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On the Brink of Extinction: The Fate of the Pacific Northwest's Southern Resident Killer Whales

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Photo by Holly Fearnbach, NOAA

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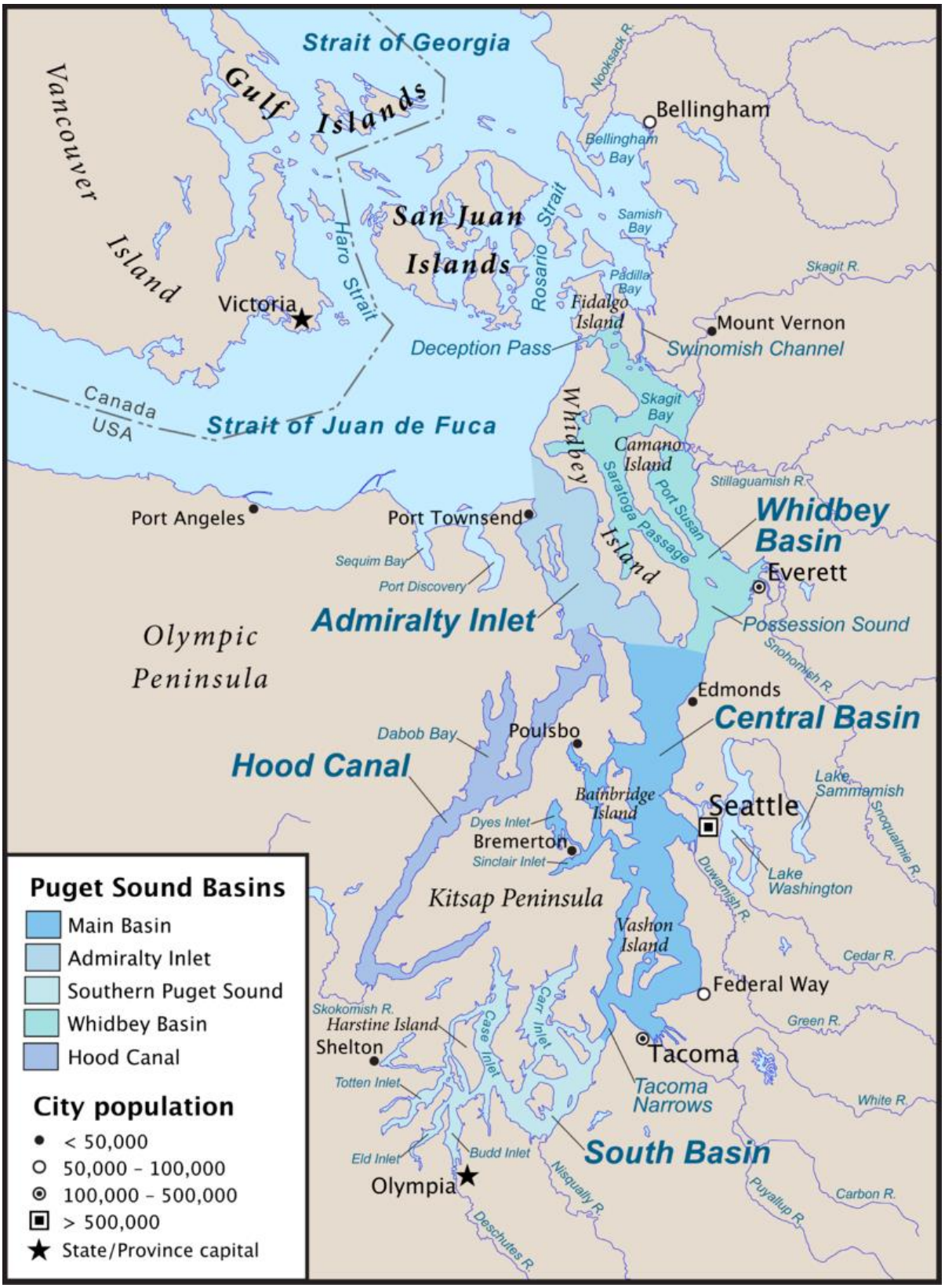

Figure 1. *The Puget Sound region*. Created by Pfly. Accessed Nov. 26, 2018, https://en.wikipedia.org/wiki/Puget_Sound#/media/File:Map-pugetsound.png

Intro

"*There are a number of very valid arguments against anthropomorphicizing the creatures with whom we share this world, not the least of which is that their inner lives deserve to be evaluated on their own terms—not ours. At times, interpreting their behavior through a human lens might be misleading, silly, or even harmful. But at other times…perceiving ourselves in these others is exactly the right response. When an animal's emotional state is obvious to anyone with eyes and a heart."* -Susan Casey, author of *The Wave*

In the past fifty years, killer whales have come to serve as an emblem of the Pacific Northwest, joining Pacific salmon as two of the most iconic species of the region. Off the shores of Seattle and Vancouver, British Columbia, their imposing fins can be seen cutting through the water, a fine mist spreading around them as they exhale. Since the 1970s, scientists have observed these whales, making them the best-studied group of killer whales in the world today. Three distinct varieties roam the waters of the northeastern Pacific: transients (also known as Bigg's killer whales), residents, and offshores.[1] While transient killer whales travel in pods of two to five whales and eat marine mammals, particularly pinnipeds, resident killer whales compose larger, matrilineal pods of 10-25 and consume fish. Offshore killer whales reside on the continental shelf and travel in groups of 30-60 individuals.[2]

Resident killer whales are seen most often near-shore and hence are the darlings of Seattle and Vancouver's wildlife advertisements and postcards, the orcas that families ply coastal parks on the weekends in hopes of seeing. Their presence is tied to the creation of the rugged, outdoorsy towns and cities of the modern northwest, and many people there view orcas, particularly resident orcas, as part of the Pacific Northwestern essence. Two populations of residents use the region as home: northern residents, who typically range north of Vancouver Island; and southern residents, who frequent the area known as the Salish Sea—the inlets of Puget Sound and the Strait of Georgia—and in the winter migrate down the coast as far south as Monterey Bay, California. Both resident populations are considered at-risk. While northern

residents are listed as threatened by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) with some 300 whales, southern residents are by far the population of most concern, with under 80 individuals remaining. As of 2001, Southern residents have been listed as endangered under the Canadian Species at Risk Act (SARA) and since 2005 have also been listed under the United States' Endangered Species Act (ESA).[3]

Three pods comprise the southern resident killer whale population: the J, K, and L pods, which as of September 2018 number 22, 18, and 24, respectively.[4] Pods consist of two to three close-knit family lineages of mothers and their offspring known as matrilines. In resident killer whale societies, calves and their mothers form tight bonds, with offspring never leaving their mothers' pods. Because the pods interbreed, all three are related. For most of the year, they roam apart, but when they have chances to interact, it is cause for excitement. Killer whales are extremely social creatures, and some marine mammal neuroscientists have even suggested that their sense of self encompasses their family members, rather solely reflecting themselves as individuals. When pods meet, they engage in what orca enthusiasts call their 'greeting ceremony': pods will line up in two straight lines, facing each other. After a few moments, they bound toward each other, leaping, slapping their tails on the water, rolling and diving. Juveniles especially tend to frolic, with younger calves staying closer to their mothers.[5,6] It is a playful way of socializing, one that has endeared them to many who can sense their excitement at being together.

The plight of the southern residents has tugged the heartstrings of Pacific Northwesterners who have come to see killer whales as part of their home, as well as citizens across the globe who have heard of the whales' struggle. In the summer of 2018, a southern resident orca from the J pod named Tahlequah gained worldwide attention when she grieved for

her dead calf by carrying her through the Puget Sound for seventeen days (Figure 1.1).[7] The calf, emaciated, lacking enough blubber to keep her afloat, and likely flooded with pollutants off-loaded from her mother, survived for only 30 minutes after her birth on July 24, despite pod members' attempts to hold her above the water. She would have been the southern residents' first successful birth in three years. It was as if Tahlequah was decrying her calf's suffering, broadcasting the fate of the southern resident community to the world. Two months later, in September, J50, a four-year-old juvenile, disappeared (Figure 1.2). Scientists had been worried about J50 for months because of her malnourished appearance. She has not been seen for since September and is presumed dead.[8]

Today, killer whales in the northeastern Pacific are accosted by multiple threats to their survival, including food shortages, pollutants such as PCBs and PBDEs, and high rates of vessel traffic. These threats developed over time and largely corresponded to increasing urbanization along the west coast. They are compounded by a history of whale captures in Washington and British Columbia, which reduced transient and resident numbers, most particularly the southern residents. Despite efforts to constrain pollution, establish protection zones for killer whales, and facilitate increased salmon runs in Washington State, the southern resident population has decreased by a quarter since 1995, when they peaked at 98 whales.[9] They stand now at 74, and orca researcher Ken Balcomb estimates that their potential to rebound will diminish after five years, when not enough mature females and males will remain to facilitate viable population growth.[10,11]

Up until 2012, there was hope that a captive female orca named Lolita, who has lived in a tank in the Miami Seaquarium for 48 years, could return to the Salish Sea and potentially facilitate reproductive success. But the Seaquarium's owners refused to consider the option, even

at the price of a million dollars.[12] Now, at 54 years old, Lolita's reproductive age has passed. But many who have followed her story still hope she may one day return to the northwest to live out her days in a sea pen off the shore of San Juan Island, where she grew up. It seems that we may owe it to her—and to her community, we owe the effort of trying to help them persist. In one *New York Times* op-ed, award-winning journalist and author Susan Casey sums up the sentiment these animals provoke in us, and what must be done so they can survive:

> "Heartbreak for Tahlequah is an appropriate starting point. In a way, it's the easy part. What's harder is turning our shared sense of grief for this mother into an impetus to solve the problems plaguing the dwindling southern resident orca population. If we aren't willing to turn our empathy into action, then one day in the near future we will explain to our children and grandchildren how incredible the orcas were, and how bad we felt about their fate. How their pain resonated with us and caught our attention. How deeply we felt their loss. Just not enough to do what was required to save them."[13]

Figure 1.1. *J35 (Tahlequah) Carrying her Dead Calf*. Photograph by Ken Balcomb. From *The New York Times*, "The Orca, Her Dead Calf, and Us," August 4, 2018, www.google.com/amp/s/www.nytimes.com/2018/08/04/opinion/sunday/the-orca-her-dead-calf-and-us.amp.html

Figure 1.2. *Orca J50 Breaches in Haro Strait.* Photograph by Clint Rivers/Eagle Wing Tours. From *Seattle Times*, "Orca J50 presumed dead but NOAA continues search," September 13, 2018, www.google.com/amp/s/www.seattletimes.com/seattle-news/environment/orca-j50-declared-dead-after-search-southern-residents-down-to-74-whales/%3famp=1

Chapter 1: The Strange Nature of Killer Whale Captures

"*When you look into their eyes, you know somebody's home. Somebody's looking back*."
-John Jett, Former SeaWorld Trainer[1]

When the boats entered Penn Cove on August 8, 1970, it was a typical summer day on the coast of Whidbey Island, Washington. The town of Coupeville, soon to be named a National Historic District, bustled with activity from interspersed locals and tourists. In the 1960s, there had been an explosion of interest in the area, and swathes of gift shops, inns and bed and breakfasts had opened, expanding the still-small town to 700 acres.[2] Highway 20, which crosses Washington from east to west, was jammed with sightseers drawn by promises of glorious views. The sloping green landscape across the cove and the Olympic Mountains to the south made the area a popular destination for travelers (Figure 2.1).

But that day, tourists were in for a surprise. The bustle of the day was interrupted with roaring boat engines, the whine of aircraft, and whoops and yells from the water. Boats raced into the bay one after another while pilots circled above, all in pursuit of the animals knifing through the water near the vessels: killer whales, emitting confused squeals and shrieks as they sought to escape the boats corralling them. Fishermen surrounded the whales, dropping seine nets into the waves. It was a day that would be remembered for decades by Whidbey residents and non-residents alike.[3]

The 1970s and 80s were the age of spectacular maritime orca shows, the period of glamorous aquaria and marine discovery. The opportunity to see the feared killer whale proved irresistible to many who had long heard tales of the whales' bloodthirsty reputation. It was the prelude to 1975's *Jaws*: the thrill of adrenaline at the sight of an apex predator just a few feet away, through a simple sheet of glass. Another movie, *Orca*, produced in 1977, featured terrifying scenes of an orca hunting a fisherman who had killed his mate.[4] The idea of a monster

lurking underneath the ocean's surface intrigued the public, drawing them to aquariums to see the sea villains up close.

Figure 2.1. *Penn Cove and Coupeville wharf (foreground) with Whidbey Island, Admiralty Inlet, and Olympic Mountains in background*. Photograph by Craig Sullivan. From http://faculty.washington.edu/rturner1/PennCove.htm

Contrary to the vicious monster most visitors expected, orcas generally proved to be curious, charismatic, and at times playful—rather like their relatives the dolphins. Sea World orchestrated shows in which trainers performed elaborate routines with orcas—mesmerizing dances between humans and the ocean's apex predators in which trainers stood on the whale's back as it swam and were lifted out of the water as the whale 'spyhopped,' or rose vertically upward. "Once regarded as a homicidal maniac, [the orca] is now the jolly and expensive star of

such entertainment complexes as SeaWorld in San Diego," reads one Sacramento Bee article from 1982, elaborating, "the killer whale…[is] 'a being possessed of a zest for life, a healthy sense of humor, and, moreover, a remarkable fondness for humans.'"[5] Trainers fell in love with the orcas they worked with, while scientists were continuously amazed by their intelligence and complex social bonds.

