

## Sea Sick

**Killer whales that live near Seattle are dying too soon and too often. Are they harbingers of an oceanic collapse— and are we next?**

***By Marguerite Holloway***

On a gray day when the seas around British Columbia and the San Juan Islands of Washington State are described by boat captains as "merely lumpy" and by lurching passengers as "too rough," a small vessel with a lot of horsepower makes its way out of Snug Harbor. For an hour and a half, the *Annie Mae* bounces along until the rocky beaches of the San Juan archipelago and the luminous red trunks of the madrona trees that stud the shores fall behind. When the boat reaches the unprotected Strait of Georgia, it joins three others that have also managed to overcome the dark weather to get close to a pod of killer whales traveling north.

On most days, orcas in these waters are surrounded by so many whale-watching boats it is difficult to imagine them as they were for millennia, unencumbered by a human entourage. But today, the orcas are alone against the glacier-scoured backdrop, their dorsal fins rising sharp like the region's peaks. They seem powerful, wild, completely free. "This is the way to see them," says captain Jim Maya, clearly pleased with the *Annie Mae's* performance.

The handful of whale watchers aboard stand on the deck in a slashing cold rain, grabbing rails as the boat surges up a wave,

then down a trough. The whales have just decided to slow for a while near the boats. Some begin to breach, jumping out of the water, leaning back into the waves, showing the long white of their bellies. Their neatly geometric black-and-white skins seem elemental art— maybe the ancient germ of the geometric-outline style of some Northwest Coast Indians. Again and again, the orcas leap and twist and fall back. Others spy-hop, lifting their upper bodies straight out of the water. They seem of two worlds: masters of their watery domain, yet able to enter ours, to relate to us in some inexplicable way.

To the native peoples of this area, orcas held that very power. They were supreme predators that could move easily between realms— creatures of both air and water, of life and death. In some tales, they are forces of salvation because they aid hunters in the pursuit of salmon; in others, their mistreatment or sudden appearance can portend death. To the Kwakiutl, orcas are part of a trinity of spiritually connected life-forms that share souls in a cycle of reincarnation: killer whales, salmon, and people.

This ancient connection has resonance today, and not just because thousands of people have developed an orca obsession that will drive watchers out in even the worst weather. These orcas appear to be in serious decline, and just as the folktales describe, their plight may be linked to our own. Since 1995, the population of three pods of killer whales has dropped precipitously from 98 to 82. Not only are middle-aged orcas dying before their time, but there is also little successful reproduction: Many newborns are not surviving. Eleven of the 18 females of reproductive age from L pod— the group encountered

by the *Annie Mae* in the Strait of Georgia— have not produced a single surviving calf in the past 10 years. The decline has conservationists, some scientists, and other orca watchers alarmed. In response, the Center for Biological Diversity, a nonprofit group based in Tucson, Arizona, advocates that the J, K, and L orcas— known collectively as the southern residents— should be listed as endangered in the United States. In 1999, they were listed as threatened in Canada.

Figuring out the why of the decline is proving complicated. It is possible the orcas have simply reached the carrying capacity of their ecosystem, that they are waning in natural response to natural limits or cycles we cannot see. If, however, they are suffering from some human-induced problem, there are three proposed culprits. One is boat traffic: Whale-watching and other vessels could somehow be stressing the killer whales or interfering with their ability to find food or communicate. Another suspect is food supply: Reductions in certain preferred prey species, such as chinook salmon, may be leaving killer whales hungry. The final possibility is the most sobering: Pollution is killing the orcas.

The killer whales of the Pacific Northwest were recently found to be among the most contaminated \ mammals in the world. Some are carrying staggering concentrations of polychlorinated biphenyls (PCBs), long-lived industrial compounds that accumulate in fat and have been linked to cancer as well as to problems with reproduction and with the immune system. If food supplies are down and if the whales are sometimes besieged by the bevy of boats, the presence of pollutants in their bodies may exacerbate any existing health problems, creating a deadly

situation.

