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Short Communication

Intraguild predation and partial consumption of blue sharks *Prionace glauca* by Cape fur seals *Arctocephalus pusillus pusillus*

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The top-down effects of predators on ecosystem structure and dynamics have been studied increasingly. However, the nature and consequence of trophic interactions between upper-trophic-level predators have received considerably less attention. This is especially the case in marine systems due to the inherent challenges of studying highly mobile marine species. Here we describe the first documentation of asymmetrical intraguild predation by a pinniped predator on a mid-sized predatory shark. The report is based on direct observations in South African waters, in which free-swimming blue sharks *Prionace glauca* were captured and partially consumed by Cape fur seals *Arctocephalus pusillus pusillus*. These observations are important not just for understanding the interactions between these two species but more broadly for their implications in understanding the trophic ecology of pinnipeds, many populations of which have increased while numerous shark populations have declined.

Keywords: belly-biting, pinnipeds, trophic interactions

Introduction

Upper-trophic-level predators are ecologically important and can initiate trophic cascades by inflicting mortality on prey or by altering prey behaviour through risk effects (Creel and Christianson 2008; Heithaus et al. 2008; Hammerschlag and Trussell 2011). However, overlap in the distribution of predators can lead to competition and intraguild predation, in turn resulting in more complex community dynamics (Polis and Holt 1992). Sharks and pinnipeds (otariid and phocid seals) are upper-trophic-level predators in many marine systems, and where they co-occur may be competitors for prey resources. Many shark species are experiencing varying levels of population decline due to overexploitation in fisheries (Worm et al. 2013). In contrast, pinnipeds have been exploited historically in many regions, resulting in population declines across their range, but the establishment of protection measures over recent decades has allowed many populations to recover (Magera et al. 2013).

Blue sharks *Prionace glauca* are considered the most abundant and widespread mid-sized shark in the world, though concerns about overfishing have resulted in a 'Near Threatened' designation by the International Union for the Conservation of Nature (Stevens 2009). The diet of the blue shark consists primarily of small pelagic fish and squid, though small sharks, bottom-dwelling fish and invertebrates, and birds, are also eaten (Scott and Scott 1988; Compagno et al. 1989). In South African fisheries, blue sharks make up the largest proportion (69%) of shark catch in longline tuna and swordfish fisheries (Gilman et al. 2008).

In South Africa, Cape fur seals *Arctocephalus pusillus pusillus* were heavily exploited in the 17th and 18th century, but populations have recovered in response to protections established in the 20th century. Butterworth et al. (1995) estimated that in South Africa, the number of Cape fur seals aged one and older increased from just 2 000 individuals in 1920 to 1 700 000 individuals in 1993, with continued population expansion. Cape fur seals are generally considered to eat small-bodied prey, comprised mainly of fish with mean lengths generally between 10 and 30 cm (e.g. Mecenero et al. 2006; Huisamen et al. 2012), a prey-size range considered typical of pinnipeds (Etnier and Fowler 2010). Other prey include cephalopods and coastal birds. The general overlap in the types of prey consumed by blue sharks and Cape fur seals places them in the same trophic guild. Consumption of commercially important teleosts by Cape fur seals has caused concern as to their effects on the resource, which has in part stimulated the development of models to better understand the South African marine ecosystem and its relationship to fisheries (e.g. Punt and Butterworth 1995; Shannon et al. 2006). Accordingly, it is important to obtain information on the diets of Cape fur seals and on their trophic dynamics with sympatric predators to parameterise these models for predicting how

ecosystems will respond to changes in seal abundance and foraging behaviour.

In this note we describe the first documentation of asymmetrical intraguild predation by a pinniped (Cape fur seal) on a mid-sized predatory shark (blue shark). The observations reported here were opportunistically made by one of us (CF), off Cape Point, South Africa. While the trophic interactions described here could be common, the probability of directly observing them is very low given the inherent difficulties of observing predator–prey relationships between highly mobile pelagic species. Cape fur seal predation on larger sharks may be a previously unknown yet ecologically significant aspect of pinniped foraging ecology.