Interest in orcas, specifically in orcas performing, had begun with Seattle Marine Aquarium owner Ted Griffin. Griffin had long been fascinated by killer whales, having been warned at age five that killer whales liked to eat small boys. While boating and scuba diving, he always hoped to come across one, secretly wondering if killer whales deserved their vicious reputations. At age 26, he opened the Seattle Marine Aquarium and soon was delighted to find that a Puget Sound fisherman had accidentally netted an orca. He promptly bought the male orca for $8000, named him Namu, and placed him in a sea-pen near the Seattle waterfront. Visitors came to gawk at the creature, so rarely seen up close. It made a striking sight: a killer whale, complete with vivid black and white markings and six-foot dorsal fin, drifting in a sea pen outside the doors of Seattle's waterfront shops.[6]

But Griffin was not yet satisfied: he wanted to get closer to the animal that had for so long occupied his thoughts. Public attention escalated when Griffin entered the pen with Namu, this so-called sea monster, and began to swim with him. The city was shocked at his daring and fascinated with the whale's placid response, and Griffin and Namu became stars of Seattle media. The two would swim together for hours, with Namu's intelligence and gentle spirit quickly becoming obvious to observers. One researcher noted that Namu, listening to Griffin attempt to produce echolocation clicks, began to mimic the sounds Griffin was making and achieved a closer resemblance to human noises than did Griffin to whale noises. Others marveled

at the fact that when Griffin eventually climbed onto the whale's back, Namu recognized what his companion was doing and patiently scooped him up when he fell off. Their relationship prompted one newsperson to later comment that Griffin was "the first man to tame, train, ride, and perhaps love a killer whale."[7]

But it was not to last. Seeking a companion for his whale, Griffin intentionally live-captured a female orca in October 1965 and placed her in the sea-pen with Namu, hoping the two would be friends. But she was aggressive and unfriendly, and it was plain that the two whales could not remain in the same pen. Griffin sold her to Don Goldsberry from the San Diego SeaWorld, where she was named Shamu—the first of many Shamus that would perform there. Back in his Seattle sea-pen, Namu ailed of an infection and died shortly thereafter, just one year after he was captured. It was later discovered that the infection was a result of polluted water inside the pen.[8]

Griffin felt the loss of his orca friend keenly. But Namu lived on in the publicity the pair had received, which was, essentially, the start of a legacy. Griffin had opened the possibility of training killer whales to American and Canadian aquaria. Perhaps more significantly, he had generated a curiosity about killer whales in the public, one that would prove hard to quench in the coming years. After being forced to give up Shamu, and his subsequent loss of Namu, Griffin was not ready to stop his quest for kinship with killer whales. He teamed up with SeaWorld's Goldsberry and together, the men brainstormed a netting technique for capturing multiple killer whales at once.

Purse seine nets, which allowed whales to be corralled so that captors could pick out young whales, proved to be most efficient. In the late 1960s, killer whales throughout the Puget Sound region were trapped by nets, ensnared and lifted onto stretchers, and strapped onto flatbed

trucks to be transported around the U.S. As more aquariums received, so demand for whales rose. In 1968, a killer whale from the southern resident L pod, dubbed Hugo, was delivered to the Miami aquarium, and captors soon returned to Puget Sound to find more.[9] While killer whales are one of the most widely distributed mammals, second only to humans, as apex predators they live in widely-dispersed populations. They appear in concentrated numbers in just a few areas, the Pacific Northwest being one of them, and Norway and Antarctica others, making the Salish Sea the most expedient place for U.S. whale captures. Moreover, in the Puget Sound region, they were known to frequent certain areas more than others, including the Rosario and Haro Straits in Washington's San Juan Islands, making them easy to track down.

And indeed, the Haro Strait was where Griffin found them on the evening of August 7, 1970.[10] Unbeknownst to him, the southern residents were at the time engaging in their annual summer reunion, where all three pods gathered to frolic, breed and forage on Fraser River salmon. A few days before, they had likely participated in their inter-pod greeting ceremony, and now they were moving loosely together, making quick, short dives as they searched for salmon. It must have been impressive: 90-some whales scudding through the water, using their classic quickly-pulsed underwater calls to communicate to one another. Griffin tracked them overnight into the channel between Whidbey and Camano Island south of Penn Cove. He and Goldsberry had scoured this region in the late 1960s, bringing orcas in for SeaWorld and other institutions. The best captures were young orcas, who were not yet in their prime and were likely to live a long time in captivity. This involved separating the juveniles from their pods to transfer them onto trucks and transport them across the nation. But by 1970, the orcas seemed to recognize the pattern of capture and tried their best to protect their young.

"The orcas had been caught before and they knew what was going on. They knew that their young would be taken from them," recounted orca researcher Howard Garrett of the 1970 whale chase. "The [orca] adults without young went east into a cul-de-sac and the boats followed, thinking they were all going that way, while the mothers with babies went north. But the capture teams had aircraft. And [the orcas] had to come up for air eventually, and when they did, the capture teams alerted the boats."[11]

The boats circled around for the mothers with calves, eventually cornering them in Penn Cove (Figure 2.2). The capture teams used bombs lit with acetylene torches, throwing them in the water to round up the bewildered whales. Fishermen with seine net encircled the pod to prevent their escape, so the captors could find the young ones. As the smaller orcas were lifted onto stretchers, ready to be transported to trucks who would shuttle them around the U.S., fishermen dropped the seine nets, and the rest of the pod was free to leave. But they remained.

Meanwhile, drivers pulled over and watched the scene unfold from the side of Highway 20. "We're there, trying to get the young orca into the stretcher, and the whole [family] is out here 25 yards away maybe in a big line and they're communicating back and forth," remembered John Crowe, a member of the capture teams. "Well, you understand then what you're doing, [and] I lost it. I mean I just started crying…It's like kidnapping a little kid away from their mother."[12] Spectators, at first excited to see a group of orcas, quickly became concerned, then horrified at the noises the whales were making. Overpowering the bustle of Coupeville tourists, the hum of boat engines, and the hollers from the men were sounds from the remaining killer whale families watching the juveniles being lifted away from them. Sharp squeals and high-pitched yelps sounded across the cove. "The whales were vocalizing so loud it was heard for miles," Garrett said. "People lined the bluffs and watched."[13]

Figure 2.2. *A whale enclosed in the purse seine net spyhops to survey its surroundings during the 1970 Penn Cove roundup*. Photograph by Wallie V. Funk. https://www.thestranger.com/features/feature/2015/09/30/22939219/its-time-to-free-lolita-a-puget-sound-killer-whale-thats-been-trapped-in-miami-for-45-years

Crowe added, "We took the last [young] one over to the dock and all of the animals…came over to the dock right where we were loading the last baby and stayed there…As soon as that stretcher left the water—when the baby whale was no longer in the water—that was the last of the communication and they knew it. And they just kind of took a deep breath and they just all turned at one time and swam out of Penn Cove. [People] tell me they haven't been back since. It was 28 years ago."[14]

Among those captured was a juvenile from the southern resident L pod named Tokitae, now more commonly known as Lolita. On September 14, 1970, she was transferred to the Miami SeaWorld aquarium, where she remains to this day in the smallest orca tank in the nation.[15] Six other juveniles were captured in Penn Cove in 1970—two were transported to Japan, one to

Texas, one to Australia, one to the United Kingdom and one to France.[16] Lolita is the last survivor of her former companions, having lived 43 years in captivity. Whales tend to live much shorter lives in captivity than in the wild; Lolita, now 54, far exceeds the norm. Garrett attributes this to her strength of character, commenting, "Lolita doesn't have the space" to frolic as her family does in the wild, but "she tries…And this is something that is incredibly insightful into her character. She does laps…She races around and around, throws water out of the tank, but she gets her exercise that way. That's the only way she can, doing one constant U-turn in that tight little tank. So that's how she maintains her stamina and, I think, her ability to survive after all the others have died years and years ago."[17]

Crowe makes clear his regret over participating in the captures, and to the modern-day reader the ordeal sounds gruesome. But what people fail to consider is that killer whale live-captures occurred at a tremendous turning point in the Pacific Northwest, and in the U.S. as a nation. In the Puget Sound region, the extractive industries that had largely fueled the region's growth in the 1800s and early 1900s, including logging, fur-trading, and commercial fishing, had only recently given way, at least in part, to office jobs.[18] The natural environment, rather than being a resource for survival and income, was now a source of recreation and escape from the monotony of city life. The region's wildlife, which in the early 1900s was a means for profit, became something to admire and to protect.

These mindset changes in the Pacific Northwest occurred in tandem with a broader shift in the U.S.'s attitude toward wildlife and the environment. On April 22, 1970, some twenty million people gathered across the nation to celebrate the nation's first Earth Day.[19] On December 2 of that same year, the Environmental Protection Agency (EPA) was established, marking the start of environmental awareness.[20] Thus, the reactions to the 1970 Penn Cove

roundup both reflected the national mindset and sparked a deep-rooted perspective shift regarding killer whale captures. The cries of the whales in the pen, particularly as they saw their young being taken from them, made a lasting impression on the events' spectators.

Additionally, putting orcas into captivity entirely revolutionized the way people viewed killer whales, and may have even saved the rest of their species from death at human hands. In the 1800s and early to mid-1900s, killer whales were not only considered bloodthirsty but were hated and feared to the extent that culling programs were set in place to shoot them. An element of fear is in their very name—killer whales—'whales that kill.' Originally 'killer of whales' to early whalers—or '*asesinas de ballena'* by the Basque people—who saw orcas finish off other whales, the name was in time reversed.[21] Fishermen hated them because they took so many fish. The public was terrified of them. In an 1890 edition of *St. Nicholas; an Illustrated Magazine for Young Folks*, John Coryell refers to orcas as 'wolves of the sea' and writes: "The shark is indeed ravenous and voracious; but in ferocity and destructiveness it is far inferior to the orca, another inhabitant of the world of waters…To call this creature the 'wolf of the sea' does not tell half the story of its savage nature. The wolf seems a puny foe compared to the orca…Its swiftness, ferocity, and rapacity make the orca a terror of the ocean."[22]

This widespread abhorrence of orcas meant that people thought nothing of killing them, and in fact, rather preferred to eliminate them. In Norway, fear that killer whales were depleting herring caused the government to encourage and even subsidize hunting killer whales. Fishermen in British Columbia also considered the whales as nuisances. Killer whales were often shot on sight, to the extent that a quarter of the whales live-captured in the 1960s and 1970s had visible evidence of a previous gunshot wound. In fact, Namu was one of these whales, though the bullet inside him was not found until after he died.[23]

In 1960, the Federal Fisheries Department even helped set in place a culling program on Vancouver Island. Sports fishing lodges in the area were upset about the presence of orcas, knowing they would take fish, so a .5 calibre machine gun was set up with instructions to open fire when whales passed by. The gun was never used; the whales moved their foraging grounds to a different area before the fishing lodges had the chance to shoot them.[24] But the federal government was ready and willing to do so, illustrating the harm that could have been inflicted on killer whale populations had public perception not changed.

Now, the plight of killer whales brings tears to the eyes of people across the U.S. and Canada. In 1976, Washington State passed a moratorium on the live-capture of whales. "It was SeaWorld by name that was told, 'do not come back to Washington to capture whales,'" recalls Garrett.[25] This shift in policy and in mindset takes root in our understanding of these oceanic mammals. People interacting closely with killer whales in captivity have seen firsthand their mischievous curiosity, lively intelligence and, at times, their wild, intimidating ferocity. Forty-seven years of intense research of killer whales in the wild has contributed in a different way, allowing us to see orcas' social interactions, societal structures, and feeding and movement behaviors in their natural environment. Coming to know killer whales has, for many, invoked a sense of empathy for these cetaceans.

Chapter 2: *Orcinus orca* in the northeastern Pacific

Research

Sparked by concern over live-capture impacts on killer whale populations in Washington state and British Columbia, scientists launched groundbreaking research on orcas in 1971. Concerned parties hoped to census the populations before more whales were taken to make sure they could remain viable. For that reason, researchers in Nanaimo, B.C. began to study population parameters of orcas that roamed through the Strait of Georgia.

This was not an easy undertaking. Marine biology was not a widely known field, and lack of technology made it difficult to study species that spent a large portion of their time underwater. In fact, marine exploration had just gained a spot on the national schedule, as fear grew that underwater vessels would be the Soviets' next mode of attack. As President John F. Kennedy put it in 1961, "Our very survival may hinge upon…[our] knowledge of the sea."[1] This mindset, paired with public spotlight on Shamu, SeaWorld's amazing killer whale, jumpstarted killer whale and other marine studies.

Up to that point, the only method of tracking killer whales was through citizen reports of various sightings. Because of frequent observations, most people believed orcas in the area numbered in the thousands, but no one knew for sure. The fins that cut through the waters of the Northwest remained mysterious, with little known about killer whale life history traits. This was about to change through the work of researchers Michael Bigg, John Ford, and Graeme Ellis, among others, who by 1980 had revolutionized killer whale study methods. Author Jason Colby attributes them with catalyzing orca conservation efforts: "It was their work, more than anything else, that spurred protection of orcas in U.S. and Canadian waters, and when the Soviet Union reported killing more than nine hundred orcas in its 1979-1980 Antarctic hunt, it was these

Pacific Northwest experts who convinced the International Whaling Commission (IWC) to halt the slaughter."[2] Their discoveries about the live-capture impacts on killer whale populations in the northeastern Pacific would put a stop to the taking of whales for aquaria, which would otherwise have quickly wiped out the southern resident population.

Acknowledging that randomized, year-round observations were not providing an accurate whale count, these researchers devised a census method that made use of whale observers in the Vancouver area. Led by Bigg, the group set dates for surveys: July 26, 1971, August 1-3, 1972, and August 1-2, 1973. Lighthouses, fishermen, boat captains, and people with homes on the coast were alerted to send in orca sightings. After receiving responses, the researchers calculated a general estimate of 200-350 killer whales in the region—far fewer than previously imagined.[3]

The question, however, remained as to how to get an exact count of the whales. In the summer of 1972, Bigg, who is often accredited as the founder of modern killer whale research, realized that the whales could be individually recognized. The dorsal fins of the whales had many nicks and wounds from their time at sea, as did their 'saddle' patches—lightly colored portions of skin at the base of the fin. The markings for each orca were distinct, and by using photographs, orcas could be distinguished from one another. A new census process was born, where whale-watching aficionados alerted the research crew whenever orcas were spotted in the Vancouver region, and the researchers responded in one of their two boats to photograph the whales.[4]

Catalogues of photographs unlocked the ability to not only learn the unique markings of each whales but also to understand their grouping patterns. In 1987, Bigg wrote of the data collecting process: "the minimum information that we try to obtain from an encounter with a pod is the identity of all individuals present. We also attempt to determine the sex and travelling

companions of each animal."[5] In 1990, Bigg passed away, but his work and passion lived on.[6] Slowly, with photographs and continued study, an image began to form: not, as had initially been thought, of an aggregate population of killer whales, but rather of several culturally distinct populations, each with their own foraging habits, social structures, and ways of interacting.

ii. Residents, transients, and offshores

Three varieties of killer whales share the waters of the northeastern Pacific, known as residents, transients, and offshores. Despite residing in close proximity to one another, these three varieties, more commonly called *ecotypes*, are socially and genetically divergent—meaning that, contrary to common perception at the time, many of these killer whales did not interbreed and were consequently more vulnerable to population depletion. Behavioral and morphological differences had led the researchers to suspect genetic differentiation in the 1970s and 1980s, but genetic testing was not conducted until the 1990s.[7] The most basic difference between ecotypes, and the first observed by researchers, is their diet. While residents eat only fish, in particular chinook salmon, transients prefer marine mammals such as harbor seals and sea lions, and offshores have recently been recorded eating Pacific sleeper sharks and Pacific halibut.[8]

Residents, transients, and offshores have been studied to varying degrees. Residents have captured the most attention because of their tendency to frequently occur in large numbers close to the shore. Consequently, they are the most well-known of the three ecotypes. Two populations of resident killer whales exist in the Salish Sea region: the northern residents, who reside in the areas around Vancouver Island and Queen Charlotte Islands in B.C., and southern residents, who normally range throughout Puget Sound, Washington (Figure 3.1). The second-most studied ecotype are the transients, who generally roam through local waters as well as farther off shore, depending where foraging seems best. Transients travel in smaller pods of three to five

individuals and move more erratically than residents. Least studied of the ecotypes are offshores, thus named because they tend to forage along the continental shelf, between 15 and 500 kilometers offshore.[9] Unnoticed until the late 1980s by Bigg's researchers, offshores are difficult to study because of their preference to stay far out at sea.

