Aquatic Mammals 2005, *31*(1), 83-88, DOI 10.1578/AM.31.1.2005.83

First Observations of Feeding on Thresher *(Alopias vulpinus)* and Hammerhead *(Sphyrna zygaena)* Sharks by Killer Whales *(Orcinus orca)*, Which Specialise on Elasmobranchs as Prey

Ingrid N. Visser

Orca Research Trust, P.O. Box 1233, Whangarei, New Zealand

Abstract

Killer whale (*Orcinus orca*) predation on elasmobranchs (sharks and rays) is not often reported. In New Zealand waters, killer whales captured and ate thresher (*Alopias vulpinus*) and smooth-hammerhead (*Sphyrna zygaena*) sharks. Both species were not reported previously as prey of killer whales. These observations help support the idea that elasmobranchs are a main prey type for New Zealand killer whales; ten species of elasmobranchs are now recorded as prey for this population.

Key Words: Killer whale, *Orcinus orca*, elasmobranch, thresher shark, *Alopias vulpinus*, smooth-hammerhead shark, *Sphyrna zygaena*, predation, behaviour, New Zealand

Introduction

Killer whale (*Orcinus orca*) predation on elasmobranchs (sharks and rays) was reviewed by Fertl et al. (1996). Further attacks on other species of elasmobranchs were since reported—for example, white shark (*Carcharodon carcharias*) (Pyle et al., 1999), scalloped-hammerhead shark (*Sphyrna lewini*), grey reef shark (*Carcharhinus amblyrhynchos*), manta ray (*Manta birostris*), blue-spotted ray (*Dasyatis kuhlii*) (Visser & Bonaccorso, 2003), and sevengill sharks (*Notorynchus cepedianus*) (Reyes & García-Borboroglu, 2004). An additional attack on manta rays (*Manta* sp.) was reported by (Gannier, 2002). Off New Zealand, killer whales previously have been observed taking eight species of elasmobranchs (Table 1). I describe killer whale predation on two additional elasmobranch prey species: thresher (*Alopias vulpinus*) and smooth-hammerhead (*S. zygaena*) sharks.

Materials and Methods

Observations were made from a 5.8-m rigid-hull inflatable as part of ongoing research on the New Zealand killer whale population. Individuals were photo-identified by dorsal fin, saddle patch, and eye patch markings, following Bigg (1982), Baird & Stacey (1988), and Visser & Mäkeläinen (2000). They were matched to the New Zealand photo-identification catalogue held by the author (unpublished data) and classified into age/sex classes, following Bigg (1982).

Results

12 September 2002

At 0720 h, the dolphin-watching vessel *Tutunui* reported a group of killer whales near Paihia (35° 16' S, 174° 15' E) in the Bay of Islands, New Zealand. I arrived at approximately 0920 h and observed a total of 12 killer whales foraging benthically on eagle rays (*Myliobatis tenuicaudatus*) and short-tailed stingrays (*Dasyatis brevicaudata*) (see Visser, 1999, for explanation of prey identification and foraging behaviours). While foraging, the killer whales traveled north and then east into Manawaora Bay (35° 15' S, 174° 10' E), a distance of approximately 15 km.

At 1316 h, an adult male killer whale (NZ7) was observed in waters with a bottom depth of 4 m, chasing a shark. The shark was approximately 1.5 m in length, in comparison to the size of the research vessel. The shark was identified as a thresher shark, based on the long pointed pectoral fins and the long curving dorsal caudal lobe of the tail, which was almost the same length as the body (Compagno, 1984). The shark had relatively small eyes, thereby eliminating confusion with the only other species of thresher shark found in New Zealand waters (i.e., the bigeye thresher, *A. superciliosus*, Compagno, 1984).

NZ7 was joined by a subadult male (NZ19), and at 1320 h, both males were milling fast in tight circles (the individuals were less than two body lengths apart). At 1324 h, NZ19 was observed with the shark in his mouth, and at 1326 h, both NZ7 and NZ19 were observed to be holding part

Table 1. During 108 encounters with New Zealand killer whales (1993-2004), elasmobranchs were taken in > 80% of the encounters (*n* = 10 species).