Methods and results

The first occurrence was in 2004, as CF was traversing by boat five nautical miles south of Cape Point. Splashing was observed at the surface, and the boat was manoeuvred to within approximately 50 m. A subadult Cape fur seal was observed repeatedly pursuing, catching, tossing and eventually killing a free-swimming blue shark of 1.2 m total length. This event lasted over 15 min, and concluded with the Cape fur seal tearing open the shark's body cavity and consuming only the viscera. During this sequence of events, there was no fishing or other human activity within the vicinity that might have attracted or distracted either animal, consistent with it being a natural occurrence. The observation was made from the boat deck and only poor-quality surface photographs were taken (not shown). The density of sharks in the area could not be ascertained.

In December 2012, a similar series of events was observed 20 nautical miles south-west of Cape Point. Here, 10 blue sharks were feeding on discarded fish waste near a shark-diving vessel. CF was in the water observing and photographing the free-swimming sharks, when a subadult male Cape fur seal moved into the area. Over a 2-hour observation period, CF observed, recorded and photo-documented the seal chasing and killing 5 of the 10 sharks. The sharks that were captured were estimated to measure between 1.1 and 1.4 m. As in the previous occurrence, the seal tore open the sharks' body cavities and consumed only their viscera (Figure 1).

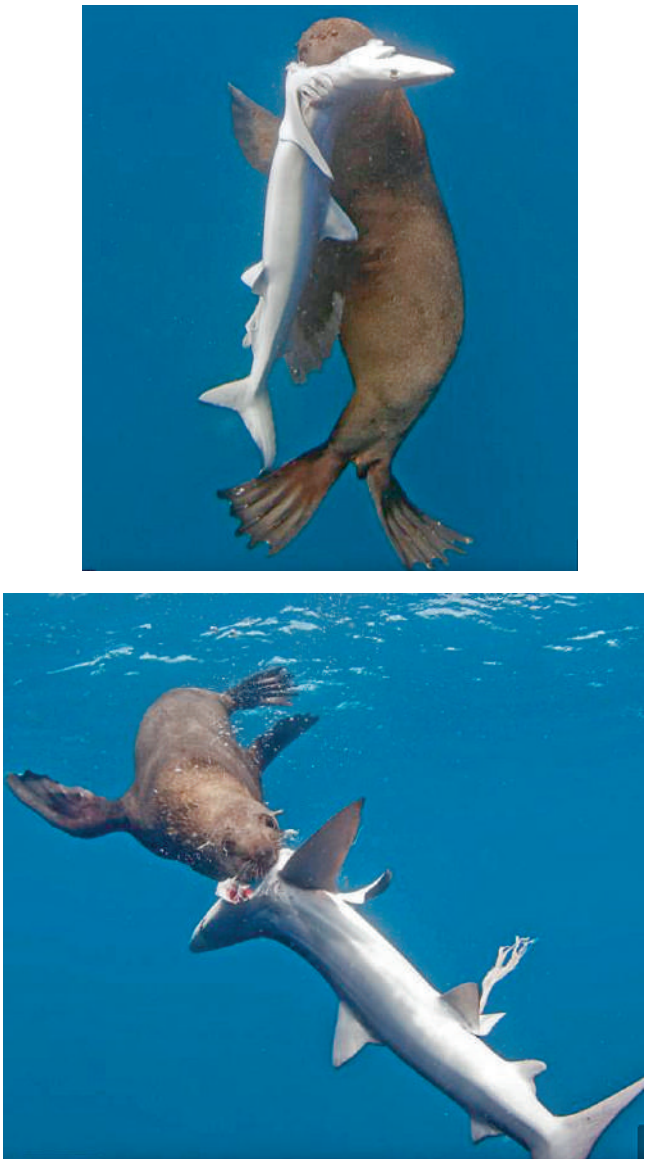

Figure 1: Cape fur seal catching and killing and then consuming the viscera of a blue shark in 2012