Figure 3.1. *Southern resident range*. Figure by Gary J. Wiles. www.researchgate.net/figure/Geographic-range-light-shading-of-the-southern-resident-left-and-northern-resident_fig3_242367775

Without being able to identify individual whales, neither researchers nor captors had had any way to know that certain whales had different dietary preferences. Early observations grouped fish-eating residents and offshores with marine mammal-inclined transients, likely resulting in unfortunate incidences where transients were shot because they were supposedly taking fishermen's catches, or residents were killed to preserve populations of northern fur seals, which were valued for their pelts. Residents were certainly attributed with bloody scenes that they in fact did not partake in. In one account from 1948, Harry Hicks, of Everett, "watched a school of killer whales smash into a log boom in Port Gamble, where harbor seals were resting. The seals deserted the log and headed for the

beach, but the whales killed so many of them that the water was fouled with blood and pieces of flesh."[10] These were transient killer whales—residents preferred fish and would not prey on seals. But until Bigg's ecotypes discovery, no one realized they were different. Transients provided the dramatic scenes that had fed 'killer' whale reputations for years, but contrary to popular perception, transients were not representative of residents, and vice versa.

Thus, like most people at the time, the researchers had originally assumed that all killer whales belonged to the same general assemblage.

> In the early stages of this study, we became accustomed to encountering killer whales in groups, or pods, containing 10 to 25 or more whales…Their movement patterns were fairly predictable, as was their occurrence in certain areas over the summer. Occasionally, however, small groups of killer whales were encountered that differed in appearance and behavior from the larger pods. Typically the smaller groups contained only two to five whales, and their patterns of occurrence and movement were erratic. We found it curious that these small groups never travelled with the larger pods and speculated that perhaps they were social outcasts in transit to other locations. For this reason, we termed the whales found in these small groups transients and those identified in the large, common pods residents.[11]

But as they later found, the two ecotypes had not interacted for many generations. Preliminary genetic testing in the 1990s indicated that residents and transients had been genetically isolated for thousands of years, perhaps before they lived in the same waters.[12] It was clear that some sort of reproductive isolation resulted in ecological divergence, but when and how this divergence occurred, and whether it occurred in allopatry or in sympatry, was not yet known.

This discovery of ecotypes and the subsequent confirmation of their genetic isolation had drastic implications for live capture policies. Since the 1970s, Don Goldsberry had been arguing for a sustainable take of ten whales per year for captivity.[13] In an aggregate, interbreeding population of hundreds or thousands, such a take rate would have been essentially harmless. But in the smaller resident and transient populations, ten whales disappearing every year would have been devastating. For the southern residents, over forty had already been taken, reducing them

from over 100 whales to just 66.[14] But in the 1970s, the researchers were still in the process of discovering population-level impacts. Differences between residents and transients had only recently been established by Bigg's photos in the late 1970s, and the two ecotypes were still being observed and defined.

Studies in the early 2000s expanded on genetic results in killer whales, finding that two major groups of haplotypes exist among orcas worldwide. While residents and offshores belong to the first clade, along with fish- and marine mammal-eating populations across the globe, transients belong to the second, smaller clade, which includes only a few populations from the Northern Pacific and the Antarctic.[15] Estimates place transients, the oldest ecotype, at having diverged approximately 700,000 years ago.[16] Residents and offshores, both fish-eating and tending to occur in large numbers, diverged more recently, likely while in sympatry.

The concept that all killer whales in the Puget Sound region are identical could therefore not have been farther from the truth. Differences between ecotypes extend from diet to social structures. For instance, residents, unlike transients, live in complex matrilineal societies. This came as a surprise to the researchers, who had initially hypothesized that resident pods were formed as a type of breeding unit typical of carnivorous societies. According to this hypothesis, males would act as the group's 'harem masters' and breed with the females.[17]

The fact that residents live in matrilineal societies places them among some of the most complex land mammals, such as primates, who also live with their mothers for most of their lives. In such societies, matriarchs are the bosses. The oldest known matriarch among southern resident killer whales, a J-pod orca aptly nicknamed 'Granny,' lived to be 105 before disappearing in 2016.[18] During her life, like most matriarchs, she guided her pod to the best

foraging areas, kept the group together, and distributed wisdom and know-how to young whales. As described by journalist Susan Casey,

> [Orcas] live in matrilineal groups that might include four generations, with the oldest grannies running the show…The matriarchs serve as midwives, babysitters, navigators and teachers. Orca mothers, grandmothers and great-grandmothers pass on so much essential knowledge that calves removed from their influence are as ill-equipped for wild orca life as children raised by wolves would be if dropped in Midtown Manhattan.[19]

The image she creates is compelling as well as accurate: matriarchs play a decisive role as teachers and leaders, and when they die, their pods often drift apart without them. One key piece of knowledge matriarchs pass on to calves is how to speak the pod's dialect—a language of sounds that to human ears resembles squawks, yelps, and squeals. A group of killer whales that share the same dialect is a *pod*, while a group of pods that use similar dialects is known as a *clan*.[20] Researchers believe that clans start out as one pod with the same dialect. As the number of whales grows and the whales divide into separate groups, their dialects develop different nuances, marking the creation of new pods. This is likely what happened with the southern resident J, K, and L pods. Among killer whale clans, dialects may even function into the breeding process by indicating how related a whale is to its potential mate. Whales may be more attracted to mates with dissimilar dialects, which to a certain extent would protect them against inbreeding.[21]

Transient killer whales also use dialects, which are predictably different from residents'. Unlike residents, transients tend to stay quiet while foraging so as not to disturb their acoustically wary prey, most often harbor seals or sea lions.[22] Their smaller, more fluid pod structures likely result from the difference in their prey preference. While residents spread out and move forward as a unit, vocalizing underwater to each other to maximize the number of salmon they can find, transients dart in and out of coves in silence. Smaller pods reduce the need to communicate,

decreasing the chance that their prey will hear them coming. Transients do not bond as tightly to their pods as residents, with members of pods sometimes interchanging. Pods do not usually exceed five whales and will often consist of a mother and her calves or of several adults.[23]

Travelling in the largest numbers are offshores, who when observed are typically in groups of 20-75 whales and may gather in groups of up to 200. Scientists speculate that offshores may have similar foraging methods and social structures to residents, given similarities in group size and preferred prey, but such speculations have not been confirmed.[24]

Thus, the familial structure of resident killer whales, unique among the three ecotypes, likely results from their evolution as predators of Pacific salmon. To understand the inner workings of these orcas is to acknowledge their tight-knit bonds, the level of intimacy between a mother and her calf. Female killer whales typically give birth every three to ten years.[25] Once born, a resident calf remains close to its mother and nurses for one to two years before beginning to socialize more with siblings and other relatives. As juveniles, residents slowly become more independent from their mothers. This is especially true for females once they have their own young. However, unless the calf dies or gets lost, the offspring will remain with its mother's pod for the rest of its life, or until the matriarch dies. As seen in Tahlequah's case, a mother feels a deep tie to her offspring, and mothers in captivity have shown similar symptoms of grief or rage when their calf is taken from them.

The way in which killer whales transmit social knowledge to their offspring may have important implications for the development of different ecotypes. Recent studies have hypothesized that killer whale culture plays a role in eventual genetic divergence. This theory would logically proceed as follows: social learning among killer whales (e.g. coaching on dialect or foraging areas) leads to the development of subgroups with slight differences from each other.

One subgroup teaches its young to forage more in one area, while another subgroup occupies a slightly different range. One food source is more prevalent in the first subgroup's area, so whales who prey on that source experience higher fitness and rates of reproductive success. In that subgroup, calves are taught to pursue the more prevalent source, which speeds the process of genetic developments in favor of catch efficiency. Simultaneously, due to preference, range limitations, or increased encounters with similar resource-users, mating increasingly occurs solely among these specialists.

Models indicate that this theory of social learning speeding up evolution is plausible and even likely. Reisch et al (2012) likens the process to early human adaptations, in which culturally-driven cultivation of high-starch foods facilitated an increase in the amylase gene.[26] Marine mammal neuroscientists also agree that social learning is incredibly important aspect of killer whale communities and likely factors into their lifestyles and long-term development. Studies in the 1990s(?) found that orcas have highly developed paralimbic lobes and insular cortexes, "both of which relate to social emotions and awareness. Like the human brain, the orca brain contains von Economo neurons: rare, specialized cells that relate to empathy, communication, intuition and social intelligence."[27] According to neuroscientist Lori Marino, "It's becoming clear that dolphins and whales have a sense of self, a sense of social bonding that they've taken to another level—much stronger, much more complex than in other mammals, including humans. Their very sense of self may depend on the group members around them." This brain structure, which facilitates complex emotional bonds, likely also lends itself to social learning, speeding the development of culture and in turn the process of genetic divergence.

The tendency for killer whales to diverge into specialized populations is not endemic to the Salish Sea region and is far more widespread than originally thought, particularly in areas of

high marine productivity. Studies following that of the Nanaimo researchers established similar ecotype formations in the eastern North Atlantic and Antarctica. Preliminary observations in New Zealand, the Russian Far East, the eastern Pacific, and the western North Atlantic also indicate the presence of sympatric ecotypes.[28] Up to five ecotypes have been reported in Antarctica and seem to reflect the same dietary patterns present in transients and residents, e.g. the dichotomous preference of marine mammals or fish. While one of the Antarctic ecotypes hunts minke whales, another preys on seals, and a third specializes on the Antarctic toothfish.[29] Ecotype differences in morphology and behavior range to the extent that Soviet scientists in the 1980s proposed that two of the whale types be named new species (*O. nanus* and *O. glacialis*).[30,31]

But while this tendency to specialize on particular prey sources allows multiple killer whale populations to occupy the same range without out-competing each other, it also makes them more vulnerable to fluctuations in their natural environment that affect that prey source. Social knowledge for hundreds, if not thousands, of years focuses on how to capitalize on one type of prey, and that knowledge and behavior will continue to be passed across generations even as the prey, and consequently the predator population, dwindles. One 2010 study summed up: "Foraging specializations have enabled this versatile predator to exploit a diversity of marine environments and prey types, at the cost of dietary flexibility at the population level…Thus, although the killer whale occupies the top trophic position in the oceans, populations may be limited by a far narrower range of prey resources than the species is theoretically capable of consuming."[32]

Populations that specialize on one particular resource are significantly more likely to go extinct than populations that forage across the resource spectrum.[33] Resident killer whales in the

northeastern Pacific seem to be evidence of this. Over thousands of years, they came to depend on salmon, particularly the large, fatty chinook salmon, as a primary food source. Like most specialized predators, their populations reflected the patterns of chinook populations, with numbers rising and falling in tandem. But with the arrival of settlers to the west coast and subsequent fluctuations in salmon populations due to over-fishing, resident orcas were vulnerable. Evidence suggests that southern residents likely numbered some 250 before the 1800s, but that by the mid-1900s the population had dropped to under 150.[34]

Then Griffin and Goldsberry entered the scene, not knowing better than anyone else that the killer whales of the Salish Sea region were comprised of different ecotypes, and that within those ecotypes were separate, non-interbreeding populations. A total of 67 killer whales were live-captured or were killed during live captures in the Salish Sea region; out of those 67, over two thirds—47 whales—were from the southern resident population. Thirty-six southern residents were collected for aquaria, while 11 drowned in the nets used to surround them.[35] The first killer whale census in 1973 placed southern resident numbers at 66, meaning their pre-capture numbers were over 100.[36] In addition, their age structure was heavily skewed, which would have long-term repercussions for the population. While southern resident numbers continued to grow some ten to twenty years after the live-captures, there came a time when Lolita, Hugo and their J, K, and L-pod comrades should have reached reproductive age and begun producing young. But they were not there to reproduce. As a result of live captures, not enough whales reached reproductive maturity to adequately substantiate the population with new calves.

It was not until these later years, after Bigg identified three different ecotypes in the Salish Sea, that the grievous impact of whale captures on Southern residents was discovered. But

by then, southern residents were facing a perfect storm of aggravating factors. Industrial development has resulted in a slow decline, later exacerbated by whale captures for aquaria. Pollution in the form of PBDEs and PCBs have invaded the waters of the Salish Sea. Heavy boat traffic in the straits where the whales roam may induce stress and behavioral changes, particularly when foraging. Salmon runs are increasingly non-existent, with dams and culverts blocking passage to native streams, fishing depleting populations, and genetic traits weakened by hatchery populations.[37] Southern residents have taken a place in the heart of the Pacific Northwest, but the changes in their natural environment have already heavily impacted them. It is the irony of our relationship with killer whales that in the time we have learned to appreciate them, we may have also ultimately doomed them.

Chapter 3: The Consequences of the Past

"*It is the singular pride of humans to place themselves at the center of a universe they did not alone create*." -Matthew Klingle, author of *Emerald City: An Environmental History of Seattle*

Humans and resident orcas have shared a long and intertwined history in the Salish Sea region, with both arriving around the end of the last ice age, thirteen thousand to fifteen thousand years ago. The events that led to southern resident killer whales' endangered status today are varied and are part of the tale of human developments in the Pacific Northwest (PNW). The resident orcas' story begins with the salmon that first colonized the region. Later, as human civilizations spread across what is now Oregon, Washington, and British Columbia, orcas would be affected by the whims and practices of their land-based neighbors. The first peoples who lived on the shores of the west coast largely did so in harmony with the land's natural rhythms; however, their way of life was transformed by the newcomers that arrived later. As people altered the habitat that salmon depend on, flushed their sewage into streams and rivers, and treated the ecosystems of the Puget Sound as limitless enterprises, they wound up depleting killer whale populations. The effects of the extractive industries which began in the region in the 1800s still resound in animal populations and ecosystem health two hundred years later.

