

URBAN ORCA: KILLER WHALES IN PUGET SOUND

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KILLER WHALES:

Killer whales (*Orcinus orca*) are the largest members of the dolphin family (Delphinidae). Their black and white pattern makes them one of the most easily recognizable cetaceans in the world. They are black dorsally and white ventrally from the tip of the mandible to the pelvic region. A small white oval patch is present dorso-caudal to the eye on each side and the white on the abdomen extends dorsally into the black on the lateral aspects of the abdomen. A gray to white saddle patch is present just caudal to the dorsal fin. Killer whales exhibit considerable sexual dimorphism. Males can grow to be 9.0 m long and weigh 5,568 kg while females only grow to be 7.7 m long and weigh 3,810 kg. In addition to length and weight differences, adult males develop larger pectoral flippers, dorsal fins, tail flukes, and girths than females. In fact, the male dorsal fin reaches heights of 1.8 m and is pointed, while in females it grows to only 0.7 m and is more curved. And while killer whales were named as killers of whales, their diet can range from fishes, sharks, squids, and rays to marine mammals with some populations around the world specializing in certain dietary items while others are more generalists.

KILLER WHALE ECOTYPES OF THE PACIFIC NORTHWEST

Killer whales have an almost cosmopolitan distribution and have been found in all of the world's oceans, but are sighted more commonly at higher latitudes than from tropical regions. In the waters of Pacific Northwest (Alaska to Northern California), there are three distinct ecotypes of killer whales. The better known "resident" and "transient" populations each display unique genetic, dietary, behavioral, vocal, and morphological differences. The resident pods eat primarily fish and occur in large stable groups, while transients feed primarily on other marine mammals and occur in smaller and less stable groups. The third type, which are seen occasionally, are called the "offshore" ecotype. These killer whales are believed to be primarily fish eaters and are smaller in size than other ecotypes and are genetically distinct from both residents and transients, although more closely related to the resident killer whales.

THE SOUTHERN RESIDENT KILLER WHALE COMMUNITY

Two distinct communities of resident killer whales frequent the waters of Washington and British Columbia, the Northern and Southern residents. Despite their overlap in geographic range, genetic analysis (microsatellite and mitochondrial DNA) indicate that the two populations are reproductively isolated. Although

believed to once be similar in size, the Northern resident community currently numbers over 200 animals, while there are only 85 Southern residents. Animals in both communities can be identified by distinct individual patterns of the dorsal fin and saddle patch and the Southern resident community is one of the few wildlife populations that receives a true annual census using photo-identification. Substantial declines in the Southern resident community lead to its listing as endangered under the Canadian Species at Risk Act, the US Endangered Species Act, and by the State of Washington. As with most endangered species, the factors leading to the decline of the Southern residents are multiple and interactive and include a history of live capture, high levels of contaminants, reduced prey abundance and disturbance by vessel noise.¹ Disease is not implicated in the population's decline, but could impede their recovery.²

LIVE CAPTURE

The live capture of killer whales for public display began in southern California in 1961 when Marineland of the Pacific captured a live killer whale, which lived briefly on display. Between 1962 and 1977 approximately 224 to 256 Southern resident killer whales were captured for aquaria. Approximately 36 were taken into captivity and while the others were released, it is believed many did not survive post capture. These removals and associated mortalities substantially reduced the size of the southern resident community and likely contributed to future population declines. The capture bias of taking younger animals also probably created a skewed age and sex composition for the population which likely slowed population recovery.

CONTAMINANTS

The Southern residents have been exposed to dichlorodiphenyltrichloroethane (DDT) since the 1920s and polychlorinated biphenyls (PCBs) since 1930s. Although their tissue levels likely peaked in the 1960s and have since declined; they are recognized as some of the most PCB-contaminated cetaceans in the world.³

Blubber biopsies revealed sum PCB concentrations (mean \pm SEM) of 146,000 \pm 32,700 ng/g lipid for males (n = 4; approximate ages 18, 37, 40, 44; mean 35) and 55,400 \pm 19,300 ng/g lipid for females (n = 2; ages 14 and 49; mean 32) biopsied between 1993 and 1996. In a more recent study, sum PCB concentrations (mean \pm SEM) were 66,000 \pm 26,000 ng/g lipid in the adult male Southern residents (n = 7; approximate ages 15, 15, 15, 18, 18, 29, 55; mean 24) and 45,000 ng/g lipid in the single adult female (age = 27).⁴ Interestingly, sum PCB levels in juveniles increase continuously until sexual maturity. Males continue to accumulate throughout their lives; however, reproductive females sharply decrease their own burden by passing PCBs to their offspring through contaminated milk. Despite reductions in PCB levels, Southern residents have shown recent increases in polybrominated diphenyl ethers (PBDEs), flame-retardant compounds with very similar structure and

likely mechanism of action as PCBs. It is believed that high PCB and PBDE levels in Southern resident killer whales decrease their immune system's capacity to fight disease.

