Predators, Prey, and Play:

Killer Whales and Other Marine Mammals

Killer whale hunting at a sea lion haulout. Despite hundreds of sea lions at this site, the whales feed almost exclusively on harbor seals when hunting there. Photo by Robin Baird

by Robin W. Baird

While working on his Ph.D. on harbor seals in the late 1980s, Peter Watts spent a lot of time watching seals at several harbor seal haulouts in Puget Sound, in the Strait of Georgia, and in Howe Sound in British Columbia. Over hundreds of hours hanging out with the "prey," Peter had never seen killer whales foraging at any of these haulout sites. Yet where I was working around the southern tip of Vancouver Island, between the Strait of Georgia and Puget Sound, a typical day following "transient" killer whales usually involved watching them catch and consume at least a couple of harbor seals. One day in 1992 I watched two whales kill nine harbor seals in three and a half hours! I was following the predator. Peter was watching the prey. If you happen to be prey, your individual chances of getting eaten are rather small – it only happens once in your life, at most. But if you are a predator you are probably eating prey on a regular basis. If you are a killer whale and harbor seals make up a large proportion of your diet, typically this means catching a seal at least once a day.

Most killer whales hunting harbor seals travel in small groups and share their prey, so actually chasing, catching, and consuming seals probably happens several times a day. If you spend your time watching harbor seals at a haulout, you are likely to conclude that predation isn't important, whereas when you follow the harbor seal predator, in this case "transient" killer whales around southern Vancouver Island, it quickly becomes clear that predation on the seals is a regular event, and can certainly strongly influence seal behavior, as well as potentially play an important role in seal population dynamics. Some back-of-the-envelope calculations in 1989, after three years of watching killer whales hunt seals around Victoria, seemed to indicate that not only were killer whales probably the most important harbor seal predator, but they could be responsible for a large proportion of the natural mortality of harbor seals in the area. Despite this, harbor seal numbers were increasing at the time, and had been for a long time since the bounty on seals ended in the area in the 1960s.

Whether killer whales might substantially influence prey numbers will of course depend on the relative densities of the predator

and prey, and on how specialized individual killer whales are within a particular population– whether they are mammal-specialists or fish-specialists as are those found in high latitude populations, or are more generalists like those found in some lower productivity, tropical areas. Much of my work for the last 12 years has focused on studies of odontocetes in the tropical waters around the main Hawaiian Islands. In 2003 while undertaking a survey off the west side of the island of Hawai'i we spotted a group of small black whales scattering in several directions at high speed. We were following the small black whales, later confirmed to be melon-headed whales, to try to get photos and figure out what they were, when one of the crew mentioned possibly seeing a killer whale when the panicked little whales were first spotted – certainly that would be a good reason to flee. This was our fourth year of field work in Hawai'i, and only our first killer whale sighting. We collected a biopsy sample and photographed the four killer whales; analysis of the biopsy sample later revealed a unique mitochondrial haplotype, most closely related to mammal-eating killer whales sampled off Alaska.

Although we did not see them catch any melon-headed whales, the reaction of the melon-headed whales certainly implied they viewed the killer whales as a threat. Were these "transient" killer whales from the west coast of North America on a far-offshore hunting trip? Not likely – in fact the whales looked different than coastal killer whales, with narrow and faint saddle patches, and regular scars from cookiecutter sharks, and were likely part of an open-ocean population inhabiting the central tropical Pacific. Seven years of additional survey effort in Hawai'i and our tracklines add up to the equivalent of boating around the circumference of the world more than one and a half times, and we have yet to see another killer whale there. We do hear of one or two sightings a year around the main Hawaiian Islands, and killer whales in the area have been recorded attacking a humpback whale, eating a shark and an octopus, and with squid beaks in their stomachs – they appear to be generalists, rather than specialists, not surprising given the overall low productivity of the central tropical Pacific. Given the paucity of sightings, and the apparent breadth of their diet in Hawai'i, killer whales probably have little impact on populations of different species of marine mammals in the area, despite the reactions of the melon-headed whales.

