The greatest threat to these whales is loose and drifting lines, such as craypot buoy lines, in which the animals can become entangled. Farm maintenance practice requires the monitoring and securing of all lines and the collection of loose lines and debris. The chance of entanglement of large whales around any farm is most unlikely.

Operational noise in the vicinity of salmon farms might possibly contribute to displacement of feeding habitat of dolphins, however this is unlikely.

The illumination of individual cages to manipulate salmon maturation is more likely to attract food fish and be a benefit to marine mammals rather than a disadvantage.

7. Species Present

Marine mammal species common to the Cook Strait / Marlborough Sounds area include the New Zealand fur seal; six baleen whale species: the humpback whale and southern right whale, blue whale, fin whale, sei whale and minke whale. Seven toothed whales are found in the area they are: killer whale, Hector's dolphin, dusky dolphin, bottlenose dolphin, common dolphin, sperm whale and beaked whales. Of the above whales, blue whales, fin, sei and minke whales, sperm whales and the beaked whales are all seen within Cook Strait but have not yet been recorded in the Marlborough Sounds. For this reason, the descriptive accounts of these species are included in Appendix 1.

7.1. Species Accounts

7.1.1. New Zealand Fur Seal (Arctocephalus forsteri)

The New Zealand fur seal *(Arctocephalus forsteri)* is one of two species of otariid (eared) seals breeding within the New Zealand region (the other is the New Zealand sea lion). This species is listed as "least concern" by the IUCN and as "not threatened" by the Department of Conservation (Hitchmough et al, 2007).

Following major depredations by pre-European Maori, 19th C. sealers and, most recently, the government sanctioned cull of 1946 when 6,187 animals were taken, the NZ fur seal stock was reduced to a fraction of its original estimated pre-exploitation size of 1,500,000 – 2,000,000 (Taylor 1992; Richards 1994a). All marine mammals are now fully protected under the Marine Mammals Protection Act 1978 and New Zealand fur seals are considered to be in an 'early re-colonisation phase' apparent from increases in abundance and expansion in range (Baird 2011).

New Zealand fur seals are found throughout New Zealand coastal waters from Three Kings Islands north of mainland New Zealand to Campbell Island, the southernmost island within the NZ 200 mile EEZ, and on most of the southern offshore islands.

7.1.2. Seal Population in the Cook Strait Marlborough region

Traditional haulouts are being re-colonised along the east coast of the South Island, and on most of the accessible rocky islands in Cook Strait, such as The Brothers and the Chetwodes Islands (Cawthorn 1985; Taylor, 1990). There are anecdotal reports of fur seal haulouts on the seaward sides of Mana and Kapiti Islands on the eastern side of Cook Strait. During a count in Jan.2007 of sexes and age classes of fur seals at the Trio Islets, between D'Urville Island and the Chetwode Islands, 51 fur seal pups were recorded (L.Boren pers com) suggesting that an established rookery exists on this group of islets. The largest established breeding rookery in Cook Strait waters is located at Stephens Island where the population was estimated to be about 1352 seals in 1994 (Taylor et al, 1995) with 200-300 pups born annually.

From 1970–71 to 1995 the fur seal population in the Cook Strait-Marlborough region went through a period of very rapid expansion increasing at up to 24% per annum (Taylor *et al*., 1995). This rate of increase slowed somewhat over the next 10 years and by 2005 had declined to about 17% per annum (K.Barton pers.comm, 2005). As the population expanded, fur seals infiltrated the outer Marlborough Sounds and along the western coast of Tasman Bay. Seals have been observed in Queen Charlotte, Pelorus and Kenepuru Sounds and along the Cook Strait coast where they now occupy at least 70 non-breeding winter haulouts. Fur seals have been observed hauled out around Arapawa Island since the 1960s (MWC pers.obs). While there is some seasonal movement of fur seals from rookeries to haulouts near feeding grounds, anecdotal reports suggest that fur seal numbers inside the Marlborough Sounds increase during winter months as animals seek shelter during rough weather on the exposed Cook Strait coast.

7.1.3. Seals and aquaculture farms

Seal predation on farmed salmon is not only a local problem. It occurs in the Marlborough Sounds, Stewart Island, Tasmania, Canada, Chile, Ireland, Norway,

Scotland and the United States. Fur seals appear to have become habituated or at least de-sensitised to the noise associated with shipping and vessel traffic and are not readily deterred by floating farm structures, lights, noise or human presence. In Big Glory Bay, Stewart Island, they frequently haul out to rest on salmon cage pontoons and anecdotal reports from the same area have been received of fur seals attempting to haul out on mussel raft floats. Their interest in farms is simply to get a feed with the least expenditure of effort. To catch salmon, seals will patrol cages to try to find a weakness or hole in the protection or cage netting that they will tear open. If they can find access they will clamber up onto the cage superstructure and dive in amongst the fish. Alternatively, they will harass fish in cages causing them to school up and swim rapidly around the pens. The seals will then push slack cage netting inward, biting fish as they swim past. Those fish which are not bitten can remain stressed, potentially resulting in reduced growth, inferior quality and /or death, resulting in large financial losses.

Since it began operations, NZ King Salmon has had marine farming and coastal permits to operate six salmon farms in the Marlborough Sounds: Ruakaka Bay and Otanerau Bay on Queen Charlotte Sound; Clay Point and Te Pangu Bays in Tory Channel; and Forsyth Bay and Bulwer in Pelorus Sound. Fur seals have occupied four of the six farms at some stage. Seals have also established non-breeding haulouts on accessible promontories close to the farms, such as Parea Pt. on the western side of Otanerau Bay, where their depredations caused substantial damage to salmon pens and stock. Initially, seal attacks on caged salmon were sporadic, however with increasing seal numbers attacks became commonplace forcing NZ King Salmon to install large 'predator nets' that fully enclose the salmon cages and, most of the time, exclude fur seals.

