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On November 27, 2017, the sailing vessel *Katla*, a Jeanneau Trinidad 48, set off from the Canary Islands to cross the Atlantic and head for the warm waters of the Caribbean. In the middle of the crossing, with the nearest coast more than 1,000 nautical miles (1,850 km) away, the crew of eight young Scandinavians spotted a small group of killer whales. Seabirds were circling overhead, so maybe the whales were feeding on fish. In any case, the whales came over, surfaced near the boat, and the crew enjoyed some close passes. The killer whales glided on their sides, all along the length of the hull, looking at the crew, who leaned over the railing looking at them. It seemed the whales were as curious about the sailors as the sailors were about the whales.

A thousand miles from shore in tropical water with nearly 2 miles (3 km) of ocean depth beneath you is one of the more unlikely places to come across killer whales. They are most often found in coastal areas and cold temperate waters. Yet sightings like the one from *Katla*, remind us that, although some regions are more typical for killer whale occurrence than others, these animals can be found all across the globe, from the ice-laden waters of the poles to the bath-temperature waters of the equator and everything in between. The diversity of their habitats reflects the diversity of killer whales themselves. Even though for the most part they all look alike—hefty black bodies with striking flashes of white—studies of behavior, vocalizations, prey preferences, and morphology (physical traits) have revealed that one population of orcas does not equal another.

When discussing the diversity of killer whales, the word "ecotype" is often used. Ecotypes are distinct populations that are reproductively isolated and that exhibit specialized behaviors, diets, social structures, and sometimes morphology—even though they are all classified as the same species. Scientists introduced the concept of ecotypes when they began to notice significant differences between one killer whale population and another, particularly in diet and social behavior. Classifying different populations into separate ecotypes allows for a more in-depth understanding of the evolutionary and ecological adaptations of the species. The ecotype classification also has significant implications for conservation. One ecotype can be thriving while another is not, depending on its habitat and food source, and each ecotype's role in the ecosystem.

A killer whale comes to the surface, about to take a breath. British Columbia, Canada.

Caribbean islands

Perhaps the killer whales that the crew on *Katla* encountered 1,300 nautical miles (2,400 km) east of the Caribbean islands belong to one of the small groups that are occasionally seen in the Caribbean and around the Bahamas. Fisheries biologists, cruise ship passengers, fishers, and crews on sailing vessels have reported occasional sightings of killer whales from the Bahamas in the north to Trinidad and Tobago in the south. Due to the lack of long-term studies in this area, little is known about their behavior or population size, but it appears they feed on turtles, fish, and marine mammals, from dolphins to large baleen whales.

The only place in the Caribbean islands where killer whales have been recorded in a systematic way is in Saint Vincent and the Grenadines, a small collection of islands in the Lesser Antilles. These records, however, are of the 109 killer whales legally caught in the local artisanal whaling industry from 1949 to 2017. Other small cetaceans, such as short-finned pilot whales, Risso's dolphins, dwarf sperm whales, and various species of dolphins, as well as a few humpback whales, are also caught in this fishery. The hunting of small cetaceans has a long history in the area. In the early 1920s, when large-scale American whaling in the Caribbean ended, smaller-scale local shore-based whaling took over on several islands. The hunting of killer whales in Saint Vincent and the Grenadines ended in 2025 but the hunting of other cetaceans continues to this day.

Strait of Gibraltar and the Iberian Peninsula

On the opposite side of the Atlantic lives a critically endangered population of killer whales of only about forty individuals. This population has been closely studied by scientists who know each individual and have been monitoring their natural history and behavior since the 1990s. These whales have a seasonal migration pattern following the migration of bluefin tuna that, during spring and summer, leave the spawning areas in the Mediterranean, pass through the Strait of Gibraltar, and head north up the coastline of Spain and Portugal.

In 2020, killer whales from this population gained international attention when they began a trend of ramming sailboats and biting rudders (see page 220).

As the herring fills the fjords, so do the whales. At the peak of the season, it's not unusual to spot over 500 killer whales in a single day.

Norway

Around the British Isles and all the way to northern Norway live some of the largest populations of killer whales in the world. As winter sets in and the sun dips below the horizon not to rise again for months, the steep mountains surrounding the fjords of northern Norway receive their first dusting of snow. Hues of pink, yellow, and purple color the sky. In November, killer whales arrive in the fjords from the open ocean where they've spent the summer. They follow schools of Norwegian spring-spawning herring that will overwinter in the fjords.