There is no doubt that a risk of getting eaten by killer whales influences the behavior and biology of their prey, whether it is hauling out behavior of seals or sea lions, vocalization patterns of porpoises (they vocalize at such high frequencies that killer whales cannot hear them), and potentially even the seasonal migratory patterns of large baleen whales. It has recently been suggested that the cryptic behavior of beaked whales, only vocalizing at depth and avoiding near-surface waters particularly during the day when visually-oriented predators like killer whales are more likely to be hunting, may be due to avoiding predators like killer whales. The schooling behavior of many species of dolphins may reduce the likelihood that any one individual in the group is taken by a hunting killer whale.
It may seem obvious to state that killer whales aren't baleen whales, but they do share some tendencies. Some baleen whales are well-known for their seasonal variations in behavior, typically spending the spring through fall feeding intensively and building up blubber stores for a winter spent in more tropical breeding areas, where feeding is rare. Toothed whales feed year-round, but at least some killer whale populations experience seasonal variability in food intake, albeit to a lesser extent than some baleen whales. In the Salish Sea, harbor seals typically give birth in mid-summer. Pups remain hauled out or close to their mother for the first six weeks of their life. After that they are on their own, naïve, and trying to learn how to survive. In late summer and early fall (August and September) the number of

No rush: a live harbor seal in the mouth of a mammal-eating killer whale, being carried awhile before it is killed. Photo by Candice Emmons/NOAA Fisheries

A badly battered minke whale seeks a moment of respite from its tormentors, but the transient killer whales are going to win this contest. Photo by Dave Ellifrit

naïve seals in the water increases dramatically, providing easy prey to mammal-eating killer whales.

From following groups of killer whales and examining food intake rates, I determined that during this period the whales consume about twice what they do during the rest of the year and much more than they need to eat – killer whales are like baleen whales, stocking up on food when it is abundant, allowing them to get through leaner times. The same is probably true for the fish-eating "resident" killer whales that spend much of their summer and fall in inshore waters, gorging on salmon that are concentrating in areas off the mouths of rivers that they will soon move into to breed. Such seasonal variation in food intake makes it difficult to extrapolate from observations in one area or at one time of the year, to determine what role killer whales may play in regulating the numbers of their prey.

What impacts killer whales have on the numbers of their prey and the potential for driving large scale changes in prey abundance is somewhat controversial. In 1998 Jim Estes and his colleagues suggested that killer whales were the likely cause of a large-scale decline in numbers of sea otters in the Aleutian Islands. Sea otters had never been considered an important part of the diet of mammal-eating killer whales. Otters rely on their dense coat, rather than a thick blubber layer, to keep warm, and thus are less likely to be chosen as prey, if the killer whale has a choice. But in the 1990s, there were increased observations of killer whales attacking or otherwise interacting with sea otters in the Aleutians, although the number of attacks observed was small and the outcomes of the attacks were not always confirmed – sometimes the otters got away or were possibly just being harassed. In one area, a large lagoon that was inaccessible to killer whales, otter numbers were stable, whereas in a nearby area exposed to potential predators otter numbers were declining.

The story was convincing and widely accepted, but a recent re-assessment of the evidence by Katie Kuker and Lance Barrett-Lennard, including information available in the 10+ years since the original publication, suggests that the jury is still out – increases in shark populations in the same time period, high levels of persistent organic pollutants such as PCBs, and potential disease outbreaks, could all have played a role in the decline of sea otters in the Aleutians. Even the observations of attacks are subject to some uncertainty – fish-eating killer whales do occasionally play with other marine mammals in a way that could easily be interpreted as a predatory attack. In the San Juan Islands, observations of fish-eating killer whales "playing" with porpoises were uncommon throughout the 1980s and 1990s, while in 2005 they increased in frequency, with eight such events observed. The whales' motives did not appear to be food consumption. There was no evidence any of the porpoises were consumed, but some of the porpoises were killed, and the fish-eating southern residents have been observed playing with and sometimes killing porpoises much more frequently in the last seven years than they had in the first 30 years of study of this population. Whatever the motivation, it doesn't really matter to the porpoise, or potentially to porpoise population dynamics, if they are killed by a killer whale.