Discussion

The observations reported here are notable for three interrelated reasons. First, to our knowledge, this is the first report of predation by a pinniped on a mid-sized predatory shark. Seals are generally considered prey of larger sharks, and blue sharks have been observed pursuing juvenile and adult male Cape fur seals, though no kills have been witnessed (Stewardson 1999 and references therein). There are relatively few reports of pinnipeds preying on sharks in general and in all cases these involved smaller sharks. For example, Cape fur seals have been found to kill puffadder shysharks *Haploblepharus edwardsii*, though this appears to have been play behaviour rather than predation for consumption (Martin 2004), and have been observed feeding on free-swimming striped catsharks *Poroderma africanum* (CF pers. obs.). Also, Australian sea lions *Neophoca cinerea* (Baylis et al. 2009) and Australian fur seals (Allen and Huveneers 2005) have been observed feeding on different species of small sharks, but some of these instances may have constituted depredation of sharks caught in fishing gear. Though mobbing of white sharks *Carcharodon carcharias* by Cape fur seals and by the conspecific Australian fur seal *A. pusillus doriferus* has been observed, this is considered a group defence tactic rather than a predatory one (Stewardson and Brett 2000; Kirkwood and Dickie 2005).

Second, observations of partial consumption of free-swimming prey by pinnipeds are rare (but see Lilly and Murphy 2004; Hauser et al. 2008). Partial consumption is predicted by optimal foraging theory when the density of prey is such that it is most profitable for a predator to feed

only on the most energy-dense parts of a prey item before moving on to a subsequent one (Sih 1980). In marine systems, this has previously been reported for harp seals *Pagophilus groenlandicus* feeding on Atlantic cod *Gadus morhua* (Lilly and Murphy 2004), white sharks selectively consuming blubber-rich areas of cetaceans (Fallows et al. 2013) and killer whales *Orcinus orca* feeding on cetacean and avian prey (e.g. Pitman and Durban 2010; Pitman et al. 2014). The observed partial consumption of blue sharks is consistent with this theory, given their confirmed high local density in the second instance we report and the nature of their anatomy in which energy is concentrated in their viscera (e.g. Sargent et al. 1973). Partial consumption of relatively large fish prey by seals has been proposed elsewhere as a possible contributor to elevated natural mortality rates of prey, though this remains somewhat speculative (Benoît et al. 2011).

Third, the consumption of large sharks by a Cape fur seal is a departure from the prevalent view of this species' diet, which is generally reported to consist of a diverse diet of small fish species, cephalopods and birds (e.g. Mecenero et al. 2006; Huisamen et al. 2012). As is the case with most pinniped diet studies, the diet of Cape fur seals has largely been inferred from prey hard parts recovered from seal scats, regurgitates or stomachs. One of the inherent biases with this method is that the recovered prey will represent only the most recent meal(s), which were likely to have been consumed near the point of collection (Bowen and Iverson 2013). Diet collections are generally made on or near shore and are therefore likely to overrepresent more-coastal prey, as well as smaller prey given inter- and intraspecific relationships between fish size and depth (Macpherson and Duarte 1991). Furthermore, failure to consume prey hard parts during partial consumption leaves no trace of predation for diets inferred using prey parts.

The prevalence of the behaviour reported here is unknown; it could reflect opportunistic predation by a generalist predator or it might be a common tactic. Regardless, quantifying the frequency of this behaviour will be nearly impossible using presently available techniques for pinniped diet estimation (Bowen and Iverson 2013). This includes methods based on chemical analyses (isotopes, fatty acids, DNA) that are unlikely to be properly calibrated to account for a possibly predominant indirect prey signal originating from the stomach contents of the predated shark. Other approaches will be required, possibly including the use of seal-borne video cameras (e.g. Hooker et al. 2008). Although we report only two series of observations, these demonstrate that relying on examinations of stomach contents or scat samples may underestimate intraguild predation on sharks, which could be a significant, yet previously unknown, component of the overall foraging ecology of Cape fur seals in the region. In turn, this could have implications for the development and use of ecosystems models to predict community impacts of declines or recoveries in populations of sharks or seals, as well as their direct and indirect consequences for commercial fisheries.