REDUCED PREY AVAILABILITY

There are five species of Pacific salmon in the Pacific Northwest and recent studies have demonstrated that southern resident killer whales specialize in one of those species, the king or Chinook salmon (*Oncorhynchus tshawytscha*). In the summer months, when diet has been better studied, Chinook salmon comprise 70% of their diet. Unfortunately for Southern residents, Chinook are the least common of all five species of salmon. Chinook are the least common species of salmon in the northeastern Pacific and long- and short-term trends in the abundance of wild stocks are predominantly downward, with some populations exhibiting severe recent declines. Overall, compared with historical salmon return numbers for the Pacific Northwest, salmon returns are down to 6% to 7% of what they were historically. Salmon declines have been caused by four major factors, often called the 4 H's: habitat, harvest, hatcheries, and hydropower. Declines in salmon are closely linked to Southern resident health and a one-year lag has been shown between declines in major salmon runs and increases in Southern resident mortality.

VESSEL NOISE DISTURBANCE

Like other toothed whales, Southern resident killer whales rely on their acoustic sensory system for detecting and capturing prey and for communicating with other whales. Anthropogenic noise can interfere with echolocation, reduce their ability to capture prey, increase stress, and cause associated stress-related physiological changes such as alternations in hormones and decreased immune function. Unfortunately, in the inland waters of Washington and British Columbia, whale watching boats often outnumber the whales being watched and shipping and other vessel traffic create a scenario where underwater noise is almost ubiquitous. In the presence of underwater noise, killer whales compensate by changing their call's amplitude, duration, repetition rate, and/or frequency. Over time as the number of whale-watching boats has increased, Southern resident killer whales have produced longer calls, an anti-masking mechanism for compensating for high background noise levels. A recent study indicates that in the presence of whale-watching and other vessels whales increase their call amplitude by 1 dB for every 1 dB increase in background noise levels. Currently, there is a 100-yard no-vessel designation around killer whales to try to reduce the impacts of vessel disturbance and there is proposed legislation to increase that distance.

DISEASE

Infectious diseases have the ability to cause declines in populations of endangered species and to negatively

impact their recovery. Very little is known about diseases of free-ranging killer whales; however, it is believed that Marine *Brucella* spp, cetacean poxvirus, cetacean morbilliviruses, and herpesviruses all have the ability to impede the recovery of the Southern resident killer whale population.² Diseases that can reduce fecundity or recruitment in this population could slow its recovery. Marine *Brucella* spp are gram-negative bacteria closely related to better known terrestrial pathogens in the genus *Brucella* that can cause abortion in captive bottlenose dolphins (*Tursiops truncatus*). Antibodies to *Brucella* have been detected in killer whales; however, *Brucella*'s ability to cause abortion or reduced fecundity in killer whales is unknown. Poxvirus can cause neonatal and calf mortality in immunologically naive cetaceans. Cetacean poxvirus has been documented to cause cutaneous lesions in killer whales and has the potential to cause neonatal calf mortality. The small size of the Southern resident killer whale population and the gregarious social nature of these animals means that the introduction of a highly virulent and transmissible pathogen has the potential to catastrophically affect the long-term viability of the population. Cetacean morbillivirus and herpesvirus are two examples of highly virulent pathogens that have been detected in sympatric odontocetes and have the ability to impact Southern resident killer whales.

URBAN KILLER WHALES

The 85 Southern resident killer whales reside in an inland sea surrounded by nearly 8.5 million people; that's one killer whale per 100,000 people. Despite being a regional icon that is responsible for driving millions of dollars in tourism annually, the factors for decline in this population are all human caused. Anthropogenic factors have caused declines in all salmon species, including the Southern resident's favored diet of Chinook salmon. Vessel traffic and boat associated noise has the ability to further reduce the ability of these animals to find and catch prey. In the absence of reduced prey consumption, killer whales mobilize adipose stores, increasing metabolism of organochlorine compounds such as PCBs and PBDEs, which have the potential to decrease the Southern resident's immune function, making them more susceptible to disease. Recovery of this unique community of endangered whales will require simultaneous efforts to increase prey availability, discontinue the dumping of persistent bioaccumulative toxins like PBDEs into their environment and providing them with an underwater soundscape that facilitates communication and capture prey.

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