By the end of the last ice age, much of the PNW was shaped as it is today. The glaciers of the early Pleistocene had scooped out the fjords of the Sound and formed the lakebeds and valleys of Washington's watersheds. Later, glacial retreat added the final touches to the landscape, when huge moraines, or leftover piles of glacial debris, formed the islands of the Puget Sound. As historian Matthew Klingle wrote:

> "the last ice sheets, the scientists say, began to retreat around fifteen thousand years ago, one mile every twenty-five years…As [they] receded toward the Canadian Arctic, the irregular topography of present-day Seattle took shape, a crazy-quilt of ravines and hills,

> the tallest almost five hundred feet high, interlaced with skeins of creeks, rivulets, and springs."[1]

Into these emerging watersheds ventured the first of the Pacific salmon, creatures that because of their key role in the region's ecosystems would come to symbolize the Pacific Northwest. Members of the genus *Oncorhynchus* (rooted in Greek 'onkos' for hook and 'rynchos,' nose) seven species comprise the salmon populations that move through the northeastern Pacific: sockeye salmon, coho salmon, chum or dog salmon, pink or humpback salmon, and chinook or king salmon—along with two other species, steelhead and cutthroat trout.[2] Today, as for hundreds of years, Pacific salmon are hailed as an emblem of the region. Residents of Washington are exposed to salmon from a young age: games about salmon life cycles are taught to schoolchildren, smoked salmon is a typical dish at any local event, and salmon migrations are a major draw for locals and tourists alike. Salmon are thrown at Pike Place Market and pictured on Washington's postcards. At the Ballard locks by Lake Washington, visitors can walk down to an underground room and watch salmon swim past the windows through the murky Ship Canal.

Salmon are a key prey species for terrestrial and marine predators such as bears, eagles, seals, sea lions, and dolphins, as well as killer whales. Most *Oncorhynchus* species are anadromous, meaning they are born in freshwater, migrate to the ocean as juveniles, and return as adults to their natal streams to spawn. The majority of Pacific salmon complete this cycle only once, dying naturally in their natal streams after they spawn.[3] But even in death they provide ecosystem services, with their carcasses supplying key marine-derived nutrients to the riparian ecosystems in which they decompose.

One of the first to rely on salmon were the early peoples of the Pacific Northwest. By 1300, people had spread across much of the northwest coast and had formed varying cultural

subsistence practices (Figure 4.1).[4] These early peoples are known to anthropologists as the Puget Sound Salish. Most spoke variations of Salish, or of a language known as Whulshootseed or Lushootseed.[5] Their lifestyles varied by region and revolved around the natural resources tribes had at their disposal. Coastal Salish such as the Songhees, Saanich, and Lummi used reef-net fishing off the coast of the San Juan Islands. Further inland, the Sauk-Suiattle hunted elk in the North Cascades and the Nisqually, near modern-day Olympia, cultivated vegetables and foraged for clams, mollusks, and geoducks on the mudflats downriver.[6,7] For many of these tribes, salmon were vital. Not only could they be relied upon to appear at expected times of year in great abundance, but when caught, they could be cooked and served immediately or dried and saved for times of scarcity.[8]

Also tracking the cycle of salmon were the aquatic neighbors of the Puget Sound Salish, the resident killer whales. As glaciers retreated and salmon colonized the streams, orcas followed, thriving on the natural abundance of the Salish Sea. With so many salmon readily available, pods reached ideal population size, and residents gradually began to drift apart. Some would eventually travel north to Alaska, where they now reside, while others would remain to comprise the groups now recognized as the Salish Sea's northern and southern residents.[*] Like the tribes, the whales developed cultural practices based on their resources; for southern residents, movements traced routes of chinook salmon, the fattiest and largest of the Pacific salmon and therefore their favorite. Author Jason Colby describes their annual patterns:

> "in the early spring, [southern residents] fed off the Sacramento River, where some one million chinook returned each year to spawn, and then moved north, gorging on Columbia River runs four times as large. Summer brought them to Haro and Rosario Straits off the San Juan Islands, chasing salmon bound for the Fraser River. If hunger beckoned, they turned to Puget Sound, catching chinook off the Duwamish River and

[*] Alaskan resident killer whales are more closely genetically related to NRKW than SRKW, potentially because of occasional interbreeding.

chum headed for the Skagit, before heading back to the Columbia for its autumn runs of chinook."[9]

Figure 4.1. *Native populations along the coast of Washington State and British Columbia*. Adapted from Salishan Languages Map in Barbara Brotherton (ed): S'abadeb, The Gifts, Pacific Coast Salish Art and Artists. Seattle: Seattle Art Museum and University of Washington Press, 2008: xix. www.burkemuseum.org/blog/coast-salish-people-languages

Both orcas and salmon feature heavily in Salish legends, as do many other creatures.

Salish tales reflected the peoples' reliance upon and esteem for their natural surroundings.

Animals were regarded as people who had been changed to other shapes and who commanded

respect because they supplied the tribes with food.[10] The Salish peoples had stories of prideful young men who disrespected salmon and suffered consequences, or of times of famine where tribes desperate for food would barter with tribes for the return of salmon runs.[11] Meanwhile, orcas acted as heroes and villains—in one instance, Snohomish tribes praised transient killer whales for killing the sea lions that were taking all the salmon at the Snohomish River mouth. In other stories, orcas were the sources of destruction, taking all the fish or blocking a river from reaching its tribe.[12] One popular story detailed the process of making thunder. A supernatural raptor, called Thunderbird, had the ability to lift Killer Whale from the sea. When Thunderbird flew over the mountains and dropped Killer Whale, the cracks of thunder that resounded throughout the Puget Sound were created (source).

Above all, an element of respect characterized the Salish people's dealings with the natural environment. Their tales reflect an understanding that they were integrated into, and dependent upon, the resources that nature provided. This land ethic was also present in the way tribes named local places. Place names took root in the natural attributes or purposes of an area. For example, "a sand spit jutting into Elliott Bay through the muddy tide flats, near where the stadium for the Seattle Mariners baseball team stands today, was called Little Crossing-Over Place. A bend in the Duwamish River lined with Oregon ash trees was named Much Paddle-Wood, and another curve just downstream [was] called Lots of Douglas Fir Bark…Names described the turn of the seasons and the flow of the waters, times to fish and to burn forests to cultivate salal, berries, or camas bulbs, or to stake nets to catch flying waterfowl."[13] A few of these names can still be found on Washington's maps. Nisqually originated from the tribal name—originally Squally-absch, 'the people of the grass country.'[14] Duwamish—originally

Dkhw'Duw'Absh, 'people of the inside,' or 'inside the bay people'—still designates the highly polluted Duwamish River that runs beside the Seattle-Tacoma airport.[15]

In these cultures, there was none of the duality between civilization and nature that characterized settler colonial society in later years. The Salish tribes, like any other population in the ecosystem, lived in a natural structure of checks and balances. They were no different than the killer whales roaming the Pacific or the salmon slipping through the eddies of the streams. Their survival depended on the well-being of everything around them, from the microorganisms in the streams to the herring that fed the salmon, to the soils in which their vegetables grew and the insects that fueled the bottom of the food chain. Billy Frank Jr. summed up the perspective often reflected in these long-historied cultures: "the sun and the stars, the water, the tides, the owls, the hawks flying, the river running, the wind talking…[are] measurements. They tell us how healthy things are. How healthy we are. Because we and they are the same."[16]

In the next hundred-and-some years, Billy's measurements would come to indicate a precipitous change in the environmental health of the PNW. The debilitating sequence of events began in the late 1700s, with several interruptions to the time-derived rhythms of the coastal Salish peoples. First, in 1774, the Spanish ship *Santiago* sailed into British Columbia's Nootka Sound, where the Nuu-chah-nulth tribe warily greeted them. The exchange passed uneventfully. Previous vessels had steered past the coast, including Sir Francis Drake's in 1579 and Danish adventurer Vitus Bering's in 1730, but none—or very few—had stopped and conversed with the native peoples there until the *Santiago*. Four years later, James Cook's expedition weighed anchor in the same makeshift harbor and bartered for furs with the Nuu-chah-nulth, accepting the first of many otter pelts that would pass hands between the Puget Sound Salish and the incoming

explorers. Cook's crew later sailed into Chinese ports to sell the furs, yielding a tidy income. It was a profit-based interaction, an indication of years to come.[17]

But the ships that would arguably make the greatest impact on the region arrived in May 1792, with British Captain George W. Vancouver leading the way. Vancouver arrived at the northwest coast around the same time as Robert Gray of the U.S. merchant vessel *Columbia Rediviva*. Both would lend their names to areas along the coast, with Gray christening a harbor that would become a major whaling port in the 1800s and Vancouver the inspiration for the Canadian city some miles north of that harbor, Vancouver B.C. The great Columbia River was dubbed after the *Columbia Rediviva*, while Mount Rainier and Puget Sound honored Vancouver's comrades, Rear Admiral Peter Rainier and Lieutenant Peter Puget.[18,19] Like those who followed them, Vancouver and Gray saw the Northwest as an enterprise. To them, the land was an empty slate—the places that natives had crafted names for were inconsequential, and the Pacific Northwest was open for newcomers to develop as they wished. Likewise, the British and Americans viewed the Puget Sound Salish as insignificant obstacles to the land they desired, mere temporary beneficiaries of a land that would soon be under a more powerful rule.

The names on Washington State's maps today invoke the battles that were to follow. Mount Rainier, Puget Sound, and the Columbia River still bear the names of those first visitors to the region. Helen Hunt Jackson, a harsh critic of U.S. policy regarding Native Americans, commented, "There seems a perverse injustice in substituting the names of wandering foreigners, however worthy" in place of the names given by the people who lived and relied on these areas for thousands of years before foreigners arrived.[20] Those names that remain, such as Samish, Snohomish, Lummi, Quileute, Muckleshoot, and Snoqualmie, among others, represent cultures afflicted by tragedy, but by no means beaten by the events of the past. Many tribes still play a

crucial role in protecting the ecosystems of the northwest, staunchly defending their lands and using their unique tribal status to halt further harm to wildlife.

At first, settlers and native peoples generally regarded each other with cautious well wishes. Vancouver's arrival had marked the start of a steadier flow of newcomers, with many seeking fortunes in the natural abundance of the region. Trade for furs became common practice—when ships sailed by, canoes full of pelts, fish, and other resources paddled out into the saltwater, ready to peddle goods. But the contact with foreigners had disastrous, unintended consequences for the native peoples. In the late 1700s, the first of the 'virgin soil epidemics' hit in the Salish Sea region. "The exact origins of the first smallpox outbreak remain unclear, but for the next hundred-plus years, cycles of disease reduced the Native peoples of Puget Sound by as much as two thirds, perhaps even more."[21] For the Nisqually, "smallpox, measles, ague, and tuberculosis [largely caused] the precipitous drop in Nisqually tribal population from about 2,000 in 1800 to fewer than 700 in the 1880s."[22] Many tribe members already bore marks of these diseases when Vancouver arrived in 1792, and sicknesses would continue to run rampant through the tribes until the 1900s.[23]

Despite reductions in numbers due to disease, natives still outnumbered British and Americans in the Puget Sound region in the mid-1800s.[24] But the half century that had passed had wrought many changes in the day-to-day life of the people in the region. Americans from New England and New York had begun to arrive in the early 1800s, with merchants and fur traders leading the way by sea and missionaries following over land.[25] The otter pelt craze that had started with James Cook's enterprising crew in 1778 had died down, likely because otters, hunted to scarcity, were harder to find. It was not a significant drawback for hunters—there were

other furs to be traded for, such as the herds of deer and elk that roamed the prairies and the bobcats and lynxes that stalked the forests.

Moreover, there was much to be gleaned from the sea, and settlers soon turned to marine creatures as a new source of profit. The plentiful whales that naturalists since Georg Stellar, travelling with Vitus Bering in 1774, had watched admiringly, were the first to grab the attention of newcomers. Humpbacks provided the easiest prey, with their slow, meandering swimming patterns close to the surface of the water. Whalers employed the Makah tribe of Cape Flattery in Washington State, who had historically hunted whales, including orcas. Marine explorer Charles Scammon recorded that the Makah prized the flesh of orcas over other whales; however, because of their speed and relatively small size, orcas were not a principal target for Salish Sea whalers.[26,27] The year 1844 marked a climax in whaling, with a few hundred whaling ships roaming the northwest coast.[28] Later, as humpbacks vanished and other whales proved too difficult to catch, the northern fur seal would become the new target of pelagic harvesters.[29]

Meanwhile, during the 1830s, a lag in the fur trade had prompted the Hudson's Bay Company to establish the beginnings of industrial farming, fishing, and logging operations. The Company had also built several trading stations, including Fort Nisqually by the Nisqually River mouth and Fort Victoria on Vancouver Island, which helped advance the nascent timber towns forming near them. However, the Hudson's Bay Company had a rooted conflict of interest with many new occupants of the Oregon Territory flowing in from the east: namely, that it was affiliated with British rule. To American settlers, the Northwest was raw, primitive land waiting to be taken and civilized, as had been done with the east coast. But first, the property had to be lawfully gained by the federal government.

An 1818 agreement between Britain and the U.S. had established that the Oregon Country, which at that time included Washington, was to be jointly occupied by both nations, but the concept of manifest destiny—the inherent duty to keep spreading westward—had taken over the hearts and minds of the citizens of the young United States. In 1838, the U.S. government decided to assert its dominance, sending the U.S. Exploring Expedition "to reconnoiter the jointly claimed lands north of the Columbia River, and then to circumnavigate the globe in a show of naval power."[30] Tensions built until 1846, when Great Britain, sensing its disadvantage, yielded the Pacific Northwest to the U.S. and withdrew north past the 49th parallel.

The retreat of Great Britain marked a shift in mindset for Americans in the Puget Sound region, one that would have far-reaching implications for the native peoples of the region and for the Salish Sea ecosystems with which those people had co-existed for 12,000 years. Without Britain in the way, only the tribes stood as obstacles to American land claims in the Northwest. As settlers had slowly moved into the region, Salish tribes had often helped them by providing boons and gifts of food, and as late as the early 1850s had contributed to the development of sawmills and dams, providing the economic backbone in what were still tiny timber towns. However, as more settlers flowed in, native peoples' contributions went unrecognized or were seen as signs of submissiveness to the newcomers. "To [Indians], mills and dams were proof of the Bostons' commitment to provide for their neighbors, but as more and more came to Puget Sound, the Americans' entrenched notions of racial superiority and Indian inferiority subverted pre-existing and fragile diplomatic arrangements."[31]

The Washington Territory, which stretched east from the coast to modern-day Montana and south through parts of Oregon, was established in 1853 and marked the shift in attitude between settlers and natives. Increasing racial prejudice allowed for immoral manipulative

subjugations by the U.S. on the land's original inhabitants. Native peoples, having been established "from the beginning of the republic…as dependent sovereign nations," had a legal right to the land they inhabited.[32] Therefore, in order to obtain land in the Northwest, the U.S. needed to have the Salish tribes sign over their property. Treaties were essential to the legal process, turning "'unclaimed' land into public domain, which could then become private property, thereby avoiding a legal mess for the federal government."[33]

In 1854, the practice of treaty-making began, spearheaded by the first governor of the Washington Territory, Isaac Stevens.[34] These treaties were often unfair, placing tribes on small reservations close to fledging industries, so that they could conveniently (for settlers) continue to work for the growing companies in Seattle and nearby settlements.[35*] Tribes were, however, given the right to continue fishing, hunting, and foraging "at all usual and accustomed grounds and stations."[36] It was an addition to the treaty that Stevens knew the tribes would not sign without—one that was not honored by the U.S. government until years after the treaty was signed, and one that would come to be important decades later, in fiery battles over tribal rights.