7.1.4. Seal mitigation measures

Predation by seals on caged stock in salmon farms is an international problem that has the potential to cost the industry in lost revenue every year the problem persists. Various techniques, described below, have been used internationally to dissuade seals from harassing fish and ripping holes in cage netting, which can result in wholesale loss of

stock, or climbing the cage structure to gain access to salmon in the pen. These techniques include:

1. increasing net strength and tension by weighting to prevent seals pushing the net inward to bite fish through the mesh;
2. rigging vertical 1.5m-2.0m jump nets around the cage perimeters to prevent seals climbing in and bird netting over the top of cages top prevent entry by gulls and shags to cages from the top;
3. rigging electric fences around the perimeter of the structure to prevent seals climbing the pontoons;
4. acoustic seal scarers, or "scrammers", i.e., acoustic devices that emit sounds of changing pitch, frequency and volume within seals' hearing range to deter seals from approaching cages;
5. seal crackers (ie., "Thunderflash' type fireworks) to scare seals away;
6. disposal of 'morts' i.e., dead salmon off-site;
7. feeding lithium-laced salmon to seals to induce vomiting and a distaste for the fish;
8. placing life-size models of seal 'predators'(such as replica sharks and killer whales) around farms to deter seals from approaching;
9. trapping and translocation of problem seals away from the farm;
10. shooting identified problem seals;
11. improving barrier/ perimeter netting;
12. improving farm maintenance practices, such as increasing frequency of net inspection and repairs.

Over the past three decades all of the above mitigation methods have been thoroughly tested overseas and 75% of them in New Zealand. While some methods had merit, they were temporary solutions only. A good example is #9, 'trapping and relocation'. Trapping and relocation of recidivist salmon killing seals was tried. A large male fur seal was trapped three times in a purpose built 'drop-door' trap at the Te Pangu farm site. It was marked and relocated each time to Carter's Beach near Westport where it was

released. On the first occasion it took 15 days to return. The second time it was caught it took 8 days to return, and the third time, three and one half days to return to the same site at Te Pangu.

Methods neither used in New Zealand nor recommended are: the use of lithium emetics, 'scarecrow'models of predators attached to the farms, and shooting of problem seals.

Instead, ongoing improvement to barrier netting systems and farm practices by NZ King Salmon staff continue to be the major contributor to excluding seals from farms and keeping seal damage to a minimum.

For NZ King Salmon, the continuing development of a very effective working partnership with the Sounds Area office of DOC has been a key to its ongoing seal management success. NZ King Salmon operates under a Permit to "Take" New Zealand fur seals issued under the Marine Mammals Protection Act 1978 (MMPA). The Nelson/ Marlborough Conservancy of DOC issued the latest 15 year permit in cognisance of the improvements made by the company over the term of the original permit, specifically in relation to technological improvements of exclusion nets, and the introduction of a formal training curriculum for staff for handling seal incursions. The company set up a seal policy incorporating training and a regular reporting system for managers and staff at all its farms that has proven to be particularly important in winter when seals move into the sounds from Cook Strait. This has allowed a system of information sharing with DOC leading to effective self-management as NZ King Salmon works to continually improve seal-mitigation measures.

Provided any new farm structures are defended with the same type of protection nets as currently used and the same operating procedures are maintained, the current procedure of installing all encompassing protection netting around the entire farm is continued, the proposed farm structures should not be adversely impacted by New Zealand fur seals at any of the proposed sites.

8. Baleen whales

Baleen whales undertake some of the longest migrations known of any mammal (Bannister, 2008). Of the eight species known in New Zealand waters, humpback and southern right whales are the most frequently encountered large baleen whales in Cook Strait-Marlborough Sounds waters. They habitually travel close inshore through Cook Strait and have been recorded as entering the Marlborough Sounds where they could potentially interact with salmon farms. Blue, fin, sei and minke whales, while known to pass through Cook Strait, have never been recorded within the Sounds area (Appendix 1).

8.1. Humpback whale (M egaptera novaeangliae)

Globally, humpback whales have been listed as 'Endangered' by the International Union for the Conservation of Nature (IUCN), given their much reduced state from excessive whaling (Baker et al 2009).

Humpback whales passing through the New Zealand region travel from feeding grounds in the Ross Sea region to breeding grounds in shallow waters around Tonga, Niue and Fiji. During the northward migration, between May-August, humpbacks travel along the east coast of New Zealand with one portion of the migrating stock passing through Cook Strait to move northward through the Tasman Sea. Southbound humpbacks pass mainly along the west coast of New Zealand between September and December grouping up off the southwest of the South Island before heading south to polar feeding grounds.

The New Zealand humpback whale stock, which sustained coastal whaling operations from the first decade of the 1900s until 1963, crashed in 1960 from over-exploitation throughout its range and was protected from all exploitation by the International Whaling Commission (IWC) in 1966. Since then, this stock has been making a very slow recovery, compared to the coastal migrating component of the east Australian stock which has been increasing at 10.6% per year from 1987-2004 (Bannister 2008). Incidental sightings collected in New Zealand waters from 1979–1992 averaged about 68

humpback whales recorded each year. From 2004 to the present, the Department of Conservation has been making daylight counts of northward migrating humpbacks passing through Cook Strait. From 2004-2010 these counts have ranged from 15-46 animals per year, averaging about 33 per year. The 2011 count increased to about 60 whales (DOC Website). Within the Marlborough region humpbacks have been recorded from Lochmara/Waikawa (cow and calf) 29.05.09, west of D'Urville I. 23.11.10 (DOC Picton database per B.Cash) and in Tory Channel (J.Heberley pers comm.).