Prey species	Number of prey	Source
Short-tailed stingray (*Dasyatis brevicaudata*)	100+	Fertl et al. (1996) Visser (1999, 2000b, unpublished data)
Long-tailed stingray (*Dasyatis thetidis*)	100+	Fertl et al. (1996) Visser (1999, 2000b, unpublished data)
Eagle ray (*Myliobatis tenuicaudatus*)	100+	Fertl et al. (1996) Visser (1999, 2000b, unpublished data)
Electric ray (*Torpedo fairchildi*)	4	Visser (2000b, 2001)
Basking shark (*Cetorhinus maximus*)	2	Fertl et al. (1996) Visser (2000b, unpublished data)
Blue shark (*Prionace glauca*)	5	Fertl et al. (1996) Visser (2000b, unpublished data)
Shortfin mako shark (*Isurus oxyrinchus*)	4	Visser et al. (2000)
School shark (*Galeorhinus galeus*)	10+	Visser (2000a)
Thresher shark (*Alopias vulpinus*)	3	(this report)
Smooth-hammerhead shark (*Sphyrna zygaena*)	1	(this report)

of the shark, appearing to share it. Between 1326 h and 1329 h, an unidentified juvenile joined the two males; by 1329 h, the shark was dismembered. The liver floated to the surface; the juvenile took this in its mouth but did not consume it, dropping it shortly thereafter. By 1337 h, all three killer whales had left the area, and neither NZ7 nor NZ19 held prey in their mouths.

At 1337 h, approximately 500 m from the first location, NZ7 was observed fast surfacing and subsequently chasing another shark. The shark passed under the research boat; it was approximately 1 m in length and identified as a smooth-hammerhead shark based on the cephalofoil being convexly rounded and without indentations; this is the only hammerhead species recorded from New Zealand waters (Compagno, 1984). By 1340 h, NZ7 had the shark in his mouth; at 1341 h, an adult female (NZ60) was alongside NZ7 and together they consumed the shark. Both killer whales were observed to leave at 1348 h. At 1359 h, approximately 200 m from the previous location, NZ7 and NZ19 were observed chasing an eagle ray, which they caught and consumed (as described by Visser, 1999).

22 July 2004

At 0900 h, the same dolphin-watching vessel, *Tutunui*, reported a group of killer whales at Parekura Bay, 8 km to the east of Manawaora Bay. I arrived at approximately 1230 h and observed a total of 14 killer whales as they foraged benthically on eagle rays and short-tailed stingrays while traveling west and then south into Manawaora Bay.

At 1513 h, six killer whales—NZ19, NZ60, three adult males (NZ21, NZ91, and NZ95), and a juvenile of unknown sex (NZ125)—were observed milling in a tight circle in waters with a bottom depth of 6 m. At 1515 h, a thresher shark, approximately 2 m in length, was observed at the surface. Water visibility was marginal (approximately 2 m); however, it could be seen that the shark was "forced" to the water surface by the "vortex" caused by the upwards stroke of NZ60's tail. She had lifted her tail fast, under, and near the shark (but it did not make physical contact with the shark) (Figure 1a).

Once at the surface, NZ60 pivoted and lifted her tail clear of the water and brought it down sideways onto the shark, striking it about midbody (Figure 1b). The shark appeared dazed and disoriented as it attempted to swim away. At 1519 h, NZ19 then performed the same sequence of events, forcing the shark to the surface with a strong vortex from his tail; he then hit the shark once it was at the surface. At 1520 h, NZ125 took the shark in its mouth; all animals came in close body contact with one another and began to dismember the shark. At 1522 h, an oily slick had begun to spread over the surface and kelp gulls (*Larus dominicanus*) picked up small particles (less than 2 cm^2) of shark liver.