And a cautionary one. Killer whales are just one group of the many marine creatures that appear to be suffering the effects of PCBs and related pollutants. Concerns about outbreaks of disease and low reproduction grow every year. Those PCBs come from the whales' diet, and in the case of the southern residents, that diet is mostly salmon— salmon that people, both in the Pacific Northwest and in the rest of the country, eat as well. Depending on our diet, some of us are top marine predators, meaning that we can also build up pollutants in ways that may impair our health. What we have dumped— directly and inadvertently— into the marine environment is coming full circle, catching up with us, perhaps ultimately making us as vulnerable as the creatures we revere. "It is just like Chief Seattle said: The fabric of the whole system is going to come apart. And there are indicators that it is coming apart," says Kenneth C. Balcomb III, director of the Center for Whale Research on San Juan Island. "So fix it before you lose your indicators. Because we are probably the next indicators."

The southern residents are a famous group of killer whales. Each summer about 300,000 people visit the San Juan Islands and British Columbia to observe them, venturing out in whale-watch vessels like the --, waiting patiently onshore— particularly on Lime Kiln Point on San Juan Island, where they can hear the vaporous exhalations of arriving orcas before they see them— or, if they have the means, tracking the whales in private pleasure boats. The locals are equally obsessed. There are orca mailboxes, orca murals, orca carvings, posters, books,

knickknacks, and kitsch at every turn.

These killer whales are renowned in large part because of the efforts of researchers like Balcomb who have photo-identified them, named them, and recorded their genetic relationships and behavior. Many visitors feel not only excitement and awe but also a kind of familiarity, a kinship. They may identify Slick (J 16) and see her baby (J 36) and one of its siblings, Mike or Keet, swimming protectively alongside. They may know that when L 51 died, leaving her 6-month-old calf unable to feed itself, that the calf's brother Nyssa tried for weeks to feed him salmon until the tiny orca disappeared.

Because of this sense of kinship— and because of their otherworldly *auravorcas* were not hunted by most Northwest Coast Indians. But they have not met with as much respect in modern times. Richard W. Osborne, the science curator at the Whale Museum in Friday Harbor on San Juan Island, has collected reports of Canadian and U. S. armed forces using whales for target practice in the 1940s and 1960s and of salmon fishermen killing their competition. Between 1965 and 1976, about 50 southern resident orcas were captured for aquariums, triggering the first major recorded decline in the population.

Time and education— perhaps even the movie *Free Willy*— have altered our view. Killer whales now elicit admiration, not aggression. Orcas are the largest members of the dolphin family, the most agile and streamlined of the cetaceans. Found throughout the world, they are intelligent, social, and matriarchal. And each pod, and sometimes each matriline within a pod, has its own dialect: not clicking, which they use for echolocation, but

a repertoire of specific cries. "The call is a screamlike sound," says John K.B. Ford of the Vancouver Aquarium Marine Science Centre. "Each pod has a dozen or so such calls. Some share a few calls, and they are passed on. Other pods have no calls in common, even if they swim together."

Orca groups differ in more than their calls. Several researchers— including Ford, Balcomb, Lance G. Barrett-Lennard of the University of British Columbia, and Graeme M. Ellis of the Canadian Department of Fisheries and Oceans— have determined that there are three types of killer whales and that they do not mix: residents, transients, and offshores. Residents— such as the southern residents and a larger cluster of 200 or so northern residents (who range from the northern half of Vancouver Island to southern Alaska)— eat fish and usually stay in a certain area for the summer. They are also quite boisterous, leaping, breaching, and spy-hopping, as L pod did near the --. Transients are much quieter, eat porpoises and other mammals such as harbor seals, and travel in small groups. The 200 or so transient orcas of the Pacific Northwest are periodically found around Vancouver Island. The third variety of killer whale was discovered in 1990: Offshores are usually seen about 15 to 20 miles out in the Pacific Ocean, from Alaska to southern California, and there is little known about them. The mystery of offshores extends to the other kinds of killer whales during the winter: No one knows where the residents go, although last year, some of the southern residents turned up in Monterey Bay.