By 1860, almost all native peoples in the Territory of Washington had been relegated and moved to reservations. [37] The next four decades were a new era for the Pacific Northwest, one in which homesteaders, engineers, and entrepreneurs capitalized on the resources of the region, in particular its land, timber, and wildlife. Economic potential was tangible, and settlers raced forward to take advantage of it. In the 1850s, several sawmills opened, including one in Seattle and one in Port Gamble, and operations sped into the next decades. Sawdust and woodchips were spat from these mills into the tidelands surrounding Elliott Bay. Homesteaders seeking more

[*] Treaties were often negotiated in the Chinook jargon—a mixture of English, French, and Salish that amounted to some 500 words total—and often set tribal reservations in unfair locations. For instance, the Nisqually tribe, a prairie and river people, were put on a two square-mile plot on top of a cliff, where they could not reach the prairie or the river.

waterfront property mimicked this practice, filling tidelands in order to extend their land rights further into the bay. By the 1880s, Elliott Bay was clogged with sawdust and effluent.[38]

Figure 4.2. *Elliott Bay, Beacon Hill, and Lake Washington*. Figure by Chris Goodman. Accessed November 23, 2018, www.historylink.org/File/3004

Meanwhile, property owners called for dikes and drainage districts to prevent their land from being flooded every winter. Farmers along the Duwamish built feeble dikes which were quickly swept away by floods, while landowners at the tip of southern Lake Washington attempted to channel Cedar River into the lake. Their prayers were answered in 1891, when Washington Territory governor Eugene Semple proposed a canal funneling through Beacon Hill from Elliott Bay to Lake Washington (Figure 4.2). Canals had been attempted before—one, between Lake Union and Lake Washington, had been drudgingly ground out from 1861 to 1885 to provide transport to and from the coal mines south of Lake Washington (Figure).[39]

With growing anticipation of the 1897-98 Klondike gold rush, Seattle became a madhouse of developments that opened a flow of pollution and induced degradation in the waters of Puget Sound. Seattle of the late 1880s was a 'roughneck Venice' that in 1889 burst into flames, providing the chance to re-build the city from the ground up. City engineer R.H. Thomson designed a combined stormwater-and-waste sewer system in 1894, and the year before, the Great Northern Railroad had forged its way west to reach Everett, then Seattle. During this time, Semple's canal plan had awaited approval. He finally began work on the canal in 1895, but quickly ran into trouble. Public favor turned toward different canal routes, and after dredging

some “two thousand feet of waterway and filling seventy acres of tidelands,” by 1903 “all that remained of Semple’s dream was a gash in the side of Beacon Hill.”[40]

> Modifications to the landscape continued, and by the beginning of World War I,
>
> dredges and steam shovels were slinging dirt and mud along almost every river and lake in urban Puget Sound. In the span of almost five years, engineers rerouted the plumbing of an entire drainage basin. It was as if someone pulled a plug and a giant sink emptied. When corps contractors completed the Montlake Cut and the locks at Ballard in the summer of 1916, Lake Washington poured into Lake Union, dropping the water level around the lake by almost ten feet in three months. With the new Lake Washington Ship Canal, sloughs along the Sammamish River on the eastern shore dried up and marshes emerged from open water in Union Bay, near the Montlake Cut. As the waters receded, houseboats and businesses on Lake Washington found their sewer outfalls dumping onto exposed mudflats.[41]

All of a sudden, the Puget Sound was a different place than it had been a decade before. Engineers completed the work that farmers a half century before them had attempted: they turned the Cedar River, which before emptied into the Black River, into Lake Washington. But without water from the Cedar River, the Black River dwindled and within a year had dried up. It was not alone: the Duwamish, too, had been steadily reduced by the re-channeling of its tributaries, along with increased water demand (Figure 4.3). Seattle’s waterfront had undergone a similar transformation during the city’s frenzy of developments. “In 1890, an apron of salt-encrusted mud and rocks hemmed in the city twice daily. Ten years later, warehouses and wharves sat where the tides had one flowed.”[42] By 1910, Seattle’s population stood at 237,000, an increase of over 200,000 people from 1880.[43]

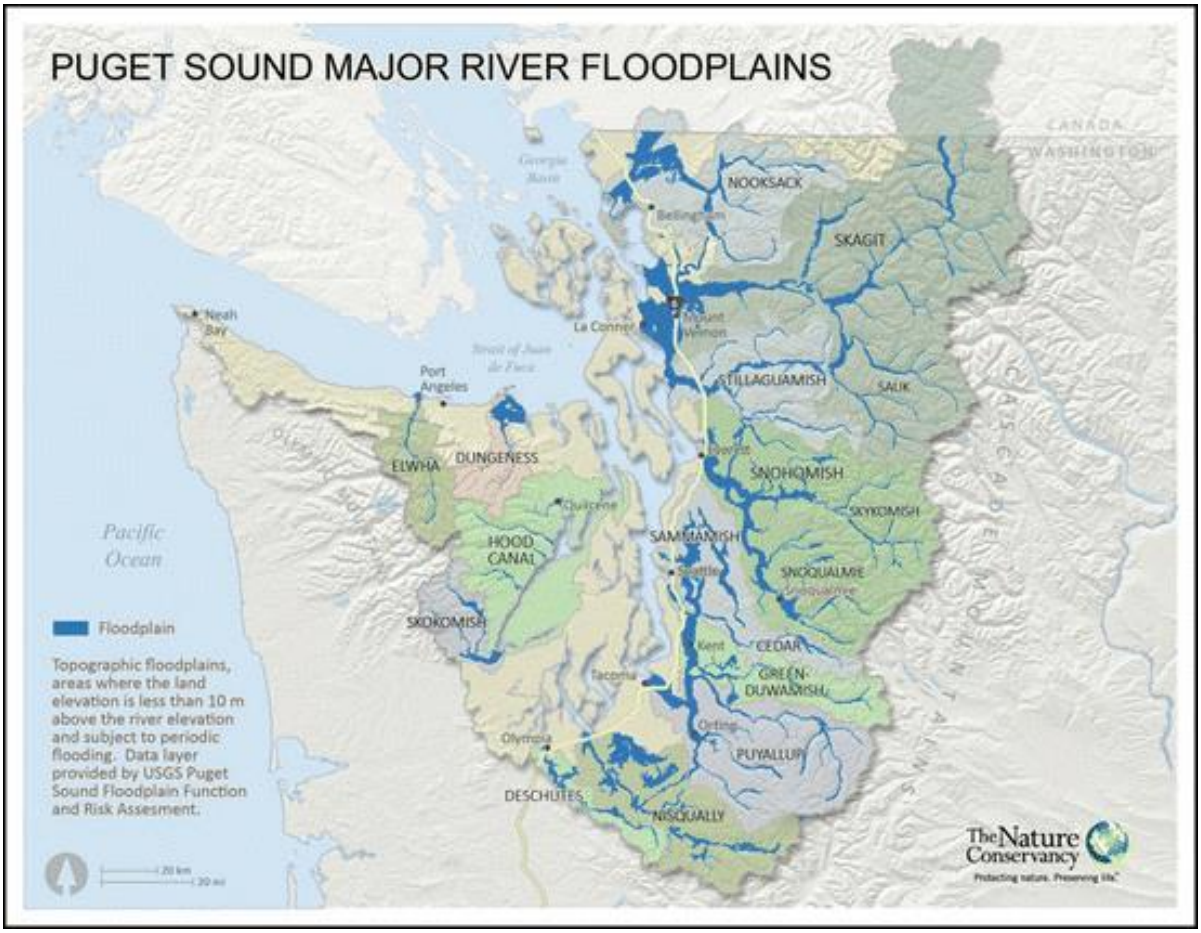

Figure 4.3. *Watersheds of Washington State's Puget Sound region*. Accessed November 20, 2018, https://www.eopugetsound.org/magazine/is/floodplain-projects

These broad-sweeping changes had not occurred without impact on the natural systems of the Puget Sound. Salmon populations had dwindled sharply—lack of snags and straightening of rivers deprived them of shady resting spots and handy hiding places from predators. City officials had blocked the Cedar River headwaters from spawning salmon out of fear that their carcasses would contaminate Seattle's drinking water, and the new Ship Canal confused salmon looking for their natal streams. Sea lions feasted at the mouth of the Ballard locks on young salmon struggling seaward, while adult salmon heading inland were forced to tackle the salmon ladder to reach their spawning grounds. Other dams blocked spawning grounds completely and made downstream flows sluggish and warm—a deadly combination for salmon (scientific

source). Water pollution was also impacting salmon. “Sawdust from lumber and shingle mills turned waters anoxic, robbing salmon and their eggs of vital oxygen; shipyards and marine shops dumped oil, gasoline, and by-products from welding and painting—lead, mercury, and other heavy metals—into the waters; and sewers discharged raw sewage or, when storm drains were overwhelmed by rainwater, untreated runoff from city streets and homes.”[44]

The years during and after World War II in particular marked a downturn for Pacific salmon. “The demand for protein to feed Allied armies resulted in intensified fishing throughout British Columbia waters. Amid this boom, the shared world of fishermen and orcas was changing. The surge in fishing reduced not only salmon but also herring—the key species on which chinook and other salmon relied…The decline was most evident in the Columbia River, where chinook numbers were crashing by the late 1940s.”[45] Dams constructed in the 1960s and 70s along the Snake River, which emptied into the Columbia, also factored into salmon decline. Increased pollution in the small streams that coho frequented made them more prone to falling ill to toxins, and in other, larger rivers such as the Duwamish, contaminant loads were simply too concentrated for fish. In the 1950s, eutrophication in Lake Washington prompted city officials to turn sewers from the lake into the Duwamish Waterway. But by 1960, multiple Sportsmen Councils in the area were noting the consequences—“rafts of dead salmon, trout, sculpin, and other fish pooling in the river’s eddies.”[46] Meanwhile, artificial propagation of salmon eggs through hatcheries was met with varying success, and a growing body of evidence in the 1970s and 80s suggested that hatcheries may in fact be harming, rather than helping, wild salmon populations because of genetic mixing between hatchery and wild populations.[47]

What impacted salmon, particularly chinook, also affected the region’s orcas. Pollution, dams, and habitat loss affected salmon runs to the extent that in some rivers in the late 1900s,

runs had dropped to a quarter of their numbers from the early 1800s.[48] Orcas had developed their movement patterns over hundreds of years to follow chinook salmon abundance along the west coast; with human arrival and subsequent overfishing, pollution, and habitat destruction, salmon populations, and consequently orca movements, were thrown off-rhythm. Colby suggests that the drop in Columbia River runs, which orcas typically attended in spring and fall, may have prompted whales to rely more heavily on the Fraser River. It also likely impacted their mortality rates and reproductive success. As late as the 1870s, when settlers were building sawmills and filling tidelands, southern resident orcas may have numbered up to 250. By 1950, they had fallen to 150, and numbered around 100-120 in the 1960s.[49]

It was during this emerging struggle between the demands of development and the needs of southern resident killer whales that Sea World began to capture orcas in the Salish Sea, taking another 47 orcas from the population.[50] Reduced numbers were compounded by other modern aggravators. Today, southern resident decline is mainly attributed to three factors: 1) environmental pollutants such as POPs, PCBs, and PBDEs, 2) disturbances from vessel traffic, including cargo shipping, whale-watching, and recreational vessels, among others, and 3) limitations in food sources. Most resident killer whale experts agree that food shortage is likely the most prominent cause of decline, but that different factors also interact at varying degrees—for example food shortage enhancing the effects of contaminants, or reduced foraging exacerbated by food limitation. With the southern resident population dropping by 16 whales since 2006, including three deaths in a four-month span in spring and summer of 2018, scientists have frantically been examining and working to mitigate the problems that these orcas face.[51]

Chapter 4. Struggling sovereigns

Measures taken to protect killer whales in the northeastern Pacific have historically moved slowly and have required years of research to push them forward—from the 1976 Washington state moratorium on live captures to the whale-watching guidelines established in the 1980s and 1990s. But protective actions have accelerated as population viability predictions for southern residents have become increasingly dire. In August 2018, Washington state Governor Jay Inslee pulled together the Orca Task Force, a group which, in the span of three months, would put forth recommendations for helping the whales.

After being subject to public review and comment, and subsequent revisions by the Task Force, the final set of recommendations was published on November 16, 2018. The report included a summation of the bodies of evidence gathered for each of the three main issues that southern residents face. Over the past forty years, studies have documented the dynamics of the current salmon shortages, vessel disturbances, and pollution in Puget Sound, as well as their effects on killer whales. It is important to understand these dynamics in order to prioritize management moving forward.