By 1526 h, the group was swimming slowly in a northerly direction; they were approximately 150 m from the kill location, while continuing to food-share. At this time, NZ95 turned back to the area of the large slick. Approximately 40 kelp gulls picked up liver particles from the surface. NZ95 took liver pieces (approximately 5-10 cm^2) floating at the surface. At 1534 h, NZ95 turned and followed the group of five individuals who were still swimming in close proximity to one another. At this time, no killer whales were observed with prey in their mouths. By 1544 h, the group had spread out over approximately 800 m. At 1631 h, NZ60 began chasing an eagle ray in approximately 2 m of water, and at 1632 h, she had the ray in her mouth. She shared this ray with NZ19. Between 1632 h and 1710 h, three additional eagle rays were caught by various killer whales in the group of six (the prey were identified, but it was not possible to ascertain which individual of the group caught the rays as they were all closely associated with the prey). At 1710 h, four of the killer whales (NZ19, NZ60, NZ91, NZ125) began hunting a large (approximately 3 m wingspan) long-tailed stingray (*Dasyatis thetidis*). The water visibility was approximately 3 m; therefore, the prey as well as the killer whales could be clearly seen as the bottom was only 3 m deep. The ray was under a rock, and the whales were attempting to extract it by pulling on its tail. The killer whales were "headstanding" and thrashing their tails in the air since the water was so shallow in this spot (as described by Visser, 1999). At 1719 h, NZ60 blew a large release of bubbles (also described by Visser, 1999). At 1720 h, NZ60 took the ray by the tail and, once it was extracted from under the rock, NZ19 and NZ125 each grasped a wing of the ray. All three killer whales surfaced together with the ray held upside down between them. At this point, NZ91 surfaced alongside, and the four individuals began food-sharing. At all times, the ray was held upside down, and twice was observed draped over the snout of NZ125, even when the ray was alive (indicated by flapping of the wings and the sideways whipping motion of the tail), although apparently injured (based on clearly visible bite marks). During the hunt, NZ21 approached the group and by 1721 h had also begun to food-share. At 1728 h, the liver of the ray (estimated to be 1 m in diameter and approximately 15 kg) floated to the surface. By 1735 h, the killer whales moved away from the area; none were observed carrying any part of the prey.

30 November 2004

At 1707 h, five killer whales were sighted at Waiwiri Rock (35° 11' S, 174° 20' E), approximately 18 km to the east, and just to the south of Cape Brett, which is the SE point of the Bay of Islands. The killer whales headed south, in waters with a bottom depth of 20 m. Although no detailed behavioural information was collected, the animals were observed for approximately 30 min, and an adult male (NZ21) was photographed. He approached the boat, swam under the bow, and was carrying a thresher shark that was approximately 3 m in length in his mouth. NZ21 was observed food-sharing with three of the other killer whales (two of adult female size, and one of juvenile size); these were not photo-identified (J. Zaeschmar, pers. comm.).[1]

Figure 1a. Killer whale using up-thrust of tail to create a "vortex" and move the thresher shark (*Alopias vulpinus*) to the water surface (shark to scale)

Figure 1b. Once the shark was at the surface, the killer whale pivoted and used the side of its caudal peduncle and tail to strike the shark before proceeding to kill and eat it.

[1] P.O. Box 91, Paihia, Bay of Islands, New Zealand

Table 2. Documented occurrences of elasmobranchs taken by individual killer whales over two days; check marks may refer to the same predation event (i.e., more than one killer whale consumed the same prey item)

Individual killer whale identification code & age/sex	NZ7 adult male	NZ19 subadult male	NZ21 adult male	NZ60 adult female	NZ91 adult male	NZ95 adult male	NZ125 juvenile unknown sex
Prey species							
Short-tailed stingray *(Dasyatis brevicaudata)*	✓	✓	✓	✓	✓	✓	✓
Long-tailed stingray *(Dasyatis thetidis)*		✓	✓	✓	✓	✓	✓
Eagle ray *(Myliobatis tenuicaudatus)*	✓	✓	✓	✓	✓	✓	✓
Thresher shark *(Alopias vulpinus)*	✓	✓	✓	✓	✓	✓	✓
Smooth-hammerhead shark *(Sphyrna zygaena)*	✓	✓		✓			

Discussion

Individual killer whales were observed feeding on a range of elasmobranch species on two of the days (12 September 2002 and 22 July 2004). During which, two photo-identified killer whales took five different elasmobranchs species, while five other killer whales took four different species (Table 2). On both days, other killer whales from the original groups could be seen from a distance, with evidence of benthic foraging visible (e.g., gulls picking up scraps, oily slicks, etc.; see Visser, 1999, for full details); however, species and number of elasmobranchs taken were not determined for those animals as the author was concentrating on the photo-identified killer whales reported here.