Over the last decade a number of humpback whales in the Cook Strait area have become entangled in crayfish pot buoy lines. These single lines are free floating and tens of metres long, usually with two or more floats on the upper (surface) end. As a whale comes into contact with the slack rope, the buoy line slides back along the whale's body until it wraps around the tail stock and flukes. As the animal swims with the line wrapped around it, the combination of drag from the floats and the animal's movement through the water causes the polypropylene to cut into the skin and blubber of the tail stock causing severe injuries which can lead to stranding and death. To date, this is the most common entanglement in any form of fishing gear in New Zealand waters. About 1st July, 2011, a distressed humpback whale, with craypot buoy lines tangled around its tail stock and flukes, was seen by DOC staff off Birdlings Flat, on the south side of Banks Peninsula. On July 5th it was seen off the mouth of the Waima (Ure) River, 25km south of Cape Campbell, travelling slowly north toward Tory Channel which it entered on 8th July. The whale made its way along Tory Channel where DOC staff managed to attach three drogue floats to the animal to slow it down so an attempt could be made to cut it free from the buoy lines around its tail. The exhausted whale swam along a mussel rope buoy line at the Hitau Bay mussel farm where the buoys attached to its tail became entangled with the mussel floats. It was successfully released by farm staff that night. The whale was migrating north; it is most unlikely, under normal circumstances, that it would have (a) entered Tory Channel and (b) become entangled in the mussel rope buoy line, if not already exhausted and encumbered by craypot buoy lines. This incident is the first entanglement of a humpback whale in any marine farm in New Zealand.

8.2. Southern right whale (Eubalaena australis)

Given the strong rates of increase off southern Australia, Argentina and South Africa, southern right whales have been listed as 'Low Risk' (conservation dependent) by IUCN.

Southern right whales can be found in winter and spring months in inshore waters of all the southern hemisphere continents as well as oceanic islands such as the Auckland and Campbell Islands south of New Zealand, where they breed. In summer months, they migrate to colder waters to feed and can be found in the vicinity of the Ross Sea (Miyashita et al 1995). The IWC currently recognizes two right whale management areas in the New Zealand region: the New Zealand/Kermadec Islands, and the New Zealand sub-antarctic islands. There has been some question in the past whether there is any movement of right whales between the sub-antarctic islands and mainland New Zealand. Recent satellite tagging and mtDNA research has confirmed that the whales in both areas are not genetically different and there is direct within-year movement between the two regions(Carroll et al 2011). The right whales found around the subantarctic islands represent to a large extent the great majority of right whales in New Zealand waters (IWC Spec.Issue 2, 2001). The IWC recognises that the Auckland Islands and Campbell Island represent the only known current calving grounds in the New Zealand area, however, on the basis of multiple sightings over several days Patenaude (2003) suggests the stretch of coastline between Napier and Mt.Maunganui is currently the primary calving habitat for right whales around mainland New Zealand.

During the winter months (July-September) they can be seen very close inshore, occasionally in company with calves, often among kelp on rocky coasts or within the surf line. Right whales are slow, highly manoeuvrable swimmers, they appear to be inquisitive and very rarely strand.

Southern Hemisphere right whale populations were severely depleted by open boat and pelagic whaling during the 19th century." The total southern hemisphere population once

numbered around 65,000 right whales and reached its lowest point in the 1920s, at around perhaps only 300 animals. The species received full protection in 1936. Following recent recovery (interrupted by illegal Soviet catches in the 1960s) the most recent southern hemisphere estimate was around 7,500 in 1997 but with a doubling time of 10 years it must be twice that amount now" (Bannister 2008). Right whales have been recorded in relatively large numbers at Campbell Island and the Auckland Islands, but they are still rare around mainland New Zealand. As of the last 25 years, at the most, only 11 different cow/calf pairs has been sighted around mainland New Zealand, suggesting that the population is still extremely depleted (Patenaude 2003). In contrast, on the basis of mark-recapture analysis of photo-identification records, the population at the Auckland Islands in 1998 was estimated to number 936 whales (95% C.I 740-1140) (Carroll et al 2011).

In the 19th century, the Cook Strait-Marlborough region was once a centre of right whale abundance and coastal whaling. Whales would move south along the North Island coast to Kapiti I. thence to Mana I. and Paremata before crossing Cook Strait to Cloudy and Clifford Bays. Such was the abundance of whales in that area, seven whaling stations in Tory Channel, and five in Port Underwood were able to operate. In 15 years of intense pelagic and bay-whaling (1830-1845) the right whale stock was almost reduced to local extinction. Such was the depletion of the stock that although a few bay stations operated around New Zealand into the 1930s by that time right whaling was commercially non-viable.

The first recorded post-whaling sighting of a right whale on the New Zealand coast was in Tory Channel in July 1963 (MWC pers obs., Gaskin,D.E. 1964c). Since then sightings around mainland New Zealand have been sparse. A few sightings have been recorded in the Marlborough Sounds. Slooten et al (2002) list 4 sightings recorded by *Dolphin Watch Marlborough*. Patenaude (2003) lists 19 right whale observations between 1991-2001. The DOC (Picton) database lists 7 observations between 2009-2010. (See Table 1. below)

Table 1. Right whale observations Cook Strait – Marlborough 1991-2010

Year	Month	No. of animals	Location
1991	Oct.	1	Fighting Bay
1994	June	1	Cloudy Bay
1994	July	3	Rununder
1994	July	4	Coombe Rocks
1995	Aug	2	Glasgow I.
1996	June	2	Port Underwood
1997	Aug	3	Perano Head
1998	Dec	1	Pattens Pssg., Queen Charlotte Sd
2000	July	1	Tory Channel
2000	Aug	1	Awaroa Estuary
2000	Aug	1	Parapara Sandspit *
2001	Sep	1	Endeavour Inlet
2001	Sep	1	Between Blumine I. & Ruakaka Bay
2001	Sep	1	Manaroa Bay Pelorus Sd.*
2009	Aug	1	Okuri Bay
2009	Aug	1	Waikawa Bay
2009	Aug	1	Kupe Bay, D'Urville I.
2009	Sep	1	Coppermine Bay
2009	Sep	1	Le Bruin, D'Urville I.
2010	July	1	C.Koamaru
2010	Aug	1	Coppermine Bay

(NB. Observations marked with * probable re-sight of one preceding)

Despite right whales' agility and manoeuvrability, like humpbacks they also occasionally become entangled in craypot buoy lines leading to exhaustion, stranding and death. Although right whales have a propensity to rub and scratch themselves on anchor chains and warps, there has never been any recorded adverse incident involving right whales

with aquaculture farms in New Zealand. Possible reasons for this are that operating regulations discourage the presence of loose-ended lines, prohibit the dumping of cordage and other waste into the sea, and anchor warps are always taut and well spaced.