Prey Shortages

By 1999, salmon numbers had fallen to the point that several species of Pacific salmon, including chinook and sockeye, had been listed as endangered.[1] Natural populations of salmon had dropped from the late 1800s to mid-1900s, with some runs declining to less than a quarter of their original size.[2] Hatcheries, which became widespread in the 1950s and 1960s, substantiated some runs but were unsuccessful in others.[3] As of 2008, 30 out of 49 Evolutionarily Significant

Units (ESUs)* of wild Pacific salmon in the western U.S. were listed as endangered or threatened or were candidates for listing under the ESA.[4,5]

The chinook or 'king' salmon were one of the most heavily affected species and are now the least common of the Pacific salmon.[6] In 2008, over half of all chinook ESUs were listed as endangered or threatened, and most are still at historically low numbers.[7] This is particularly problematic for resident killer whales, as chinook comprise around 80 percent of their overall diet and may account for over 90 percent of southern residents' diet in the summer.[8,9] Studies since the 1990s have documented resident killer whales' preference for chinook salmon, likely because of its large size and high lipid content.[10] However, many of the Puget Sound region's once-flush chinook runs have dwindled to almost nothing. For instance, the Fraser River's runs have been reduced from an estimated 750,000 to under 280,000. Likewise, the Columbia River, which in the late 1800s supported runs of some five to nine million chinook, has now been diminished to runs of under 700,000.[11]

The absence of the Columbia's abundant runs, especially in the spring, likely has drastic impacts on southern resident killer whales, who rely on the Columbia runs to survive the last throes of winter.[12] The spring runs in the Puget Sound have also declined, meaning that even after the whales return to their summer range, they cannot immediately replenish their energy stores (NMFS 2008). It is possible that during these months of chinook shortage, particularly spring and fall, southern residents have adjusted their diets to include a wider variety of species. For instance, Hanson et al (2010) noted that steelhead were eaten more in May and September than during summer months—in May nearly equaling chinook—and Ford et al (2016)

*ESUs are defined by NOAA as "a Pacific salmon population or group of populations that is substantially reproductively isolated from other conspecific populations and that represents an important component of the evolutionary legacy of the species."

documented a late summer increase in feeding on coho salmon.[13,14] However, steelhead and coho are both typically smaller than chinook, reaching only 30 to 40 pounds while chinook may grow up to 135 pounds.[15] Therefore, southern residents achieve a lower amount of food intake for the energy spent foraging on steelhead or coho. This, along with smaller chinook sizes in recent years, and a tendency among resident killer whales to forage across greater areas during periods of chinook shortages, indicates that southern residents are experiencing large energetic costs in their daily lives.[16,17]

Chinook may be suffering high rates of decline because of their life history traits and habitat requirements, which are unique among Pacific salmon. Chinook, unlike coho or chum, prefer to spawn in large rivers and bury their eggs in gravel beds along deep stretches of water.[18] This means that they are more inclined to rely on the rivers that humans harness for hydropower, in the process effectively blocking salmon spawning habitat. Those chinook that do manage to spawn leave their young to face the challenges of altered waterways. Chinook fry tend to stay in their natal streams for up to one year, and during that year, they survive best in streams with multiple channels and ample cool, shady resting places, along with adjacent floodplain and tidal habitat where they can take refuge from fast currents and predators.[19] Chinook from streams with bountiful floodplain habitat have been shown to reach larger sizes and have higher survival rates than chinook from streams with no adjacent floodplains.[20]

However, floodplains and tidelands were not popular among early settlers in the region, who immediately began changing the geography of those areas to fit their needs. Soggy land masses did not adhere to these homesteaders' visions of ideal real estate or farmland—thus began the dumping of sawdust effluent into Elliott Bay and the construction of flood-prevention canals south of the Duwamish.[21] Now, studies estimate that "Puget Sound has experienced [a] 77

percent loss of vegetated estuarine tidal wetlands from natal chinook deltas, and in some cases as much as nearly 100 percent loss."[22] The Columbia basin has experienced a similar loss, with "68-70 percent of its tidally influenced floodplain wetlands that provide critical foraging and rearing habitats for migratory chinook" having been developed or altered.[23]

Such dramatic landscape alterations, by virtue of reducing chinook populations, have also influenced southern resident killer whales. Chinook abundances correlate strongly with resident killer whale survival rates and reproductive success.[24,25] Wasser and Lundin (2017) linked recent southern resident killer whale miscarriages to food shortages.[26] On average, an adult orca consumes 325 pounds of fish daily—anywhere from 21 to 39 chinook, depending on size, or 40 or more for a smaller species.[27,28] A pregnant female should eat four to five percent of her body weight.[29] Recent estimates place the southern resident population's nutritional needs at 662 chinook daily.[30] But chinook simply do not exist in the numbers they did a century ago, or even half a century. Southern residents are roaming the waters of the Salish Sea, seeking the prey that has always roamed with them, but dams, habitat loss and overfishing have reduced that prey nearly into non-existence.

Fishing battles began to occur in the 1920s between sport anglers, commercial fishermen, and subsistence fishers as the decline of fish became apparent. Sport anglers, angry at the reduced fish numbers, argued that commercial and subsistence fishers—which included members of Salish tribes—were taking too many fish. Unsurprisingly, when the issue was brought to court, the predominantly white, middle-class sport anglers won out, causing regulations to be put on other fishers.[31] In the 1940s through 1970s, hundreds of native subsistence fishers, who by treaty terms had the right to fish in all usual and accustomed places, were arrested and put in jail for fishing the streams their ancestors had lived along for hundreds

of years.[32] It was an injustice that would be corrected in 1974 by Judge George H. Boldt, who ruled that all tribes could take up to half the catch in their traditional streams.[33]

But the issue of fish remained heated. For many Seattleites, the 1999 endangered listings hit home that fact that developments in their city had killed off a significant portion of the salmon in which they took so much pride—the alleged icons of the PNW. Tideland-filling and floodplain-altering were not the only activities to impact the fish:

> More than a century of commercial and sport fishing in local rivers, Puget Sound, and the ocean had diminished salmon numbers, especially the chinook or king salmon, which was prized for its fighting abilities and its sweet flesh. Reliance on artificial hatcheries only worsened the problem by diluting the genetic vitality of wild populations… When salmon did return [to spawn], they sometimes could not find their streams. Storm sewers or culverts entombed creeks. Loggers and bulldozers hauled away the forests that kept spawning streams cool and young fish hidden from predators. Lakes and rivers became sinks for household waste and industrial pollution. Dams that generated electrical power or impounded water to irrigate farmlands also chewed up juvenile salmon in their turbines and penstocks…Shopping malls and subdivisions, floating on tides of concrete and asphalt, smothered estuaries beneath parking lots and pavement.[34]

Mitigation and Protective Measures

But when those who felt remorse for the salmon began to take action, they were met with conflicts of interest from others whose lives revolved around the developments that were now being condemned for their impacts on salmon. In the 1990s, environmentalists in Seattle, seeking to boost salmon runs, advocated for the removal of the lower Snake River dams constructed in the 1930s and 1940s.[35] By 2000, they had convinced the Seattle City Council to pass a resolution to remove the four dams. Predictably, farmers in eastern Washington, who needed the Snake River water for their crops, did not take kindly to the resolution. "The caustic replies from state representatives, whose livelihoods depended on irrigated agriculture, took many liberal Seattleites by surprise. One resident from Wenatchee, the apple-growing capital of the Northwest, called Seattleites 'sanctimonious hypocrites' and said they should demolish Ship Canal, since 'there was no salmon run through the locks before the locks were built.'"[36]

The economy built around these dams prevented a repercussion-free removal: if they were taken down, farmers lost their jobs, and if not, salmon lost their lives. The best the state could do was install fish ladders and screens, ways for the fish to pass by the dams without certain death awaiting them. A similar case to the Snake River dams existed in Washington state's road culverts, which in many instances were too small or were blocked by effluent so that salmon could not move through them. But in this case, salmon had a powerful set of supporters on their side: eleven western Washington tribes, who by a 1980 court decision had the right to protect salmon habitat.[37] In 2001, the U.S. government sued Washington state on behalf of these tribes, mandating that the state fix its ill-made culverts.[38] The decision was challenged in 2017 by Washington state Attorney General Bob Ferguson, who voiced concerns about the legal implications of the decision, as well as the cost. The estimated 3.7 billion-dollar price tag of the project would be shouldered by Washington taxpayers, when the shoddy culverts were in fact installed under faulty federal—not state—standards.[39] Additionally, Ferguson argued, the right for tribes to demand culvert improvements on non-tribal lands implied a right to numerous other demands, and someone needed to draw the line.[40]

But in June 2018, the Supreme Court upheld the Ninth Circuit ruling with a tied vote.[41] The culvert improvement program will continue in Washington, with project managers prioritizing streams most important to salmon. However, while this will mitigate some salmon runs, culverts are ultimately a fraction of the problem.[42*] Scientists are demanding more dramatic measures to help salmon reach the sea so that southern resident killer whales can attain enough food to reproduce. A recent letter to Governor Jay Inslee in October 2018 repeated the plea of Seattle environmentalists nearly 20 years ago. The letter, signed by multiple killer whale experts,

[*] Culverts affect an estimated 200,000 salmon—a small fraction of the annual fishing harvest.

called for the breaching of the four dams along the lower Snake River (Figure 5.1). At this point, it may be the only sufficient quick-acting move that can save southern resident killer whales from extinction. The letter suggested immediately spilling more water over the Columbia and Snake River dams and initiating removal processes on the Snake. "We believe that restoration measures in [the Snake and Columbia] watershed are an essential piece of a larger orca conservation strategy," they wrote. "Indeed, we believe that southern resident orca survival may be impossible to achieve without it."[43]

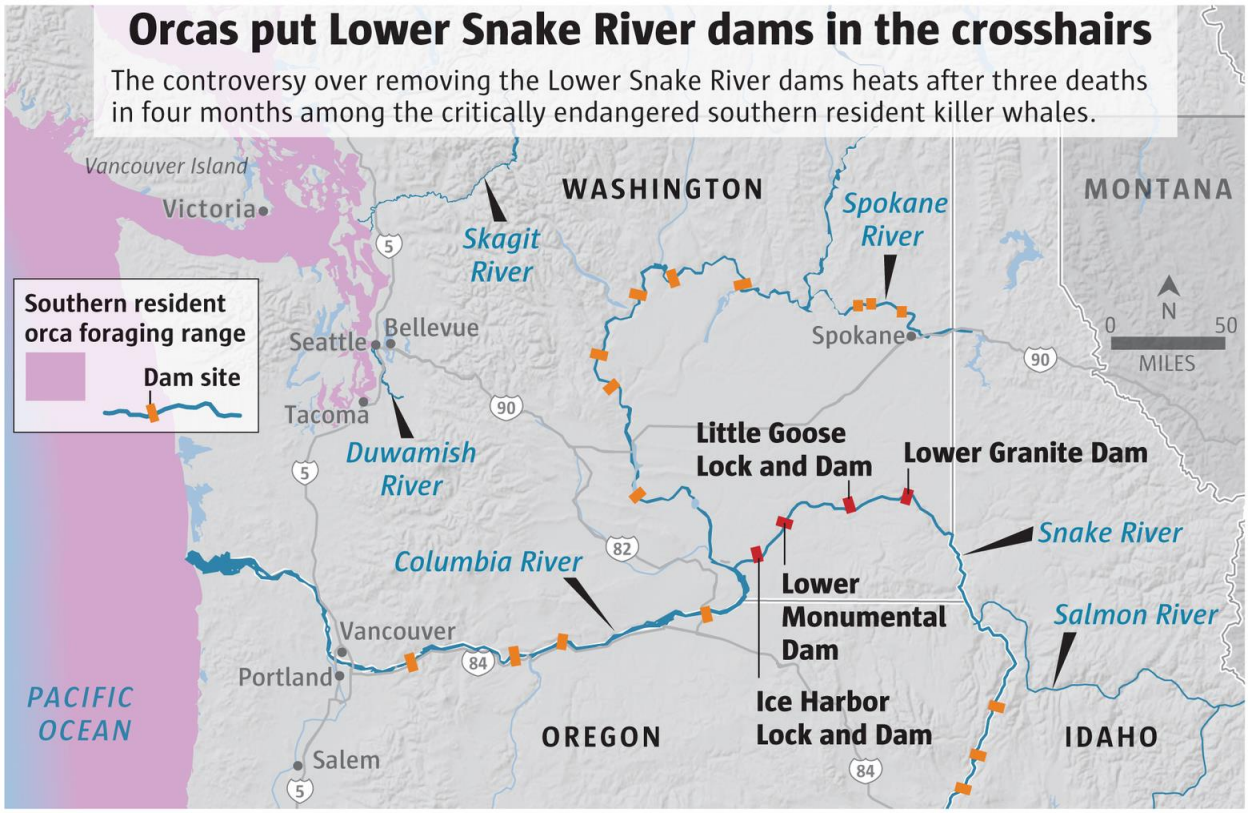

Figure 5.1. *Dams along the Lower Snake River, the Spokane River, and the Columbia River*. Figure by Mark Nowlin. From *The Seattle Times*, "Orca survival may be impossible without Lower Snake River dam removal, scientists say," October 15, 2018, https://www.seattletimes.com/seattle-news/environment/orca-survival-may-be-impossible-without-lower-snake-river-dam-removal-scientists-say/

While the Bonnevile Power Administration (BPA)—a nonprofit federal administration that markets the hydropower from over 30 dams in the PNW, including the Snake River dams—

is pushing back, the time has come when action is critical.[44] The southern resident crisis is reaching a crescendo: either the orcas will persist through the next generation and recover, or they will vanish within the next hundred years. Ken Balcomb, director of the Whale Research Center in Friday Harbor, summed it up: "If the southern residents don't get food fast, they will keep losing mothers and their babies…Then it's over. You will still have whales going around, but it will just be a few grandmothers and old guys. The population will be functionally extinct."[45]

Scientists hope that spilling water from behind the dams will push enough fish through to satisfy orcas at the mouth of the river in the coming spring seasons, when adult chinook will be returning to spawn. The 'spilling' process is the safest way to move juveniles through dams. Pooled water from behind the dams is shifted into spillways that allow salmon to pass through easily, as opposed to risking their lives dodging turbines or exhausting themselves in elaborate re-routing systems.[46] This will provide fish for the transition period while Snake River dams are breached. It is no small decision. Either the economy takes a hit and farmers in southeastern Washington lose their livelihoods, creating a potential for massive in-state political tensions, or the southern resident killer whales almost certainly disappear.

Meanwhile, state Governor Jay Inslee has created a Task Force for Orca Recovery which in November 2018 released an official set of recommendations for helping the southern resident killer whales (Table 1). While the task force refrained from recommending removal of the Snake River dams—instead putting the issue to a study team—they did support immediately spilling water through the dams. They organized their suggestions regarding salmon into three categories: habitat, hatcheries, harvest, and predation. In particular, they suggested restoring estuarine tidal wetlands and preserving nearshore habitat to boost juvenile chinook survival, as

well as increasing hatchery production of chinook. Strategically-timed releases of hatchery chinook could significantly improve nutrition for southern residents during times of extreme shortage, while restoration of habitat would help lift numbers in wild populations.