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References

Allen S, Huveneers C. 2005. First record of an Australian fur seal (*Arctocephalus pusillus doriferus*) feeding on a wobbegong shark (*Orectolobus ornatus*). *Proceedings of the Linnean Society of New South Wales* 126: 95–97.

Baylis AMM, Hamer DJ, Nichols PD. 2009. Assessing the use of milk fatty acids to infer the diet of the Australian sea lion (*Neophoca cinerea*). *Wildlife Research* 36: 169–176.

Benoît HP, Swain DP, Bowen WD, Breed GA, Hammill MO, Harvey V. 2011. Evaluating the potential for grey seal predation to explain elevated natural mortality in three fish species in the southern Gulf of St. Lawrence. *Marine Ecology Progress Series* 442: 149–167.

Bowen WD, Iverson SJ. 2013. Methods of estimating marine mammal diets: a review of validation experiments and sources of bias and uncertainty. *Marine Mammal Science* 29: 719–754.

Butterworth DS, Punt AE, Oosthuizen WH, Wickens PA. 1995. The effects of future consumption by the Cape fur seal on catches and catch rates of the Cape hakes. 3. Modelling the dynamics of the Cape fur seal *Arctocephalus pusillus pusillus*. *South African Journal of Marine Science* 16: 161–183.

Compagno LJV, Ebert DA, Smale MJ. 1989. *Guide to the sharks and rays of southern Africa*. London: New Holland Publishers Ltd.

Creel S, Christianson D. 2008. Relationships between direct predation and risk effects. *Trends in Ecology and Evolution* 23: 194–201.

Etnier MA, Fowler CW. 2010. Size selectivity in marine mammal diets as a guide to evolutionarily enlightened fisheries management. *North American Journal of Fisheries Management* 30: 588–603.

Fallows C, Gallagher AJ, Hammerschlag N. 2013. White sharks (*Carcharodon carcharias*) scavenging on whales and its potential role in further shaping the ecology of an apex predator. *PLoS ONE* 8: e60797.

Gilman E, Clarke S, Brothers N, Alfaro-Shigueto J, Mandelman J, Mangel J et al. 2008. Shark interactions in pelagic longline fisheries. *Marine Policy* 32: 1–18.

Hammerschlag N, Trussell G. 2011. Beyond the body count: behavioral downgrading of planet earth. *Science E-Letter*, 11 November 2011. Available at www.sciencemag.org/content/333/6040/301/reply.

Hauser DDW, Allen CS, Rich HBJ, Quinn TP. 2008. Resident harbor seals (*Phoca vitulina*) in Iliamna Lake, Alaska: summer diet and partial consumption of adult sockeye salmon (*Oncorhynchus nerka*). *Aquatic Mammals* 34: 303–309.

Heithaus MR, Frid A, Wirsing AJ, Worm B. 2008. Predicting ecological consequences of marine top predator declines. *Trends in Ecology and Evolution* 23: 202–210.

Hooker SK, Heaslip SG, Matthiopoulos J, Cox O, Boyd IL. 2008. Data sampling options for animal-borne video cameras: considerations based on deployments with Antarctic fur seals. *Marine Technology Society Journal* 42: 65–75.

Huisamen J, Kirkman SP, van der Lingen CD, Watson LH, Cockcroft VG, Jewell R, Pistorius PA. 2012. Diet of the Cape fur seal *Arctocephalus pusillus pusillus* at the Robberg Peninsula, Plettenberg Bay, and implications for local fisheries. *African Journal of Marine Science* 34: 431–441.

Kirkwood R, Dickie J. 2005. Mobbing of a great white shark (*Carcharodon carcharias*) by adult male Australian fur seals (*Arctocephalus pusillus doriferus*). *Marine Mammal Science* 21: 336–339.