9. Toothed whales

The largest of the toothed whales, the sperm whale, frequents continental shelf edge waters over 200m depth. It is frequently seen in Cook Strait in passage or feeding in deep water around banks such as Fishermans Rock and along the steep canyon margins off Wellington and in western Palliser Bay. Despite this, it does not move into the shallow waters of the Marlborough Sounds. The beaked whales are generally oceanic and are found along the continental shelf edge and in the vicinity of sea mounts. They too do not enter the Marlborough Sounds (Appendix 1). The following species have all been recorded within the Marlborough Sounds.

9.1. Killer whale (Orcinus orca)

Despite killer whales being found in all oceans from equatorial to polar waters they are currently listed as 'Data Deficient', 'Least Concern' by IUCN.

They are most frequently seen within 800km of continental coasts, and may also be found in mid-ocean (Leatherwood and Reeves, 1983). They are gregarious and the family groups will aggregate into pods of up to 50 individuals that hunt cooperatively for anything from fish to seals to blue whales.

In the New Zealand region there appear to be inshore and offshore groups of killer whales. Preliminary DNA analyses suggests the inshore animals may form three distinct groups, South Island, North Island, and a central group which moves between the northern and southern groups. It is also possible that offshore killer whale populations may contribute to the New Zealand population but the amount of genetic interchange between these groups is currently unknown. Vessels crossing the Tasman Sea frequently reported groups of up to 30 killer whales (Gaskin 1968a); similar sized aggregations have been observed in the Bay of Plenty and off the Chatham Islands. Killer whales tend to arrive off the Stephens Island fur seal rookery in Cook Strait in early winter as weaned fur seal yearlings begin to leave (MWC pers obs). Despite their large size (males to

9m), killer whales are extremely manoeuvrable and have never been recorded entangled in New Zealand. Sightings of killer whales in the vicinity of salmon farms may be as much to do with the abundance of either fur seals or stingrays in the area rather than salmon.

Within the Marlborough region, sightings from Queen Charlotte Sound, Port Underwood, Port Gore and Tennyson Inlet and Catherine Cove were reported by Duffy and Brown (1994). Killer whales were observed catching stingrays in Hallam Cove in the early 1990s, they are also routinely seen in Waihinau Bay, Cook Strait and Queen Charlotte Sound, Endeavour Inlet, Northwest Bay, and Crail Bay in inner Pelorus Sound. Sightings have been recorded in Elmslie Bay and on the east side of D'Urville Island. The DOC Sounds Area Office data base for 2009 records a pod of 6 killer whales off Maud Island, the same number at Snake Point, a pod of 6 in outer Pelorus Sound, 4 at Waimaru bay, Pelorus Sound, and 9 animals at Endeavour Inlet. In 2010, the database records observations of killer whales at Endeavour Inlet/Deep Bay, School House Bay, Boat Rock into Waitata Bay, Ketu Bay (Pelorus Sound), Resolution and Ruakaka Bays.

9.2. Hector's dolphin (Cephalorynchus hectori hectori)

Hector's dolphins are listed by IUCN as 'Endangered' with a CD qualifier which means they are 'conservation dependent' i.e., if current management ceases they will move to a higher threat category.

Hector's dolphin is endemic to New Zealand's South Island and has a limited distribution with the bulk of the population found along the South Island west coast from Karamea to Okarito, in Te Waewae Bay, at Banks Peninsula, and Clifford and Cloudy Bays. This species has a preference for inshore waters and its offshore distribution appears to be limited by the 100m isobath rather than a fixed distance from shore. Hectors dolphin has a high degree of site fidelity and does not make significant migrations along the coast,

however they do appear to have a seasonal change in offshore distribution with animals moving inshore in summer and offshore in winter (Slooten et al 2002).

Hector's dolphin is a social species, usually found in small pods of 2-8 individuals, although these pods will cluster when feeding or in areas of high abundance (Slooten et al 2002). Hector's dolphins feed on a variety of fish species in the 10-35cm size range, including mid-water and bottom dwelling species such as red cod, ahuru, arrow squid, yellow-eyed mullet, stargazer, sole, hake and hoki (Dawson & Slooten 1988, Dawson & Slooten 1996).

Hector's and Commerson's dolphin are the only two of four species (and one sub-species) in the genus *Cephalorynchus* whose sounds have been comprehensively studied. Almost all Hector's dolphins sounds are short, high frequency (ca.125kHz) narrow-band ultrasonic clicks. Click rates can be exceptionally high generating an audible tone in the same frequency as the click rate to sound like a squeal. These signals are strongly linked to aerial behaviours and apparently indicate excitement (Dawson,S.M. 2002).

Hector's dolphins are regularly sighted in the Marlborough region. Sightings have been gathered from the following sources: Duffy & Brown (1994; *Dolphin Watch Marlborough, French Pass Sea Safaris;* DOC Sounds Area database; published accounts of systematic line transect surveys, a three year aerial survey in Clifford and Cloudy Bays, and anecdotal information. The 24 observations of 142 Hector's dolphins, in groups ranging from 1 – 50 animals, recorded between 15 Jan.'09 and 16 May '11 in the DOC Sounds Area database, suggest Hector's dolphins are most frequently seen in the middle reaches of Queen Charlotte Sound and are concentrated in the area around Blumine Island. Sightings are less frequent in other regions of the Sounds, however, in 1984 an aggregation of pods totalling about 30 Hector's dolphins was observed feeding on anchovies in Kenepuru Sound (Cawthorn, 1988). Based on aerial survey results, the Hector's dolphin population in Clifford and Cloudy Bays varies from a maximum summer abundance of 951 (95% CI 573 – 1077) to a minimum abundance of 188 (95% CI 100 – 355) in spring (DuFresne & Mattlin 2009).