Early in the season, tourists, fishers, and scientists will report seeing a few scattered groups of killer whales here and there, but as the herring fills the fjords, so do the whales. At the peak of the season, it's not unusual to spot over 500 killer whales in a single day. These whales are part of the northeast Atlantic population of about 15,000 individuals whose range includes the coasts of Iceland and the North Sea.

Norwegian killer whales have been studied since the late 1980s and so far about 1,500 individuals have been identified. We know from field observations and diet analysis that not all Norwegian killer whales eat herring. Some eat marine mammals, and at least four groups specialize in hunting harbor seals and gray seals. However, the distinction between fish-eating and seal-eating killer

At the end of the 1950s, as fishers gradually shifted to different ways of fishing, the war on whales came to an end. Today there is a healthy population of several hundred killer whales in Iceland.

whales in Norway is not as clear-cut as it is in North America. The herring-eating killer whales consume other fish too, like lumpfish, particularly when herring is scarce; and the seal-eating killer whales eat fish as well as marine mammals.

Iceland

In many places around the world, the relationship between fishers and killer whales can often be strained, but in the 1950s it reached an all-time low in Iceland. Icelandic fishers were repeatedly finding their drift nets wrecked by killer whales. They were losing not only their catch, but also their patience. The fishers appealed to the Icelandic government for help, and they in turn appealed to the nearby American airbase, which led to United States military bombers conducting a series of air raids that killed hundreds of whales (see page 172).

At the end of the 1950s, as fishers gradually shifted to different ways of fishing, the war on whales came to an end. Today there is a healthy population of several hundred killer whales in Iceland.

Icelandic killer whales feed primarily on herring so they appear to have much the same diet and hunting strategies as the herring-eating killer whales in Norway. Indeed, there are reports of Norwegian killer whales in Iceland (and vice versa). However, Icelandic killer whales have

A killer whale's warm breath is clearly visible in the cold wintry air of a Norwegian fjord.

Killer whales off the coast of Iceland.

also been spotted in the Shetland Islands, where they seem to hunt seals, which suggests that at least some Icelandic killer whales have a mixed diet of both fish and marine mammals.

Greenland and the Canadian Arctic

The east Greenlandic coast stretches for more than 1,000 miles (1,600 km) from Cape Farewell in the south to just 400 miles (643 km) shy of the North Pole. There are only two small settlements along this vast coastline; the rest is untouched wilderness. It's a harsh environment. Glaciers dump chunks of ice the size of warehouses into the sea. A conveyor belt of sea ice moves in from the polar north and blocks the land from the sea for much of the year. It is only during the brief summer months, when temperatures rise enough to melt the ice, that the coastal waters become accessible to marine mammals from the south.

According to local Greenlandic Inuit (and the Greenland Institute of Natural Resources), killer whales used to be rare along the east Greenland coastline. But with rising global ocean temperatures, the ice has thinned and no longer stretches as far south during the summer. This means that fish species like mackerel and even tuna have moved into Greenlandic waters. Along with the fish came killer whales, pilot whales, white-sided dolphins, and white-beaked dolphins. Since 2003, the year that the summer ice collapsed, killer whales have become regular summer visitors to eastern Greenland. Even though they're likely following the fish, they appear to also eat marine mammals, especially seals.

There are two distinct populations of killer whales in the Canadian Arctic. One is related to whales further south but, with warming Arctic temperatures and shorter seasons of sea ice, now appears more frequently in the Arctic and moves between Canada's northernmost provinces and western Greenland. The other is likely related to a population from eastern Greenland, Iceland, and Norway that expanded into the western North Atlantic.

Hunting marine mammals is integral to Greenlandic and Canadian Inuit culture. Seal and whale meat are an important part of the Inuit diet and hunting contributes to the local economy. But the hunting of killer whales, as well as other small cetaceans, is unregulated in Greenland.

Killer whales in the frigid waters off the coast of sparsely populated western Greenland.

So with the increase in whale occurrence in east Greenland, there has also been an increase in the number of whales taken. The impact of these takes is unknown because there is insufficient data on the size of the population, and little is known about the relationship between the East Greenlandic killer whales and killer whales in other regions.

North America

The waters off the coast of Washington state in the United States and British Columbia in Canada are the first place where scientists discovered that different killer whale populations have completely different diets and behavior, even when they share the same habitat. It was in this region, thanks to research that started in the 1970s that scientists first discovered two different ecotypes. Here, the resident killer whales feed exclusively on salmon; while Bigg's killer whales (formerly known as transients) feed on a variety of marine mammals, including harbor porpoises, Dall's porpoises, harbor seals, California and Steller sea lions, and sometimes minke whales and other baleen whales. Even though these two ecotypes share the same habitat and sometimes pass each other in the same stretch of water, they do not mix or interbreed.