Genetic research on these distinct populations led to the discovery that the killer whales were high in PCBs. Ellis and his colleagues had collected blubber samples from the southern

residents, northern residents, and transients of the area. (A sample is a three-quarter-inch deep and one-quarter-inch wide plug of skin and fat from right behind the dorsal fin. Orca researchers do not believe taking the biopsy harms the killer whales. "It is actually more harassing to chase them down than to take a little piece of tissue," says Balcomb. "They remove many times more tissue from each other just by tooth scratches and stuff.") The skin samples were analyzed for genetic information, and some of the blubber had also been analyzed for contaminants, but no one had interpreted the latter findings, so they just sat in a folder until Peter S. Ross arrived at the Institute of Ocean Sciences in Sidney, British Columbia. Ross had done work in the Netherlands on harbor seals and the effects of PCBs on their health, and so Ellis suggested he examine the data set. When Ross did, he told Ellis, "These guys are hot; they are really hot." They then looked at more samples, analyzing 47 in all.

What Ross saw— and what he and his colleagues published last summer in *Marine Pollution Bulletin*— was that the southern resident males had, on average, about 150 parts per million (ppm) of PCBs. The northern resident males were much lower: 40 ppm. And the transient males were higher than even the southern residents: They had a stunning 250 ppm. In each of the killer whale populations, the females were significantly less contaminated because they had passed along their store of pollutants to their offspring. "She is giving the baby a toxic load before it is even born and then by nursing afterward," explains Balcomb. "She is dumping her burden. But the baby is starting out on the wrong foot."

PCBs are man-made waxy compounds that have been used in

electronics and printing since 1929. They are in a class of compounds called endocrine disrupters, chemicals that can work like hormones, interfering with all sorts of systems in the body, from thyroid function and vitamin A processing to the activity of estrogen. Although they were banned in the United States in the 1970s as probable carcinogens and are being targeted by the United Nations for elimination as one of the world's "dirty dozen" persistent organic pollutants, they are still produced in Russia and used in several countries.

PCBs don't break down easily. So although overall production levels are declining, hundreds of thousands of tons of PCBs still move around the planet, says oceanographer Robie W. Macdonald of the Institute of Ocean Sciences. PCBs can stick to sediments and stay still for years and then suddenly move again, making their way into the atmosphere, globe-hopping, and ultimately gluing themselves into the food web. PCBs have contaminated waterways all over America, most notably the Hudson River in New York State and the Great Lakes. In total, according to the Environmental Protection Agency, 703 bodies of water in the United States have health advisories posted because of PCB pollution: Local departments of health have warned people against eating certain PCB-ridden fish.

Like other persistent organic pollutants, including dioxins and the pesticide DDT, PCBs are fat loving. And for marine mammals, fat is currency. Mammals at the top of the food chain eat and store most of the combined mass of pollutants that every species below them on the chain has eaten and stored, a process called bioaccumulation. So the full contamination of the 100 to 300 pounds of fish or other food that killer whales eat each day

largely stays with them. The southern residents are not as contaminated as the transients because they eat fish, which are lower on the food chain than the seals and porpoises constituting the transients' diet. (The northern residents are lowest because the fish they eat are thought to be less contaminated than the fish farther south.) By the same principle, baby whales end up higher on the food chain than their mothers, receiving many of the pollutants that have been accumulating in nutritious maternal fat.

What concerns Ross and many others about the high levels in the killer whales is that much lower levels of PCBs in some marine creatures have been linked to serious health problems. Harbor seals eating PCB-contaminated fish reportedly have low reproduction rates and suppressed immune function. PCBs have also been implicated in the ongoing demise of the St. Lawrence River beluga whales, whose population has fallen from between 5,000 and 10,000 at the turn of the century to 500 today, despite the fact that they have been protected since 1962. Indeed, concern about persistent organic pollutants in the marine environment is reaching a crescendo as more cases of high levels of contaminants, altered reproductive ability, disease outbreak, and even hermaphroditism are reported—turning up in species as diverse as bald eagles, bottle-nosed dolphins, and polar bears.