9.3. Dusky dolphin (Lagenorhynchus obscurus)

Dusky dolphins are currently listed as 'Data Deficient' secure overseas by IUCN and have a discontinuous, circumpolar distribution in the southern hemisphere., occurring off South America, southwestern Africa, New Zealand and several islands in the South Atlantic and southern Indian Ocean (Würsig et al, 1997). They are highly gregarious with pods numbering 6-20 individuals, and occasionally amalgamate into super-schools of several hundred. Dusky dolphins are found from Poverty Bay south along the east coast of the North Island to Cook Strait and south to Kaikoura and Otago. They are seen off Fiordland and the West Coast, and sightings have been made off the Auckland Islands, and Campbell Island. Some pods are resident or semi-resident year round, while others make predictable seasonal migrations. In a five year study of movements of dusky dolphins from Kaikoura, Markowitz et al (2004) found that over 1000 photo-identified dusky dolphins used Admiralty Bay in the Marlborough Sounds over winter. The average number found in the bay was 220 per week in the winters of 1998-2002 with as many as 55% returning in successive winters after summering off Kaikoura. Markowitz et al (2004) determined that dusky dolphins in Admiralty Bay spent 25% of their time actively feeding on small schoolfish and foraging. In the Marlborough Sounds they feed by cooperatively herding small pelagic schooling fish during daylight hours.

Most of the shoreline of Admiralty Bay is taken up by mussel farms. Despite the density of farms in that area, no fatalities of dusky dolphins through entanglement or other causes associated with the mussel farms have been reported from Admiralty Bay. Throughout the inner and outer Marlborough Sounds sightings have been made in Cloudy Bay, Port Underwood, Queen Charlotte Sound in the vicinity of Blumine Island, Pelorus Sound around Maud Island, Tory Channel, Port Gore and east of D'Urville Island. Dusky dolphins are frequently reported in Cook Strait by fishers, rail ferries and yachts.

9.4. Bottlenose dolphin (Tursiops truncatus)

The bottlenose dolphin in New Zealand has been listed as 'Data Deficient' with the qualifiers: A(1/1), 250-1000 mature individuals (natural or unnatural); any trend;
SP (Sparse: occurring within small and widely scattered populations) and SO (Secure overseas).

The bottlenose dolphin is found from estuaries and bays to deep open sea. In New Zealand waters, populations of bottlenose dolphins can be found in the warm waters of the Bay of Islands, the Marlborough Sounds and Fiordland. This species home range is variable. Some animals exhibit long term residency and site fidelity while other range long distances. Seasonal movement may be tied to prey distribution and can therefore vary from region to region. Bräger & Schneider (1998) re-sighted a bottlenose dolphin off the west coast of the South Island that had previously been photographed in Queen Charlotte Sound, over 200nm away, 66 days previously. There is little information on feeding in New Zealand waters other than Duffy & Brown (1994) and Gaskin (1972) who both noted this species feeds on fish and squid. Bottlenose have been observed in East Bay, Arapawa Island, chasing and herding schools of pilchards (MWC pers obs). DOC Sounds Area personnel have recorded bottlenose dolphins feeding on kahawai in Big Bay. In the first systematic study of the bottlenose dolphins which range across the Marlborough Sounds region, Merriman (2007) photographically documented 335 individuals between 1992 and 2005. Abundance estimates showed that 195-232 individuals visit the Marlborough Sounds annually with a between year immigration/emigration rate of 25%. Long-term site fidelity was observed in the Marlborough Sounds with one individual showing site fidelity over a 10 year period. Calves were observed year around with greatest numbers per group sighted during spring and autumn.

Other Marlborough regional data sources have noted bottlenose sightingshave in Port Underwood and Cloudy Bay, French Pass, Elmslie Bay and Catherine Cove, Tory Channel, Queen Charlotte Sound, Torea Bay and Big Bay, Waikawa Bay and Picton Harbour. *Dolphin Watch Marlborough* maintain an extensive database of sightings of

bottlenose that indicates that these animals are most frequently seen around Blumine and Allports Islands and the inner reaches of Queen Charlotte Sound.

9.5. Common dolphin (Delphinus delphis)

Common dolphins are listed by IUCN as a species of 'Least Concern' with the qualifiers SO (Secure overseas) and DP (Data poor).

Common dolphins are cosmopolitan being found throughout the world's oceans but are restricted to tropical and temperate latitudes (Gaskin, 1968). They are probably the most abundant species in New Zealand continental shelf waters.
Common dolphins are highly gregarious and will form pods of 2-30. However, when feeding or travelling, pods will amalgamate into 'super-schools' that can be in excess of 1000 animals. Common dolphins feed on kahawai, jack mackerel, and small squids and lantern fish that rise to the surface in the scattering layer with the onset of nightfall.

In the Marlborough region, sightings of common dolphins have been made throughout the area but not with the frequency of either Hector's dolphins, dusky dolphins or bottlenose dolphins. Duffy and Brown (1994) reported frequent sightings throughout Queen Charlotte Sound with pod sizes ranging from 2-30 individuals and most sightings being made in autumn. Common dolphins are seen regularly on both sides of Cook Strait in the vicinity of the northern entrance to Queen Charlotte Sound.

10. Assessment of effects of salmon farms on marine mammals

In New Zealand, the only reported mortalities since 1996 of any baleen whales associated with aquaculture installations involved 'two Bryde's whales which reportedly died in separate incidents in the Hauraki Gulf after entanglement in mussel spat collection ropes (Lloyd,B.D.2003)'. Bryde's whales in New Zealand waters are seasonal inhabitants of the warm waters (≥14°C) of Hauraki Gulf and do not migrate south of 40°S. Because of the northern distribution of this species, the chances of this happening in Marlborough Sounds would be exceptionally unusual.

The two species of baleen whales most likely to be impacted by the proposed farms are southern right whales and humpback whales, which are uncommon seasonal visitors to the Marlborough Sounds. Given the low incidence of both humpbacks and right whales within the Marlborough Sounds, and the small numbers of these animals passing through Cook Strait annually, the chances of either of these species becoming involved is very low. Killer whales, Hector's dolphin, bottlenose dolphin and dusky dolphins have been observed frequently enough to be classed as semi resident.