The oceanic ecosystems in which killer whales live today have changed dramatically in the last few hundred years. Populations of many species of whales and dolphins were greatly reduced by large-scale commercial whaling or by bycatch in commercial fisheries, many pinniped populations were reduced due to hunting or culling, or more recently due to collapses in fish populations caused by over-fishing, and numerous fish populations have been harvested to the point where the populations have collapsed, and few have

recovered. Such changes in prey populations not only may have influenced what killer whales feed on today but also what role killer whales have played in food web dynamics.

Teamwork: a pod of transient killer whales work cooperatively to separate a gray whale calf from its mother (left) in Monterey Bay, California. Photo by Alisa Schulman-Janiger

In 2003 Alan Springer, Jim Estes, and their colleagues, championed the view that reduction of large whale populations in the North Pacific by commercial whaling resulted in a greatly depleted prey base for mammal-eating killer whales, resulting in killer whales switching their diet to smaller prey such as pinnipeds and sea otters, eventually resulting in the sequential collapse of many of those populations in the area. Their hypothesis has received plenty of attention, a fair share of criticism, and a number of rebuttals – a detailed review of the arguments on both sides would fill this issue of *Whalewatcher*. Rather than summarize these, I offer my own "two-cents," in particular on the issue of whether large whales were ever an important part of the diet of mammal-eating killer whales in coastal areas where large whale populations overlap with pinniped and sea otter populations.

Given a choice, whether a killer whale will decide to attack a large whale, a seal or sea lion, or a sea otter, will depend on how profitable and how risky the different choices will be. Adult male sea lions or large whales can both fight back, and thus there is some risk to attacking them. Having a risk of getting killed or injured over a meal makes it a poor choice, unless it is the best choice available. What that means is such choices will depend not on the availability of whales or sea lions to hunt, but whether there are other, less risky, or more profitable, prey around. If you are a mammal-eating killer whale, the ideal prey is not only going to be high in energy, but be easy to kill, with little or no risk of getting injured when doing so. Elephant seals are probably one of the most preferred prey, easy to kill, lots of energy, and not particularly dangerous when in the water. Harbor seals and harbor porpoise are probably high on the list, but most of the large baleen whales, and sperm whales, are likely near the bottom, at least as adults. Sea lions and sea otters are probably somewhere in the middle, and in the case of sea lions the choice will depend in part on the age and sex of the sea lion, how close to shore (i.e., a refuge) it is, and how big is the group of killer whales that find it. In a large group, the whales can cooperate in the attack, reduce the risk of injury, and the likelihood of the sea lion escaping. In terms of the sequential megafaunal collapse hypothesis, this suggests that, at least in coastal areas where the whales likely had, or have, a choice, large whales were probably not particularly important in the diet of mammal-eating killer whales. Do the mammal-eating killer whales spend most of their time on the continental shelf where they are most likely to overlap both with a number of species of pinnipeds and large whale species? Evidence from mammal-eating killer whales satellite-tagged in an area southeast of where the population declines have occurred, off the Washington coast, suggest mammal-eating killer whales in that area do spend most of their time on the shelf, but some animals tagged in western and central Alaska by John Durban and colleagues have ranged further offshore. Unfortunately, assessing where the killer whales that live around the Aleutians spent their time prior to and immediately after the heavy exploitation of large whales will never be possible.

Killer whales are at the top of the food web, but their position there is precarious. As top predators, killer whales accumulate persistent organic pollutants such as PCBs and flame retardants more so than predators further down the food web. Since they are long-lived, mature slowly, and reproduce so infrequently, such toxins may build up to levels that may be affecting their reproduction or their susceptibility to disease. Such impacts are insidious, and by the time they are obvious to us it will be too late to do anything about it. If we want killer whales to remain a functioning part of the ecosystems in which they live, some action to deal with these pollutants is needed on both a national and international scale.