The southern residents' plight seems to fit the pattern. They have a low rate of reproduction, and some orcas have died of infections they would be expected to fight off. Last year, for instance, 22-year-old Everett (J 18) "died of a massive bacterial infection," says Osborne. "They traced the source to an abscess

on his stomach. The bacteria that was involved is very common in the marine environment." An inability to reproduce is also being observed in a group of transient killer whales in southern Alaska. Recent data indicates that these orcas have PCB levels of about 230 ppm, says Craig O. Matkin, a killer whale researcher who studies the Alaska populations. The group has dropped from 22 members in the late 1980s to 10 this year.

Little is known about the transients in Ross's study. Their PCB levels were the highest, but because transients are seen so infrequently— and because males do not stay in their maternal pod as resident males do— it is difficult to study this population. Nevertheless, Ellis plans to review the data because his intuitive sense is that something has changed. "I have a hunch that we may have lower calving rates," he says.

The problem with definitively tying PCBs to the killer whale decline is that it can't be done. There are so many unknowns, not only about other factors that may be affecting the orcas but also on a purely fundamental cause-and-effect level. "It is almost insurmountable to collect direct evidence to provide direct links," notes Thomas J. O'Shea, who chaired a U.S. Marine Mammal Commission meeting about persistent organic pollutants three years ago. One noted complication is that marine mammals are exposed to complex mixtures of compounds, so it is difficult to tease apart the precise impact of each, or their additive, synergistic, or antagonistic effects. Another complication is that species react differently to the same compounds. Killer whales and seals, for instance, seem to have the ability to break down dioxins, compounds that some forms of PCBs closely resemble; yet other mammals, including humans, cannot do that readily. So

the question is: Should research data from one species be used to draw conclusions about others?

Yes, say Ross and many others who advocate a "weight of evidence" approach. "The critics are technically correct in saying that we do not have strong evidence that PCBs in particular are adversely affecting these marine mammals," Ross acknowledges. "Doing that in a scientific way, with direct manipulation, is out." We can no more experiment on killer whales than we can on people, he says. For example, it would be unethical to capture orcas and feed them fish high in PCBs to see what such a diet would do to them— just as it would be unethical to purposefully feed people PCB-laden food and see if they developed health problems, including cancer. But, Ross notes, "there are thousands of papers showing how PCBs adversely affect rats and mice and monkeys, dating back to the 1960s. And there is increasing evidence that wildlife— fish-eating birds, seals, and cetaceans— are adversely affected by these chemicals."

And it isn't just wildlife that is at risk. PCBs in the aquatic food chain have been shown to have developmental effects, lowering IQ and increasing learning disorders in children born to mothers who ate fish from Lake Michigan. Dutch infants who were breast-fed milk with elevated PCB levels have had some of the same problems, as well as low birth weight. At the top of the food chain in the Arctic are Inuit hunters. High levels of PCBs have been linked to weakened immune systems and ear infections in Inuit children. And the Environmental Protection Agency has associated the consumption of PCBs in some Hudson River fish

with an elevated risk of cancer.

In Washington State, salmon are not officially viewed with concern. The Department of Health there has issued no consumption advisories on salmon in Puget Sound or elsewhere. Salmon transported for sale elsewhere in the country haven't been tested for PCBs by the Food and Drug Administration for about 10 years. "There were never any there," says FDA spokesperson Susan Hutchcroft, explaining why the agency stopped checking.

But James E. West, a biologist with the Washington State Department of Fish and Wildlife, and his colleagues have been testing salmon in different areas in Puget Sound since 1989 and have found some elevated PCB levels. According to a 1998 report by the Puget Sound Ambient Monitoring Program, the PCBs in those fish could pose an increased risk of cancer in people who eat 54 grams a day, roughly what a typical recreational fisherman would consume. Because of data from West and others, the Department of Health is investigating whether advisories will be needed. A final report is expected later this year.