Lilly GR, Murphy EF. 2004. Biology, fishery and status of the 2GH and 2J3KL (northern) cod stocks: information supporting an assessment of allowable harm under the Species at Risk Act for the COSEWIC-defined Newfoundland and Labrador population

of Atlantic cod (*Gadus morhua*). *Canadian Science Advisory Secretariat Research Document* 2004/102.

Macpherson E, Duarte CM. 1991. Bathymetric trends in demersal fish size: is there a general relationship? *Marine Ecology Progress Series* 71: 103–112.

Magera AM, Mills Flemming JE, Kaschner K, Christensen LB, Lotze HK. 2013. Recovery trends in marine mammal populations. *PLoS ONE* 8: e77908.

Martin RA. 2004. Natural mortality of the puffadder shyshark (*Haploblepharus edwardsii*) due to two species of marine tetrapod, the Cape fur seal (*Arctocephalus pusillus pusillus*) and black-backed kelp gull (*Larus dominicanus vetula*) at Seal Island, False Bay, South Africa. *Journal of Fish Biology* 64: 1–6.

Mecenero S, Roux J-P, Underhill LG, Bester MN. 2006. Diet of Cape fur seals *Arctocephalus pusillus pusillus* at three mainland breeding colonies in Namibia. 1. Spatial variation. *African Journal of Marine Science* 28: 57–71.

Pitman RL, Durban JW. 2010. Killer whale predation on penguins in Antarctica. *Polar Biology* 33: 1589–1594.

Pitman RL, Totterdell JA, Fearnbach H, Balance LT, Durban JW, Kemps H. 2014. Whale killers: prevalence and ecological implications of killer whale predation on humpback whale calves off Western Australia. *Marine Mammal Science*. DOI: 10.1111/mms.12182.

Polis GA, Holt RD. 1992. Intraguild predation: the dynamics of complex trophic interactions. *Trends in Ecology and Evolution* 7: 151–154.

Punt AE, Butterworth DS. 1995. The effects of future consumption by the Cape fur seal on catches and catch rates of the Cape hakes. 4. Modelling the biological interaction between Cape fur seals *Arctocephalus pusillus pusillus* and the Cape hakes *Merluccius capensis* and *M. paradoxus*. *South African Journal of Marine Science* 16: 255–285.

Sargent JR, Gatten RR, McIntosh R. 1973. The distribution of neutral lipids in shark tissues. *Journal of the Marine Biological Association of the United Kingdom* 53: 649–656.

Scott WB, Scott MG. 1988. *Atlantic fishes of Canada*. *Canadian Bulletin of Fisheries and Aquatic Sciences* 219. Toronto: University of Toronto Press.

Shannon LJ, van der Lingen CD, Crawford RJM, Moloney CL, Cury PM, Fréon P. 2006. Ecosystem modelling approaches for South African fisheries management. *American Fisheries Society Symposium* 2006: 587–607.

Sih A. 1980. Optimal foraging: partial consumption of prey. *American Naturalist* 116: 281–290.

Stevens J. 2009. *Prionace glauca*. In: IUCN 2013. *IUCN Red List of threatened species. Version 2013.2.* Available at www.iucnredlist.org [accessed 05 May 2014].

Stewardson CL. 1999. Preliminary investigations of shark predation on Cape fur seals *Arctocephalus pusillus pusillus* from the Eastern Cape coast of South Africa. *Transactions of the Royal Society of South Africa* 54: 191–203.

Stewardson CL, Brett M. 2000. Aggressive behaviour of an adult male Cape fur seal (*Arctocephalus pusillus pusillus*) towards a great white shark (*Carcharodon carcharias*). *African Zoology* 35: 147–150.

Worm B, Davis B, Kettermer L, Ward-Paige CA, Chapman D, Heithaus MR, Kessel ST, Gruber SH. 2013. Global catches, exploitation rates, and rebuilding options for sharks. *Marine Policy* 40: 194–204.

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