Another short-term strategy for helping southern residents involves eliminating other salmon predators such as sea lions. Numbers of sea lions have grown exponentially as a result of human constructs that make salmon easier for them to catch, as well as prohibition laws on hunting. Dams and other stream blockages, such as the fish ladder in Ship Canal, deliver disoriented juvenile salmon straight into the waiting mouths of sea lions. By the Columbia River mouth, some 100 sea lions often gather to collect five to ten percent salmon out of the already heavily-reduced runs.[47] Thus, while some researchers such as Balcomb think this strategy "is a knee-jerk response" and instead promote a natural rejuvenation of the ecosystem, the numbers sea lions have reached are certainly not entirely natural.[48] In the Columbia River, government officials have euthanized several sea lions after more humane methods, such as transporting them to other, less troublesome locations, proved ineffective.[49]

Table 1. Orca Task Force recommendations for improving chinook salmon habitat

No.	Department/ Agency	Recommended Action	Funding
1	Recreation and Conservation Office (RCO) Department of Ecology (ECY)	-Increase funding to restore estuaries and acquire habitat in the Nooksack, Skagit, Stillaguamish, Green-Duwamish, Puyallup, Chehalis and Columbia River, as well as others important to chinook -Continue culvert improvements	-From legislature; create a new funding source for habitat protection and refund counties for land used in restoration
2	None specified	-Restore habitat important to forage fish (the preferred prey of chinook salmon)	-From legislature; fund already-approved 2018 programs
3	Washington Department of Fish and Wildlife (WDFW), Department of Natural Resources (DNR), Department of Ecology (ECY)	-Increase stringent enforcement and report on existing effectiveness of habitat protection laws, instream flow regulations, and standards for water quality	-Funding for WDFW/ ECY to increase enforcement capacity

4	ECY, WDFW, DNR	-Increase stringency and enforcement of existing legislation that protects chinook and forage fish habitat -Ensure issuance of Hydraulic Project Approvals (HPAs) only occurs with evidence of required permits	-None needed/ mentioned
5	Natural Resource Conservation Service and similar federal agencies	-Motivate landowners to protect stream/salmon habitat on their own volition -Fund cooperative conservation programs	-10-year funding proposal from state and federal agencies by June 2020

Ultimately, the recovery of southern resident killer whales will require multiple overlapping efforts, addressing not only food shortages but also vessel traffic and pollution.

Vessels

Vessel traffic in the Salish Sea began to increase in the late 1800s and early 1900s as commercial fisheries were established and Seattle's population exploded by some 230,000.[50] Motorized boats, introduced in 1903,[51] made fishing easier and more efficient, and rugged northwesterners took advantage:

> Using gas engines and purse seine nets, [Gig Harbor's] plucky Croatian and Norwegian immigrants built a thriving port known for its large salmon catches and custom-built boats. Similar trends came to southern British Columbia, where a rail connection completed in 1886 transformed Vancouver into a timber and fishing hub…On the Fraser River near Vancouver, the town of Steveston became an important fishing center, boasting hundreds of vessels and nearly twenty canneries.[52]

Soon, recreational boaters joined the melee of fishing vessels as Seattle transitioned from an unknown timber town to a booming metropolis. Homesteaders drawn to the region by its beautiful scenery and plentiful resources did not hesitate to enjoy it. By the 1920s, "motorized launches, powered by small and affordable gasoline engines, had opened marine and freshwaters to legions of weekend explorers."[53]

Devoted fishermen lodged themselves and their boats on productive fishing grounds for months at a time. Often, they capitalized on salmon runs between May and October—meaning they shared the waters with killer whales in their summer range, seeking the same prey. Today,

though fishing boats do not congregate in the numbers they did historically, vessel traffic from other industries has increased. The Strait of Georgia and the Puget Sound are two of the most heavily frequented waterways in the world, with thousands of ships passing through each month.[54] In addition, whale-watching tours venture through the southern residents' favorite foraging areas daily in the summer, with trips running from 9:00 a.m. to 9:00 p.m., and boats so constantly surrounding the whales that scientists have never had the chance to study the whales' behavior when boats are not present.[55]

Between 1998 and 2006, as many as 72-120 boats could be observed following the whales, though more commonly boats numbered from 18-26.[56] The whale-watching industry brought in some 13.6 million dollars to Washington state's economy in 1998.[57] Because southern residents typically roam closer to urban areas than northern residents, they are subject to higher rates of vessel traffic, including that of whale-watching operations. Furthermore, because of reduced salmon runs in the Columbia River, southern residents may spend more time in areas of high vessel traffic than they historically would have, such as near the Fraser River.

Motorized vessels pose threats to killer whales in several ways: direct ship strikes—which, though rare, do occur and can cause injury or fatality—stress, which if chronically induced likely affects whales' physical conditions; and sound, which can interfere with the whales' communication and echolocation abilities. Williams and O'Hara (2010) reviewed ship strike occurrences among whales and found that since 1980, one southern resident was killed and two others maimed by ship strikes.[58] However, these numbers may be conservative, because ships may not notice or may not record collisions with whales. In recent decades, whale-watching operations and private speedboats were themselves objects of worry, with

Washington's secretary of state expressing concern that whale calves would be hurt by the engines of careless boat owners.[59]

Of greater concern to most scientists are the cumulative, short-term effects that vessel traffic has on killer whales. Whales tend to move away from boats that have approached within 100 to 400 meters, which in areas of high traffic could result in a three percent or greater increase in daily energy expenditure.[60]Williams et al 2006). In addition, whales in proximity to boats tend to stop foraging and spend more time socializing and travelling. Williams et al (2006) calculated that reductions in foraging behavior when boats are near could amount to an 18 percent loss in energy acquisition daily—or more in areas of heavier traffic. Scientists are unsure if whales change behavior and move away from boats because the vessels act as stressors, [*] or because engines impact hearing ability.[61] If the former, chronic stress, particularly for the constantly-exposed southern residents, could result in lowered immune system function.[62]

Studies have confirmed that engine noises travel long distances underwater and are audible to whales over 15 kilometers away. Erbe (2002) modelled the effects of vessel noise on killer whales and found that boat speed significantly affected noise levels, with faster boats audible to whales up to 16 km away. Within 14 km, engines could mask whale calls; boats as close as 450 m could even temporarily impact the whales' hearing if exposed for more than 45 minutes.[63] In addition, some ships produce noises other than the roar of engines: cargo ships and ferries, for example, sometimes use "high-pitched horns and echoes to guide them through fog and darkness…a simple form of echolocation that nearby killer whales almost certainly [hear] along with the drone of engines."[64]

[*]Ayres et al (2012) examined thyroid (T3) and glucocortinoid (GC) hormone levels in southern resident killer whales to differentiate stress that originated from vessel disturbances from nutritional stress caused by food shortages. They found that GC levels increased and T3 levels decreased consistently with food shortage, but not vessel traffic, indicating that nutritional stress is the primary factor influencing southern resident killer whales.

Other underwater sonar activity, such as drilling, construction or military exercises, almost certainly has similar impacts. In May 2003, whales from J pod were observed acting disoriented after a navy ship passed through Haro Strait while emitting mid-frequency sonar. In another instance, J pod quickly changed direction after underwater detonations near Vancouver Island.[65] Recently, Canadians near Vancouver Island were angered when the U.S. Coast Guard and the Canadian Navy carried out live fire exercises off the coast of the island in an area designated as critical habitat for resident killer whales.[66]

Mitigation and Protective Measures

In 2006, NMFS designated several areas of critical habitat for southern resident killer whales. Essentially, these areas are protected under section seven of the ESA, which mandates that federal agencies cannot "destroy or adversely modify [a listed species'] designated critical habitat" and must "ensure that any actions they authorize, fund, or carry out are not likely to jeopardize the continued existence of a listed species."[67] In other words, designated critical habitat cannot be developed in a way that puts resident killer whales at risk. Other areas off Vancouver Island have been appointed as no-fishing zones, while areas in the San Juan Islands are voluntary no-boat zones, where commercial vessels do not follow whales.[68,69]

Whale-watching guidelines first put forth in the 1980s and modified in subsequent years mandated that boaters stay over 100 m from whales at all times. Several programs monitor whale-watching operators, particularly during months of peak activity, and give companies 'report cards' on their vessels' behavior. Monitoring programs also supervise recreational boaters and inform them of whale-watching guidelines. However, the whales are still surrounded by enough boats that their foraging behaviors may be affected, compounding already-debilitating food shortages. As a result, the Orca Task Force recommended implementing a permit system for whale-watching industries and kayakers that would restrict boat numbers on the water.[70] This

would decrease the levels of disturbance to the whales and could be supplemented with increased emphasis on whale-watching from land.

Particularly problematic in terms of vessel traffic through the Georgia Basin is the proposed TransMountain pipeline that would transport oil barrels in from Alberta and would increase vessels sevenfold. The pipeline, initially approved by the Canadian government, is now being subjected to evaluation due to concern for the southern resident killer whales.[71]

Pollution

Southern resident killer whales have been established as some of the most chemically contaminated marine mammals in the world.[72] Their proximity to the highly urbanized Washington state coast means they swim in waters with high rates of persistent organic pollutants (POPs) and other deleterious chemicals. As of 2008, the Puget Sound region claimed a total of 31 Superfund sites, with 11 of those known to be leaching chemicals into the Sound.[73] POPs such as polychlorinated biphenyls (PCBs), polybrominated diphenyl ethers (PBDEs), and dichlorodiphenyltrichloroethane (DDT), as well as polycyclic aromatic hydrocarbons (PAHs), have emerged as chemicals of concern for southern resident killer whales. Effects of these chemicals in marine mammals range from reproductive impairment to immunotoxicity to hormone disruption (Table 2).

PCBs and PBDEs tend to occur in higher concentrations near urban areas, and accordingly, southern residents demonstrate considerably higher PCB and PBDE levels than the more remote northern residents.[7475,76] Though PCB levels peaked in North America in the 1960s and early 1970s before being banned in North America in 1972, the long biological half-life of PCBs ensures that they persist in the marine environment—and in long-lived killer whales—for generations. In addition, chemicals that have been banned in the U.S., such as PCBs and DDTs, can be transported by air and ocean currents from areas where their use is still prevalent, in

particular from Asia to the Salish Sea region.[77] These chemicals are therefore still present in the Puget Sound despite attempts to limit them.

Many of these chemicals, most notably PCBs, appear in southern residents and their prey at levels that exceed the harm thresholds for marine mammals. Pollutants in forage fish and in chinook salmon pose an especially significant threat to southern residents, as these pollutants will biomagnify up the food chain. Cullon et al (2009) estimated that higher contaminant rates and lower lipid content in chinook in more southerly parts of the Salish Sea add up to a daily PCB intake that is 4.0 to 6.6 times higher in southern residents than in northern residents. Chinook from the Deschutes and Fraser River had particularly high total PCB concentrations (56.09±17.97 and 46.97±8.06, respectively). Deschutes River salmon exceeded the guidelines put forth by the Canadian Council of Ministers for the Environment (CCME) (0.79 ng TEQ/ kg diet wet wt) for tissue residue. Likewise, total DDT levels in Chinook from the Duwamish River surpassed CCME guidelines (18.31±3.94 µg/kg wet wt, as opposed to 14.0 µg/kg wet wt).[78]

PCB levels in southern residents have dropped off since the 1960s but remain within or above the harm thresholds, which range from 10 to 77 mg/kg lipid blubber. As of 2006, PCB levels sorted by age group were approximately 195 mg/kg lipid blubber in calves, 40 mg/kg lipid blubber in juveniles, 84 mg/kg lipid blubber in middle-aged males, and 26 mg/kg lipid blubber in reproductive females.[79] All of these age groups contain PCB concentrations more than twice that associated with a 50 percent calf mortality rate in free-ranging dolphins (10 mg/kg lipid blubber).[80] All age groups also exceed the 17 mg/kg blubber lipid threshold used in several PCB risk assessments and observed to affect immune system and endocrine function in harbor seals. Reproductive impairment in harbor seals and Baltic ringed seals occurred at higher concentrations but still under the levels seen most southern residents. Models indicate that

southern resident PCB levels will not drop below harm thresholds until sometime between 2063 and 2089.

Furthermore, while PCBs decline, other chemicals of emerging concern (CECs) are appearing in Puget Sound waters, including PBDEs, per- and polyfluoroalkyl substances (PFAs), phthalates, pesticides, and even pharmaceuticals.[81] PBDEs have been associated with immune system problems, neurotoxicity, and developmental issues in animals and are currently increasing in southern resident killer whales.[82] Widespread use of PBDEs in recent decades has resulted in quickly-rising concentrations that are expected to surpass PCB levels in the next 15 years, indicating their emergence as a chemical of concern.[83] Current PBDE levels in southern residents demonstrate a doubling rate of 3.2 to 4.0 years and surpass those linked to altered thyroid hormone levels in juvenile grey seals.[84] While two forms of PBDEs—penta- and octa-BDEs—were banned in the U.S. in 2004, followed by deca-BDEs in 2013, multiple PBDE forms exist that are still used globally.[85]

Chemicals such as PCBs and PBDEs pose additional threats to marine mammal populations in that they are off-loaded from mothers to their calves, both during gestation and through nursing (source). In the 1960s, during peak PCB levels, southern resident calves likely experienced PCB concentrations as high as 507 mg/kg lipid blubber—over six times the highest marine mammal harm threshold estimate.[86] While levels have decreased since then, the effects in southern residents are still notable. Tahlequah's emaciated calf born in July 2018 likely suffered problems associated with pollutants that contributed to her death, and scientists suspect that contamination played a role in J50's disappearance as well.[87] Effects of combined

Table 2. Chemicals found in Puget Sound that pose significant threats to southern resident killer whales

Chemical	Trends	Regulations	Health Effects	Uses
PCBs Polychlorinated biphenyls	-Slowly decreasing (levels peaked in 1960s and 1970s before rapid decline in the next 30 years, but decline has slowed since the 2000s due to PCBs' biological persistence)[1]	-Manufacture, import, and sale of PCBs was banned in Canada in 1977, followed by a ban on environmental PCB releases in 1985[2] -Banned in the U.S. in 1979[3]	-Harm thresholds from 10 to 77 mg/kg lipid in blubber/ liver of marine mammals -Associated with calf mortality, immune system and endocrine dysfunction, and reproductive impairment[4]	-used in industrial lubricants, coolants for machinery[5] -still appear in some materials such as paints, adhesives, electrical equipment, and caulking[6]
PBDEs Polybrominated diphenyl ethers	-Have reached steady state, may be declining (levels peaked in 1970s-1990s, before regulations were put in place)[7]	-no longer used in Canada[8] -penta- and octa-BDEs banned in the U.S. in 2004[9]; deca-BDEs banned in 2013[10]	-altered thyroid hormone function in grey seals[11] -immune dysfunction, neurotoxicity in lab animals[12]	-flame retardant (found in household items such as curtains and furniture, as well as vehicle seats and televisions[13]
PAHs Polycyclic aromatic hydrocarbons	-Unknown	-not typically produced commercially in the U.S.[14] -16 PAHs have been listed by the EPA; but many others remain unregulated[15]	-Carcinogen[16] -Associated with deformities, adrenal and immune dysfunction, growth issues in fish -Linked to fetal distress, organ lesions, and neural problems in marine mammals[17]	-found in petroleum products, asphalt, roofing tar, creosote-treated pilings and telephone poles[18,19]
DDT Dichlorodiphenyl-trichloroethane	-Decreasing (levels typically highest near California where use was prevalent in the 1960s and 1970s)[20]	-Banned in the U.S. and Canada in 1972	-Premature births, impaired reproduction, altered thyroid metabolism, immunosuppression[21]	-Pesticide
CECs Chemicals of Emerging Concern	-Increasing	-None or few	-May disrupt endocrine and metabolic functions[22]	-Pharmaceuticals, soap, makeup, detergents, plastics, pesticides[23]

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contaminants—such as the combination of PCBs, PBDEs, and methylmercury (MeHg), among others—are still being studied, and may interact in particularly harmful ways.[1] Moreover, contamination is compounded by current food shortages, because killer whales use the blubber in which pollutants have been stored during times of malnutrition.[2] As southern residents increasingly call upon blubber due to lack of chinook, more and more contaminants will be released into their systems, increasing their risk of lowered immune system functions and other aggravating effects.