Advisories, of course, won't help the southern residents. Nevertheless, many researchers, even if they do not agree that PCBs are causing the decline, believe steps could be taken to improve the health of the killer whale population. "We have to control those things we can control," Ford says. And those things are the other two potential— and controversial— culprits in the decline: boat traffic and food supply.

On a beautiful clear morning, two days after the *Annie Mae*

struggled through the rain and high waves to reach L pod, Rich Osborne of the Whale Museum in Friday Harbor and two volunteers motor into posh Roche Harbor on San Juan Island. Osborne slips away from the boat, *Soundwatch*, for a moment, leaving his crew members to fuel up. Suddenly a tanned, immaculately coiffed blond woman with huge gold glasses storms up, demanding to know what the crew had been doing out there on the open water a day or so ago, foisting pamphlets on boaters. "It wasn't very tastefully done," she fumes, adding that she had had guests on board.

Almost every day during the summer, *Soundwatch*, which is run by the Whale Museum, patrols the San Juans, making sure that whale-watch vessels and private boaters observe guidelines established to protect orcas. Boaters are asked to stay 100 meters from the whales, turn off motors if the whales get close, and never chase or herd the whales. *Soundwatch* volunteers approach boats and hand them pamphlets on one of those long poles grocers use to reach the top shelves.

Whether boaters bother and stress orcas to the point that they would begin to die off seems unlikely, Osborne says. Informal study suggests that the boats do not unduly tax the orcas, which do not seem to behave differently around boats. But new evidence suggests that engine noise could interfere with their communication and hearing. Christine Erbe of the Institute for Ocean Sciences recently reported that most boat traffic between Vancouver Island and the San Juans produces sounds between 100 hertz to 3 kilohertz, right in the acoustical range of the killer whales, whose screamlike and squeal-like cries are between 200 Hz to 14 kHz. Erbe says that echolocation clicks, which the

whales use to find food and navigate, are probably not obscured. More worrisome, their overall hearing could be impaired. Erbe is concerned about hearing damage that could occur after 20 minutes of being within one kilometer of a boat traveling 22 to 32 knots. The continuous presence of boats near the whales— day after day during whale-watching season, year after year— also worries Erbe.

Private boaters pose more of a threat than whale-watching vessels, say Erbe and others, because they are both excited and, in general, ignorant. The 60 or so commercial boats from Canada and the United States, like the *Annie Mae*, follow guidelines to ensure that whales are not harassed.

Although the number of whale-watch boats has been constant for the last few years, overall traffic in the region has increased. The human population of the area is expected to double in the next few decades, and that will only mean more boats, more noise, and less habitat for salmon. West, for one, is skeptical that the salmon population available as prey to the southern residents has declined. According to his colleague Greg Bargmann's data, populations of chinook, which appear to be the southern residents' favorite fish, are lower than they were in the early 1990s but not lower than they have been at times in the past. One key reason: The Department of Fish and Wildlife has increased the production of hatchery chinook substantially since the 1970s.

But other researchers point to the fact that wild chinook salmon were listed as threatened in the fall of 1999. They also note that there is not a lot of good information on what killer whales eat,

particularly in winter. If killer whales are indeed working harder to find food, they may need to draw on fat reserves, which would release pollutants into their bloodstreams.

If the southern residents eventually become listed under the Endangered Species Act, boat traffic rules could be enforced and the orcas' food supply could be regulated. Populations of salmon could be managed so that a portion is set aside for the whales, says Robin W. Baird of Dalhousie University in Halifax, Nova Scotia, who was instrumental in getting the population listed in Canada two years ago. "Fish stocks are not currently managed with wildlife in mind," he says.

The pollution, however, will persist— in the oceans, in the orcas, in the salmon, and in us. "Some people continue to have trouble believing that we are affecting the planet," says Ross. "Now we have the most contaminated marine mammals in the world, and that is a reflection largely, or at least in part, of global pollution. It is a very stark, heavy, and noteworthy reminder that we are in everyone's backyard."

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