Fertl et al. (1996) suggested that elasmobranchs were probably taken more often by killer whales than reported, and Visser (1999) went so far as to suggest that New Zealand killer whales specialise in foraging on elasmobranchs. To understand the frequency with which killer whales feed on elasmobranchs, it is valuable to understand what percentage of killer whale observations involve feeding on what species, as well as how many are taken. It is often not possible to ascertain details since such observations are typically published only as anecdotal information; however, for example, despite the extensive whale-watch effort off California, and a dedicated killer whale research project in the area since 1990 (Black et al., 1997), there are only six published reports of killer whales taking elasmobranchs (three different species identified, another identified to family, and another unidentified) over a 41-year period (Fertl et al., 1996; Pyle et al., 1999). Off the Galápagos Islands, where ship-based ecotourism has been long-running, reports of killer whales are infrequent (Day, 1994; Smith & Whitehead, 1999). Observations of feeding on elasmobranchs are also infrequent (i.e., only two species of elasmobranchs, and another identified to genus, were taken on four separate occasions over a 12-year period) (Fertl et al., 1996). Off Papua New Guinea there is limited effort for any cetacean research, but of the 94 sightings of killer whales over a 15-year period, only four species of elasmobranchs were recorded as prey, with six individuals taken (Visser & Bonaccorso, 2003).

These findings are in contrast to New Zealand where, during a 12-year period, killer whales have now been observed foraging on ten different elasmobranch species (Table 1). These observations were made during 108 encounters (1993-2004), with more than 80% involving killer whales feeding on elasmobranchs. Additionally, for the two days described in detail here, four different species of elasmobranchs were taken on one day and three on another. Furthermore, it is not unusual to observe multiple specimens of a species of elasmobranch being taken by an individual killer whale during one encounter (Visser, unpublished data).

Although New Zealand killer whales have been observed feeding most frequently on short-tailed, long-tailed, and eagle rays (Table 1), other elasmobranch species are likely to be important prey. These species may be comparatively more widely dispersed, either spatially or temporally (e.g., the smaller/younger sharks taken here were in shallow and sheltered bays, and their presence may be linked to a breeding season, M. Francis, pers. comm.[2]).

[2] National Institute of Water and Atmospheric Research, P.O. Box 14-901, Kilbirnie, Wellington, New Zealand

The observations reported here, separated as they were over time, suggest that New Zealand killer whales are likely to regularly feed on small sharks. Additionally, the extended time period that the killer whales stayed in these areas (longer than seven h for both of the days described in detail) may be indicative of a high prey density or a habitat which makes hunting for elasmobranchs favourable.

Visser (2000b) reported unidentified New Zealand killer whales killing a blue shark (*Prionace glauca*) by hitting the shark at the water's surface with their tails in a similar method to that described here. This technique may be used more often than previously recorded as a way to disorient and kill sharks.

There is the question as to why killer whales force such small sharks to the surface and then hit them with their tail and do not just swim up and take these sharks in their jaws. There may be several possible explanations for this behaviour.

First, killer whales are large, fast predators, which should be able to easily outswim sharks; however, the smaller size of these sharks might give them the ability to outmaneuver a larger killer whale. Hence, the killer whale might benefit from a strategy that would reduce the shark's maneuverability. A shark may be less aware of a potential attack when in proximity of killer whale flukes compared to an anterior attack. If a killer whale moves into such a position (i.e., head away from the shark), the shark may presume the predator is moving away and is no longer a threat. If swept upwards by the vortex, the shark is unlikely to expect an aerial impact from a predator it can view alongside (see Figure 1b). The impact may disorientate the shark thereby reducing its maneuverability.

Second, assuming a reduction of maneuverability is not necessarily a requirement to effectively kill the prey, the observed behaviours may be an expression of play; however, when hunting the thresher sharks, the time frames between initiation and prey consumption were short (i.e., 8 min and 7 min, respectively), therefore, predation seems to have been the primary goal.

Third, when defending themselves, sharks may attempt to inflict wounds on their predator. Such wounds may be minor in the case of small sharks, but they may be serious from larger sharks. In an anterior attack, killer whale eyes are relatively vulnerable based on their location near the gape of the mouth. Therefore, creating a vortex and subsequent impact may represent a safer hunting strategy for catching larger sharks. Given the latter explanation, the killer whales may have been practicing either solitary or cooperative hunting techniques for larger, potentially lethal sharks. It is noteworthy that NZ60 (an adult female) instigated the "tail-attack," which was repeated by NZ19 (a subadult male), and that NZ125 (a juvenile of unknown sex) claimed the prey first, and then subsequently shared it with the other killer whales present. Lastly, it cannot be ruled out that a combination of these three factors come into play.