Mitigation and Protective Measures

However, researchers are renewing their demands for mitigation efforts to help the southern residents, including reductions in chemical use, clean-up efforts in toxic hotspots, and prioritization of chemicals of emerging concern (Table 3). Protective measures taken in the past include banning PCBs, DDTs, and dioxins and furans produced by pulp mills, as well as PBDEs.[3] In addition, the National Pollutant Discharge Elimination System (NPDES) program, introduced in 1972, issues permits for waste discharge standards from industries and has significantly improved U.S. water quality. But clean up processes must continue and expand if they are to help the ailing southern residents. In particular, the Orca Task Force highlights the importance of cleaning up areas in which chinook salmon spawn or forage, as well as areas in which southern residents frequently roam.

Table 3. Orca Task Force recommendations for mitigating pollution in southern residents

Department/ Agency	Recommended Action	Funding
Department of Enterprise Services	-Speed up enactment of Washington state law banning agencies from purchasing products containing PCBs -Provide information online about products containing PCBs	-Unidentified/ unneeded
Department of Ecology, WDFW, NOAA	-Identify chemicals of emerging concern (CECs) such as flame retardants, per- and polyfluoroalkyls (PFAs), and pesticides and plan for their management	-Request in 2019 legislative session

Department of Ecology, WDFW, NOAA, Puget Sound Partnership	-Identify sources of polluted stormwater runoff entering Puget Sound -Retrofit and/or redevelop these areas, prioritizing polluted sections of chinook rearing habitat	-Stormwater Financial Assistance Program
Department of Ecology	-Increase effectiveness of National Pollutant Discharge Elimination System (NPDES) by more stringently enforcing them -Prioritize contaminants most harmful to southern residents in aquatic life water quality standards	-Request in 2019 legislative session
Department of Ecology, WDFW, Puget Sound Ecosystem Monitoring Program	-Create and expand research programs to more closely monitor CECs in the Puget Sound, identify impacts on southern residents, and develop management strategies	-Request in 2019 legislative session

Future studies should focus on the deleterious ways in which chemicals may interact in the Puget Sound, as well as the areas which should be prioritized for clean-up, in order to minimize contaminant levels and effects of contaminants in southern residents. Efforts to boost chinook numbers will compound pollutant clean-up efforts by reducing the amount of blubber southern residents use during times of malnutrition, thereby reducing the amount of contaminants that enter their systems.

Chapter 5: Conclusions and Next Steps

"The greatness of a nation and its moral progress can be determined by the way it treats its animals."
-Mahatma Ghandi

People have said some strange things about orcas—from accrediting them with the ability to see into a person's soul to suggesting they have other supernatural abilities. While these claims have no scientific basis, it seems to be true that the more the public learns about these whales, the more claim they lay on people's minds and hearts. From *Free Willy*, the movie that roused a 20 million dollar effort to free the killer whale Keiko in his native Icelandic waters, to the heartbreaking stories of Lolita and Tahlequah, which sparked widespread activism to stop whale captivity and help southern residents, orcas have the power to inspire people.[1] Nowhere is this truer than in the Pacific Northwest, where southern resident killer whales are viewed as a part of the region's identity and culture.

It's been nearly fifty years since researchers began to study killer whales in the northeastern Pacific; over thirty since they discovered that resident orcas live in matrilineal societies, and that orcas seem to experience emotions such as excitement upon seeing each other and grief at the loss of a calf. And it's been over fifteen years since researchers realized the southern resident population was in decline, and that people might need to take action to help them. In the two and a half centuries European-originating settlers have occupied Washington state and British Columbia, they have had a grievous impact on these orcas, even if unwittingly. The question now is, are we watching these orcas go extinct? And if so, are we going to do something about it?

Most scientists agree that without mitigative action, the southern residents will disappear within a few generations. And as Jason Colby, who authored a book on killer whale captures in

the Pacific Northwest, points out, part of the reason their suffering is so hard for us to bear is "because of people's own knowledge, deep down, that we are connected to their plight." He commented in a *Seattle Times* article, "We know on a fundamental level, or we should know, that this is caused by us, that the pain she is experiencing and showing and the hunger [southern residents] are experiencing is the result of hard decisions we haven't made. We did this" (Mapes, A Task Force Forms). From taking southern resident calves for live captures, to dumping our effluent in Puget Sound and building dams and shopping malls without regard for salmon or any other creature, we have caused a significant part of their decline. But now we've built up our economy and lifestyle around these developments, and it is impossible to backtrack without sacrificing something.

So the second part of the question is, do people owe them the effort required to save them—after taking over a third of their population to entertain us in aquariums, after pushing them to the brink of extinction? Do we owe them nothing? Perhaps some would argue that we should accept their decline—that they are simply another group of animals that we have depleted, albeit intelligent, complex animals that have awed and inspired people for centuries. We can hope that what we've already done is enough; that by reducing vessel speeds, prohibiting harassment, and modifying road culverts, we've made sufficient improvements for southern residents to effectively reproduce. But if, a few years from now, they've had no births, can we accept that we are seeing the last of the J, K, and L pods? Can we watch the last of the orcas grow up, knowing the population will not persist, knowing there was more we could have done to save them?

Breaching the Snake River Dams

Since the topic of removing the Snake River dams first arose in 2000, studies on southern resident killer whales have confirmed what scientists then suspected: the whales are suffering from reductions in salmon runs. "There is no question the whales are starving," said Samuel Wasser, who helps run the Center for Conservation Biology at the University of Washington. Rick Williams, a fisheries ecologist at The College of Idaho, agreed: "We really have enough science [to provoke action]. I guess I am wondering if we have the courage to act rather than just talk."[2]

In this sense, the Orca Task Force may have failed the whales, deciding to push the issue of the Snake River dams' removal to further study rather than recommending action. Many researchers believe that breaching the dams is essential for orca survival, and dam removal was the most heavily supported suggestion among public comments to the Task Force. Experts such as Ken Balcomb were disappointed with the move, commenting, "The whales are on their own in their downward spiral toward extinction, along with the natural wild runs of chinook salmon we used to call 'king.'"[3]

While the orcas depend on salmon runs from multiple rivers—as pointed out by dam proponents—the salmon returning to the Columbia in the spring are particularly crucial because of their size, lipid content, and location. As the whales move back up the coast to their summer range in Puget Sound, they need nutrition to ensure they are physically fit for the breeding season and subsequent reproduction. The Columbia River chinook runs, once surpassing 9 million king salmon, have been reduced to numbers in the thousands.[4] Despite fish passage technologies and federally-funded programs that transport salmon in trucks past the dams, estimates place juvenile mortality at three percent per each of the eight dams, and adults face

warm reservoirs that can quickly kill them.[5] Returning rates of adult chinook to Snake River chinook fry are "below what's needed to prevent extinction [of chinook], let alone recover the species."[6]

Balcomb's frustration likely takes root in the fact that the southern residents do not have time for future studies on dam removal. The population needs to substantially reproduce before 2023, or not enough reproductive males and females will remain for the community to persist. Reproduction will not happen without proper nutrition. While increasing spill volumes through the dam will help, federal agencies have been declaring for years that dam removal would drive the largest increases in salmon.

Moreover, the arguments against dam removal have weakened over time as transportation methods and power supply and demand dynamics have changed. Dam supporters historically included wheat growers, who use the river for transportation of wheat; farmers, who depend on water from the dams for agriculture; and the BPA, which sells power from the dams. However, the usefulness of the dams to these groups has faltered as new technologies have come into play. Shipping of wheat and other products on the river has steadily decreased over past decades as growers increasingly rely on road vehicles, with total tonnage shipped falling 37 percent from 2006 to 2016. Use of river water for irrigation is limited to the area around the Ice Harbor dam, which is closest to the Columbia.[7]

Additionally, recent increases in California's wind and solar energy undermined BPA's steadfast argument that the dams are crucial to power supply. In the 2000s, BPA customers began switching to cheaper energy from California, leaving BPA to up their prices four times in a decade to avoid debt. Today, the lower Snake River dams "provide only about five percent of the region's power, which…is easily replaced, if it's needed at all."[8] The matter is simple: more

options for energy exist than they did twenty years ago, reducing the dams' significance to the eastern Washington economy. Simultaneously, the dams are draining federal budgets, using up 500 million dollars of agencies' budgets annually to mitigate damage to the fish and wildlife.

BPA's reasons for keeping the dams are no longer good enough. Unharnessing the hydropower of the Snake River, once considered an exotic idea put forth by tree-hugging Seattleites, is a viable option, and a necessary one if southern residents are to persist. But moving slow will defeat the purpose. It's been almost twenty years since the idea was first brought up. If the death of three whales in four months and three years of reproductive failures isn't convincing enough, what will be?

Lolita's Return

In May 2018, the Lummi tribe of northwestern Washington state travelled from Bellingham, Washington to Miami, Florida with a 16-foot totem pole. The tribe's 7,000 mile journey was made in honor of Lolita, or Tokitae, the killer whale that was captured in Penn Cove in 1970 and has lived in the Miami Seaquarium ever since.[9] Born in 1964, Lolita was captured at age six. She is now 54 years old and is the last survivor of the 36 southern residents taken during live captures in the 1960s and 1970s.[10]

The Lummi tribe, along with multiple killer whale researchers and thousands of activists, have supported the motion to bring Lolita home. Washington state officials first formally requested her return in 1996.[11] Lolita would first be placed in a sea-pen off Orcas Island, where she grew up. Her return would not provide the southern resident population with an additional reproductive female, though when the idea was first proposed twenty years ago, she would still have been able to bear calves. But researchers advocate for her return for a less conservation-oriented reason: justice. They feel that the killer whale who has entertained millions of Americans while living in the smallest orca tank in the world deserves the chance to see her

family again. “She’s made the money for [the Seaquarium],” said Ken Balcomb. “She’s paid for her retirement too.”[12]

If Lolita returns to her native Salish Sea, her prospects at re-adapting to life in the wild are particularly bright, for several reasons. “We’re really interested in Lolita because she spent that real formative part of her life with her family,” said Balcomb. “The first six years were out there [in the ocean]. So she had all of her education and all of her language skills; everything that her society could teach her she already knew.”[13] Lolita has showed that she still remembers what her pod taught her. She speaks the L pod’s language, though no one is there to respond to her. “From the vocalizations that Lolita makes in her tank, both under the water and sometimes even through the air—those have been recorded, and they’ve been matched up with the vocalizations of the wild whales,” said researcher Howard Garrett.[14]

In addition, scientists know who Lolita’s family is: she’s a member of the L25 matriline. Her mother, L25, or Ocean Sun, is still alive.[15] Balcomb and Garrett hope that the L-pod would recognize Lolita as their own, especially because she speaks their language. “It would be no problem at all to get them in close enough range to hear each other,” said Garrett. “Then that vocal recognition would take over, and we presume that she would resume her place in that family.”[16]

Seaquarium workers argue that returning Lolita to the PNW is an unnecessary gamble with her well-being. “We will not jeopardize her life by considering such a risky move,” said Eric A. Eimstad, Seaquarium’s general manager. He advised the Lummi tribe to focus instead “on the plight of the killer whales of Puget Sound, near the home of the Lummi nation.” Others point out that the re-introduction of Keiko, the star of *Free Willy*, to his native waters in Iceland did not go as hoped, with Keiko dying of pneumonia within three years of his return.[17]

But Keiko is not Lolita, and her return is not as risky as the picture Seaquarium paints. Several key differences exist between the two whales. For one, Keiko was captured at about two years old, likely before he had all the skills he need to survive in the wild.[18] Lolita had four more years to learn from her family before she was captured. Additionally—and in some ways more importantly—no one knew exactly what group of killer whales Keiko came from. In general, killer whales do not travel alone, but Keiko was wandering alone for nearly three years. It is really no surprise that he did not fare well.

And the alternative to Lolita's return, as Balcomb puts it, "is just a gloomy thought." One day, in her 35-foot-wide tank, she will become lethargic.[19] All the people who have stood outside the Seaquarium and protested her captivity, all the researchers in the PNW, all the Seaquarium workers will cringe, knowing what's coming. Or maybe there will be no warning at all. And then she'll be gone. "That we would, in this century, with all the enlightenment we have about freedoms and equalities and humanity toward other creatures, that we would allow [her captivity] to continue—it's just absurd," said Balcomb.[20]

Lolita has persevered through conditions that for a highly intelligent, social, acoustically-oriented creature must have been nightmare-ish. When she was originally brought to Miami in 1970, she at least had a tank mate, Hugo, who was also from the L pod. But in 1980, Hugo died of a brain aneurysm after repeatedly bashing his head against the concrete pool wall. Since then, "she [hasn't] touched or heard another killer whale," reflected Colby. "What does that do to a complex social animal hard-wired for acoustic stimulation? Do young orcas fear silence the way children fear the dark?"[21] Former dolphin and whale trainer Ric O' Barry added, "When you capture an animal like Lolita and put her in this concrete box, you take away the two most important aspects of her life—her family and the world of sound. They use their sonar for

capturing fish, chasing fish, for navigating, finding one another. In captivity, in isolation…they don't use their sonar—there's no need for it. So it's a form of sensory deprivation." [22]

As of 2008, Lolita had earned the Miami Seaquarium roughly 160 million dollars.[23] Small wonder the business is loath to relinquish its star attraction, despite offers of up to one million dollars for her freedom. But Lolita is more than an awe-inspiring, majestic pool decoration. She's a daughter, a sister, a niece to her family members back in the Puget Sound. She's our connection back to those days of live capture, when we sparked the first declines of the southern residents. She's the last survivor of the orcas taken that fateful day in 1970, the last of any of the southern residents that were taken. If we seek justice for the southern residents, she is an inherent part of it. For 48 years she's been trapped in a tank. Her mother is now 90 years old.[24] What if L25 remembered the calf she lost? What if the L pod recognized Lolita as part of the family? For a population that may be seeing the twilight of its existence, perhaps the only real justice is to give the southern residents back what we took from them.

Intro

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