Floating salmon farms are significantly different from mussel farms in that the anchor lines are the only underwater structures beneath the cages and protection netting. These lines by their very nature are always taught, unlike suspended mussel growing ropes which hang in slack loops close to the seabed. Salmon cage netting hangs well clear of the seafloor. Despite continuing concerns regarding potential entanglement in aquaculture structures, there has only been one recorded incident of either entanglement by large whales with any salmon farm in New Zealand (see pg.16-17).

Dolphins, particularly the four species mentioned above, will by now be well accustomed to aquaculture installations in the Marlborough Sounds. Salmon farms are continuously manned and have a barged accommodation building on site. This means there is added

noise and light at the installation and possibly increased vessel traffic. From 2006 to the present, NZ King Salmon staff at the Clay Point, Otanerau, Te Pangu, Ruakaka and Forsyth farms have been required to log any dolphins or whales within the immediate vicinity of the farms. Regrettably, the identification of cetaceans around salmon farms is rudimentary, separating small cetaceans into dolphins and killer whales (Orca) only. The tallies are as follows: Clay Point (7 dolphins), Otanerau (8 dolphins,1 Orca), Te Pangu (6 dolphins), Ruakaka (13 dolphins), Forsyth (5 dolphins). A total of 40 recorded cetacean observations in 5 years operation. No incidents were recorded. Dolphins and killer whales are all highly manoeuvrable and while Hector's dolphins and Killer whales are the only two species likely to forage on the seabed in the vicinity of farms, for bottom fish and stingrays respectively, there has never been any reported incident in which either of these animals has collided with, become caught or entangled in a farm.

The currently used system of feed pellet dispersal monitoring will limit pellet fall to the bottom and will minimise the influx of benthic feeding fish species preyed on by Hector's dolphins and killer whales. Location of the farms in relatively deep water with strong currents will help to reduce any accumulation of unconsumed feed pellets on the seafloor. Dusky, common and bottlenose dolphins tend to forage in the upper part of the water column on schoolfish and will be unaffected .

It is highly unlikely that there will be any adverse effects on these animals.

As stated above, both dolphins and seals are by now habituated to vessel noise and the sounds from commercial aquaculture structures. Both appear unaffected by the sounds of water-blasting, and the regular sounds generated by human activity and machinery on the barges. The New Zealand marine environment is not quiet. Propagated sounds from rain, wind and waves on the shore combine with those generated by earthquakes, volcanic activity and biological sources such as fish, shrimps and marine mammals. Added to this is the noise from shipping, ferries, military activities and seismic exploration, echo sounders, small craft and marine farms all of which contribute to the ambient background noise in the marine environment.

Marine mammals have evolved to occupy this noisy acoustic environment. As water transmits sound about four times faster than air, they use sound to communicate, find food and navigate. Large baleen whales, such as southern right whales produce low frequency sounds, usually below 500Hz and descending into the infrasonic range less than 50Hz ranging from 172-187 dB re 1µPa at 1m; humpback whales (particularly male singers) produce sounds ranging from 20Hz up to 10kHz. Bottlenose dolphins whistles are in the range 125-173 dB re 1µPa at 1m (DOSITS:www.dosits.org). Most Hector's dolphins clicks are of a frequency around 125kHz and can reach about 163 dB re 1µPa at 1m(Dawson and Slooten, 1996). Seals' sounds are usually between 0.5-10kHz frequency range, very similar to the optimum frequencies for human hearing. By comparison, a 34m, twin diesel engine workboat will generate sounds of about 159 dB re 1µPa at 1m at a frequency of 0.63kHz , almost the same as a 7m long outboard powered motor boat (Malme et al 1989).

These sounds are toward the lower end of the hearing range of cetaceans and below that of seals thus these animals are unlikely to be bothered by this noise.

The noise produced during the normal operation of marine farms from generators, pumps, feeders, water blasters and other gear does not appear to bother dolphins or seals and, in many cases, they have been observed to approach very loud sound sources apparently out of curiosity to investigate (MWC Pers obs). If the sound level being produced is uncomfortable dolphins will move away until the noise abates; fur seals will lift their heads and ears from the water and/or move away and remain unaffected. Anecdotal reports from NZ King Salmon staff and observations from Clay Point and Te Pangu noted that while water-blasting was being carried out underwater, seals in the vicinity and a dolphin with a calf moved a short distance away from the sound source and "cruised" nearby. In another incident a dolphin and its calf swam around the farm while water blasting was being carried out with no sign of agitation. Staff believed the dolphins were attracted by the activity.

It has frequently been suggested that marine mammals close to marine farms, or other "noisy" operations, might not be able to hear sounds important to them (e.g., communication from others or predator calls) because the sounds of interest are obscured by anthropogenic sounds from the farm machinery. This is known as "masking". If the dolphin or seal does not connect danger with the sound it will effectively ignore or tolerate it; particularly if it can perceive some benefit (such as food) from doing so. It is unlikely that these sounds will have any adverse effect on these animals.

Insofar as marine mammals are concerned, lights in cages will attract small schoolfish, on which seals and dolphins feed, such as pilchards, anchovies, yellow eyed mullet, squids, and possibly kahawai, toward the cages. Similar attraction to lights has been frequently observed on large trawlers fishing at night. The deck lights attract small fish and squids to the vessel where they are preyed upon by dolphins and seals. As pilchards and anchovy are small enough to pass through the salmon cage meshes these species may also benefit the caged salmon as supplementary food. Fur seals have eyes adapted for low light and as they are primarily nocturnal feeders they are likely to investigate unlit as well as lit cages.

The lighting of salmon pens at night is more likely to aid rather than hinder foraging around cages by seals and dolphins, however, currently there is little to no research available on this subject.