Sharks are long-lived, with many being apex-predators themselves and, therefore, they may contain high levels of heavy metals and organochlorides (Cox & Francis, 1997; Fenaughty et al., 1988). Rays also may bioaccumulate toxins as they feed primarily on filter-feeders (Devadoss, 1978; Gregory et al., 1979; Montgomery & Skipworth, 1997), which may ingest contaminants from sediments in areas with anthropogenic pollution.

Bioaccumulation is known to occur in killer whales in the coastal waters of British Columbia, Canada (Ross et al., 2000). One population that frequents industrialised coastline and specialises in feeding on fish has high levels of total PCB (polychlorinated biphenyls) concentrations (146.3 $\pm$ 32.7 mg kg^{-1} lipid weight in adult males, see Ross et al., 2000, for full details of analysis). St. Lawrence beluga whales (*Delphinapterus leucas*), who have low recruitment rates and large numbers of tumours, are considered highly contaminated. Other studies indicate that cetaceans are effected adversely by contaminants (see Ross et al., 2000).

Bioaccumulation may pose a threat to New Zealand killer whales, who are known to forage for elasmobranchs near heavily populated areas (e.g., Bay of Islands, Whangarei Harbour, Gulf Harbour, Auckland Harbour: Visser, 1999; Visser et al., 2000). Since it appears that at least for some New Zealand killer whales elasmobranchs (especially rays) form a major component of their diet, it is recommended to assess this potential risk by analysing rays in both industrialised and relatively pristine areas.

The observations reported here may help us understand sources of natural mortality in elasmobranchs. Further field observations and/or analysis of tissue samples to establish trophic levels, and fatty-acid markers to identify prey species (e.g., Iverson et al., 1997; Iverson et al., 2004; Koopman et al., 1996; Smith et al., 1997), may help to ascertain the extent to which elasmobranchs play a role in the total prey intake of New Zealand killer whales.

Acknowledgments

Dagmar Fertl, Malcolm Francis, Astrid van Ginneken, and Pablo García Borboroglu kindly suggested improvements and reviewed the manuscript. Thank you to Jo "Floppy" Haliday, Tammy Jameson, and Ross Lorimer who called to report the orca sightings, and to John Zaeschmar for his orca-thresher report; Malcolm Francis and Peter Ross who provided information, references, and helpful discussion; and Sarah Graham and Tanya Rutherford who helped with field and data work. Support for this research was provided by the Orca Research Trust, Adopt an Orca, the Whale and Dolphin Conservation Society, Moller-Yamaha, TowTeam & Trojan, and the Trillian Trust. A permit to conduct this research was issued by the New Zealand Department of Conservation.

Literature Cited

Baird, R. W., & Stacey, P. J. (1988). Variation in saddle patch pigmentation in populations of killer whales (*Orcinus orca*) from British Columbia, Alaska, and Washington State. *Canadian Journal of Zoology*, *66*, 2582-2585.

Bigg, M. (1982). An assessment of killer whale (*Orcinus orca*) stocks off Vancouver Island, British Columbia. *Reports of the International Whaling Commission*, *32*, 655-666.

Black, N. A., Schulman-Janiger, A., Ternullo, R. L., & Guerero-Ruiz, M. (1997). Killer whales of California and western Mexico: A catalog of photo-identified individuals. *NOAA Technical Memorandum* (Report No. NOAA-TM-NMFS-SWFSC-246). 174 pp.

Compagno, L. J. V. (Ed.). (1984). *FAO species catalogue. Vol. 4: Sharks of the world. Fisheries Synopsis.* Rome: Food and Agriculture Organisation. 125 pp.

Cox, G., & Francis, M. (1997). *Sharks and rays of New Zealand*. Christchurch, New Zealand: Canterbury University Press. 68 pp.

Day, D. (1994). List of cetaceans seen in Galàpagos. *Noticias de Galàpagos*, *53*, 5-6.

Devadoss, P. (1978). On the food of rays, *Dasyatis uarnak* (Forskal), *D. alcockii* (Annandale) and *D. sephen* (Forskal). *Indian Journal of Fisheries. Ernakulam, 25*, 9-13.

Fenaughty, C. M., Tracey, D. M., & Lock, J. W. (1988). Heavy metal and organochlorine concentrations in New Zealand aquatic fish, crustaceans, and molluscs. *New Zealand Fisheries Data Report*, *34*. 44 pp.