11. Mitigation recommendations

Over the last three decades many methods to mitigate marine mammal interactions with marine fish farms have been tried. These include the use of 'clangers' or other devices to alert whales to the presence of structures in the water preventing entanglements; acoustic harassment devices (AHDs) to repel dolphins and seals; the use of small firework type explosives to scare animals away; lithium emetics in fish to make them unappetizing; full-size models of predators such as killer whales; electric fences to prevent seals climbing up the structure to get access to cages; shooting of repeat offending seals, and trapping and relocation. All of these methods have, at best, either a temporary effect only, or do not work at all.

Those methods which do work involve improved farm structural design, the use of well tensioned protection nets surrounding the entire farm, improved net maintenance and farm management practices, such as retention of all net and cordage debris, plastic strapping and other domestic rubbish for disposal ashore. These methods have become NZ King Salmon normal operating procedure.

Interactions between marine mammals and finfish farms are inevitable and can be detrimental to both marine mammals and the aquaculture industry. In New Zealand, the greatest threat is from fur seals constantly seeking a way into farm cages. The best methods for minimizing attacks is by appropriate net design, constant vigilance by farm staff, appropriate feeding systems, site management and constant gear maintenance.

It is imperative that appropriate net tension is constantly maintained and net maintenance regimes (inspection, maintenance, rapid removal of dead fish from the bottom of the net, and net cleaning) are enforced. New generation, light weight, ultra-strong net materials, such as Dyneema, can be used where appropriate.

New Zealand fur seals are exceptionally agile and good climbers. To prevent access to the cages jump nets should extend at least 2m above the water around the farm.

Farm staff should be instructed in the identification and safe handling of both live seals and cetaceans.

Reduction of pelletised feed waste will reduce the influx of fish to the farm area and also maintain the biological integrity of the seafloor beneath the farms.

12. Conclusions

In New Zealand, the adoption by NZ King Salmon of rectangular farming systems that allow for correct and constant net tension to be maintained, and the use of all-encompassing protection nets has had a major effect in reducing the potential for small cetacean entanglements and fur seal attacks.

In contrast, in South Australia and Tasmania, Polar Circle cages with flat-bottomed nets are commonly used for bluefin tuna and salmon rearing respectively. Polar Circles are floating, flexible, circular pens with the nets slung beneath. Their utility lies in their robustness in inshore waters, relatively inexpensive capital cost and ease of towing from site to site while stocked. The problems experienced with this system in South Australia and Tasmania has been ever increasing predation by sharks and seals on farmed tuna and salmon held in flexible pens which do not readily allow for adequate net tensioning through the base of the nets. As a result, high incidences of both seal attacks and dolphin entanglement have occured (D.Pemberton Dept Primary Industries, Parks, Water and Environment pers comm.).

Polar Circle systems are currently in place at the Crail Bay farm site and are planned for the Papatua site in Port Gore. At both sites it is vital that the growing nets and protection nets are adequately tensioned to resist deformation by currents which can push the protection net against the inner grower net. This is a simple matter if the nets are conical. They can be evenly and heavily tensioned by a single anchor weight from the base (or apex) of the inverted cone and, in that state, are resistant to deformation both by seals and strong currents. When the conical shape is truncated, and a flat base inserted into the net, adequate tensioning and separation of both the growing and protection nets becomes technically more difficult, but not insurmountable. The experience and technical skills developed by NZ King Salmon to date is more than adequate to overcome the above problems.

The marine mammals most likely to have any contact with any of the proposed salmon farms are fur seals, Hector's dolphins, dusky dolphins, bottlenose dolphins, killer whales, southern right and humpback whales. Fur seals will always be in the vicinity as salmon are probably the most nutritious fish they can find locally and, as fur seals are always ready to feed with the least expenditure of energy, salmon farms and their contents will always provide an incentive to haul out nearby, or on the structure itself. Those farm sites closest to Cook Strait are likely to attract a lot of seals in the early phases of development. Provided any new farm structures are defended with the same type of protection nets as currently used and the same operating procedures are maintained seals should not be a problem.

For NZ King Salmon, the continuing development of its very effective working partnership with the Sounds Area office of DOC has been a key factor in its ongoing marine mammal management success. NZ King Salmon's marine mammal policy, incorporating training and reporting systems for all farm staff, has proven to be particularly effective in allowing a system of information sharing with DOC leading to very effective self-management.

The area taken up by the existing and proposed farm sites in the Marlborough Sounds is very small in the context of the Sounds as a whole. As a management measure cage structures are occasionally moved from one location to another to avoid excessive build up of nutrients and degradation of the seabed beneath the farm. The risk to dolphins of displacement from feeding areas is very low. Similarly, any risk from disturbance from noise, lights and vessel traffic is also likely to be exceedingly low. The possibility of either humpback whales or southern right whales colliding with the structure or becoming entangled in any loose lines is most unlikely. One possibility however is that right whales may decide to 'scratch' their backs on the mooring warps. This they have done on anchor chains from vessels lying at anchor in Port Ross at the Auckland Islands and, once satisfied, they move on.

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Appendix 1

1. **Blue whale (Balaenoptera musculus intermedia) /Pigmy blue whale (B.m.brevicauda).**

In the southern hemisphere two species of blue whale are recognised: the 'true' or Antarctic blue whale, and the pigmy blue whale. The primary differences between the two species are size, body proportions, head shape and colour. True blue whales grow to about 30m length and a maximum weight over 130 tonnes. Pigmy blues grow only to about 25m and, as their scientific name indicates are relatively shorter from the dorsal fin to the tail flukes. 'True' blue whales migrate from breeding grounds presumed to be in tropical to warm temperate waters to the Antarctic to feed; pigmy blues tend to feed only as far as 50°S. Blue whales have been seen in Cook Strait waters as recently as July 2011 when 14 animals (including one pod of five) were observed (DOC website) suggesting that their N-S migration routes include both the Tasman Sea and the Pacific. They tend to swim offshore and are not known to enter the Marlborough Sounds.
Blue whales are listed as 'Critically Endangered' by IUCN.

2. **Fin whale (Balaenoptera physalus)**

Fin whales are second largest of the baleen whales reaching a maximum length of about 25m. In the South Pacific fin whales do not migrate as far south as the larger blue whales and are found mainly between 50°S and 65°S. They make long migrations between their winter breeding grounds and summer feeding grounds in the Southern Ocean and tend to travel mostly in open oceanic water away from land. " Migration streams appear to pass both coasts of New Zealand and whalers in Cook Strait have observed fin whales passing through the narrows while going north, crossing from the east side of New Zealand to the west" (Gaskin 1972). On migration they rarely feed and swim steadily at 9-10 knots. At times in the Southern Ocean feeding grounds fin whales will aggregate with blue whales feeding on krill, fish and squid.

Their habit of travelling in open oceanic water would preclude them from entering the Marlborough Sounds.
Fin whales are listed as 'Endangered' by IUCN.

3. Sei whale(Balaenoptera borealis)

Sei whales are the third largest of the baleen whales after blue and fin respectively. They are cosmopolitan and oceanic in distribution and undertake long migrations between summer feeding grounds and winter breeding grounds. In general, they do not travel as far south as fin and blue whales to feed, and are found predominantly between 40°S and 60°S in the summer months in the south west Pacific. Sei whales are generalist feeders taking krill in the Antarctic and fish, squid and copepods in more northern waters around the Subtropical Convergence in the southern Tasman Sea. The physically very similar, but slightly smaller Bryde's whale is a tropical to sub-tropical species, a seasonal visitor to the warm waters of the Hauraki Gulf, and is very rarely seen south of 38°S.

Tory Channel whalers took five sei whales between 1956 and 1964 confirming that sei whales travel from east to west through Cook Strait in early June during the northward migration of humpback whales.
Because of very heavy exploitation between 1960-70 when the southern population was reduced to perhaps less than 10% of its original size (Bannister 2008) and slow recovery this species is listed as 'Endangered' by IUCN.

4. Minke whale (Balaenoptera bonaerensis)

Two forms of minke whales are found in New Zealand waters, the Antarctic minke, and a dwarf form found only in the southern hemisphere. They are small whales growing to a maximum of about 10m and 7m respectively. Antarctic minkes migrate farther south than most other baleen whales except the blue whale and are frequently seen in the open water within the fields of pack-ice as far as 77°46'S. Dwarf minkes do not appear to migrate into Antarctic water although some have been recorded at 65°S. In polar waters, Antarctic minkes feed predominantly on Antarctic krill and Ice krill, a smaller species.

Dwarf minke feed on lantern fishes, small school fish and krill. Minke whales are not frequently seen at sea around New Zealand, possibly because of their small size, but do occur off the east and west coasts of both the North and South Islands where they have been recorded as strandings. They have been sighted at sea in Cook Strait and recorded as strandings on both sides of the Strait (Brabyn 1991).
The Antarctic minke whale is classified as 'Secure' while the dwarf minke is classified 'Insufficiently Known'.

Toothed whales:

5. Sperm whale (Physeter macrocephalus)

Sperm whales are the largest and most easily recognised of all the toothed whales. They are strongly sexually dimorphic, i.e., males are larger than females, reaching a maximum of about 17m-18m in length and about 60 tonnes weight, females reach about 12 metres and about 25 tonnes in weight. In the south west Pacific, sperm whales calve and breed in warm tropical waters at 20°S around Fiji and the Solomon Islands, then, as mixed sex and age schools migrate south to about 40°S - 43°S where they segregate, the females and juveniles in mixed 'nursery' groups return north to the tropics while post-breeding and 'bachelor' males continue south to sub-Antarctic and Antarctic waters to feed. Their migration routes take them either side of New Zealand. On the east side they follow the Tonga-Kermadec Trench south to New Zealand then continue down along the Hikurangi Trench passing Cook Strait and Kaikoura en route. Those animals travelling through the Tasman Sea take a route along the Lord Howe Ridge then due south almost halfway between Australia and New Zealand. Sperm whales are primarily oceanic whales which approach steep continental shelf margins and seamounts, where upwellings of nutrient rich water occur, to feed on squid and fish. Examples of such features are around the Kermadec Islands, Palliser Bay, Cook Strait canyon, Kaikoura, the eastern end of the Chatham Rise and Solander Island. They are prodigious divers and will submerge for 60 minutes, or more, to depths in excess of 2 kilometres seeking their prey. Sperm whales, like most toothed whales, are highly social animals. The 'family unit' usually comprises 10-20 adult females and their young. Large, 'socially' mature males of 25 or more years

of age roam between these family groups seeking receptive females. One calf may be born every 3-6 years after a gestation of 16 months.

The Perano's whaling operation in Tory Channel switched from humpback whaling to sperm whaling in 1962. Over the three seasons until closure in December 1964, 251 sperm whales were taken from the Cook Strait whaling ground which extended from Cook Strait south to Kaikoura and north to the south Wairarapa coast. Despite these catches, sperm whales are probably the most populous species of large whale in the New Zealand region and are still frequently sighted on both sides of the Strait particularly off the mouth of Wellington Harbour, in western Palliser Bay, off the Brothers and in the vicinity of Fishermans Rock in the centre of the Strait, all areas where the strong tides through Cook Strait canyon cause substantial upwelling in each of these locations.
Despite the proximity of deep water to the Marlborough Sounds sperm whales do not enter this area.

Sperm whales are classified as 'Vulnerable' by IUCN.

6. Beaked whales

Beaked whales are the least understood of almost all whale species. They are oceanic whales and all are thought to be deep divers. They are rarely seen at sea because they are usually solitary or found in small pods of 2-7 individuals. What has been discovered about them has been from examination of stranded specimens. Cook Strait is a deep water passage connecting two major oceanic regions and eight species of beaked whales are recorded as stranding in this area. Four species of beaked whales: Gray's beaked whale *(Mesoplodon grayi),* the Straptoothed whale *(Mesoplodon layardi),* Cuvier's beaked whale *(Ziphius cavirostris)* and Arnoux' beaked whale *(Berardius arnuxii)* predominate in all strandings in the Cook Strait region yet none of these species has been sighted at sea in this area.
All the beaked whales are listed as 'Data Deficient' or, in the case of Cuvier's beaked whale.