Fertl, D., Acevedo-Gutiérrez, A., & Darby, F. L. (1996). A report of killer whales (*Orcinus orca*) feeding on a carcharhinid shark in Costa Rica. *Marine Mammal Science, 12*, 606-611.

Gannier, A. (2002). Cetaceans of the Marquesas Islands (French Polynesia): Distribution and relative abundance as obtained from a small boat dedicated survey. *Aquatic Mammals*, *28*, 198-210.

Gregory, M. R., Ballance, P. F., Gibson, G. W., & Ayling, A. M. (1979). On how some rays (*Elasmobranchia*) excavate feeding depressions by jetting water. *Journal of Sedimentary Petrology, 49*, 1125-1130.

Iverson, S. J., Frost, K. J., & Lowry, L. F. (1997). Fatty acid signatures reveal fine scale structure of foraging distribution of harbor seals and their prey in Prince William Sound, Alaska. *Marine Ecology Progress Series*, *151*, 255-271.

Iverson, S. J., Field, C., Bowen, D. W., & Blanchard, W. (2004). Quantitative fatty acid signature analysis: A new method of estimating predator diets. *Ecological Monographs*, *74*, 211-235.

Koopman, H. N., Iverson, S. J., & Gaskin, D. E. (1996). Stratification and age-related differences in blubber fatty acids of the male harbour porpoise (*Phocoena phocoena*). *Journal of Comparative Physiology and Behaviour*, *165*, 628-639.

Montgomery, J., & Skipworth, E. (1997). Detection of weak water jets by the short-tailed stingray *Dasyatis brevicaudata* (Pisces: Dasyatidae). *Copeia*, *4*, 881-883.

Pyle, P., Schramm, M. J., Keiper, C., & Anderson, S. D. (1999). Predation on a white shark (*Carcharodon carcharias*) by a killer whale (*Orcinus orca*) and a possible case of competitive displacement. *Marine Mammal Science*, *15*, 563-568.

Reyes, L. M., & García-Borboroglu, P. (2004). Killer whale (*Orcinus orca*) predation on sharks in Patagonia, Argentina: A first report. *Aquatic Mammals, 30*(3), 376-379.

Ross, P., Ellis, G. M., Ikonomou, M. G., Barrett-Lennard, L. G., & Addison, R. F. (2000). High PCB concentrations in free-ranging Pacific killer whales, *Orcinus orca*: Effects of age, sex and dietary preference. *Marine Pollution Bulletin*, *40*, 504-515.

Smith, D. S., & Whitehead, H. (1999). Distribution of dolphins in Galápagos waters. *Marine Mammal Science*, *15*, 550-555.

Smith, S. J., Iverson, S. J., & Bowen, W. D. (1997). Fatty acid signatures and classification trees: New tools for investigating the foraging ecology of seals. *Canadian Journal of Fisheries and Aquatic Sciences, 54*, 1377-1386.

Visser, I. N. (1999). Benthic foraging on stingrays by killer whales (*Orcinus orca*) in New Zealand waters. *Marine Mammal Science*, *15*, 220-227.

Visser, I. N. (2000a). Killer whale (*Orcinus orca*) interactions with longlines fisheries in New Zealand waters. *Aquatic Mammals*, *26*, 241-252.

Visser, I. N. (2000b). *Orca* (Orcinus orca) *in New Zealand waters.* Ph.D. dissertation, University of Auckland, Auckland, New Zealand.

Visser, I. N. (2001). Foraging behaviour and diet of orca (*Orcinus orca*) in New Zealand waters. *Abstracts of the 14th Biennial Conference on the Biology of Marine Mammals*, Vancouver, BC, Canada.

Visser, I. N., & Bonaccorso, F. J. (2003). New observations and a review of killer whale (*Orcinus orca*) sightings in Papua New Guinea waters. *Aquatic Mammals*, *29(1)*, 150-172.

Visser, I. N., Fertl, D., Berghan, J., & van Meurs, R. (2000). Killer whale (*Orcinus orca*) predation on a shortfin mako shark (*Isurus oxyrinchus*), in New Zealand waters. *Aquatic Mammals*, *26*, 229-231.

Visser, I. N., & Mäkeläinen, P. (2000). Variation in eye patch shape of killer whales (*Orcinus orca*) in New Zealand waters. *Marine Mammal Science*, *16*, 459-469