Within the resident killer whale ecotype there are several separate populations in the north Pacific. The Southern Residents' range reaches as far north as halfway up Vancouver Island and as far south as Oregon and California. They spend significant time in the inland waters of Puget Sound and the coastal waters of the Salish Sea.

The second population, the Northern Residents, have a range that abuts the Southern Residents' northern boundary but extends up into the coastal waters of British Columbia and southeast Alaska and offshore to Haida Gwaii. These two populations are neighbors that only barely, and only very rarely, overlap where their ranges meet, and even then they don't interact with each other. With a population of fewer than seventy-five animals, the Southern Residents are critically endangered. The Northern Residents' population, with around 300 animals, is considered threatened.

The resident killer whales and Bigg's killer whales differ not only in their diet but also morphologically. Resident killer whales are smaller and

Southern Residents swim past a Seattle neighborhood in Washington state.

more slender, with more curved dorsal fins, and can have an "open" saddle patch with an interrupted outline. Bigg's killer whales, on the other hand, are larger and more robust; the dorsal fins are more triangular and straight, and the saddle patches are "closed," fully encircled by black. The population of Bigg's killer whales is estimated to be around 400 individuals. Their range stretches from southeast Alaska to California.

In 1988, long after the discovery of the residents and the Bigg's, researchers noticed a third ecotype of killer whale in the area. They are known as the offshores because they roam 6 miles (10 km) or more off the outer coast of Vancouver Island, out to Haida Gwaii, and beyond. They only rarely come into contact with researchers and that's why it took a while before local killer whale scientists established that this third group also had a special diet. The offshore killer whales eat rays and sharks and dive to great depths to find them. There are an estimated 300 individuals in this population.

Alaska

In Alaska's Prince William Sound, more than a hundred glaciers calve white and turquoise icebergs into the ultramarine water; there are snow-capped mountains and pristine wilderness in every direction. It is a natural wonder. But this natural wonder all changed on March 24, 1989. The oil tanker *Exxon Valdez* was transiting the waterway when it hit a reef and spilled more than 10 million gallons (nearly 38 million liters) of crude oil into the sound—forever ruining the integrity of this spectacular environment. Thousands of sea otters died. Hundreds of harbor seals died. Hundreds of thousands of seabirds died. Innumerable fish and other marine organisms died. Killer whales died, too.

Killer whales in Alaska have been studied since the 1970s; researchers know the different ecotypes, as well as the pods and families and their life histories. Almost 2,000 whales have been identified; half of them are in the Gulf of Alaska (that includes Prince William Sound) and the other half are in the Aleutian Islands. Similar to the situation in Washington state and British Columbia, some of the Alaskan killer whales are the fish-eating ecotype (residents) and others are the marine-mammal-eating ecotype (transients); there is some overlap in range.

Resident killer whales are smaller and more slender, with more curved dorsal fins, and can have an open saddle patch. Bigg's killer whales, are larger and more robust; the dorsal fins are more triangular and straight.

While most of the killer whale populations in Alaska appear to be thriving, two groups were hit hard in the aftermath of the *Exxon Valdez* disaster. Just days after the ship ran aground, the resident AB pod and the transient AT1 pod swam through the oil slick. By the following year, thirteen of the thirty-six whales in the AB pod had died, and nine of the twenty-two whales in the AT1 pod had died.

Russia

If you were to extend the line that traces the arc of Alaska's Aleutian Islands, you would eventually reach Russia's Commander Islands and the Kamchatka Peninsula. Here, the wingbeats of millions of seabirds blur the boundary between sea and sky, and the flukes of humpback whales, the splash of Steller's sea lions, and the blows of killer whales break the surface as they dive to feed in the frigid waters of the Bering Sea.

Since 1999, more than 800 killer whales have been individually identified and cataloged in Russia. Similar to the killer whales off the Pacific coast of North America, the killer whales in Russia fall into two distinct ecotypes: most are fish-eaters and a smaller population hunts marine mammals. Both ecotypes inhabit both sides of the Kamchatka Peninsula.

In 2003, business consortia began to capture killer whales in Russian waters and sell them to marine parks. By 2018, about thirty whales (of the marine-mammal-eating ecotype) had been captured near Kamchatka. Some were sent to China, some elsewhere in Russia, and some died during or shortly after capture. In 2021, protests, negative media attention, and charges by Russian conservationists culminated in a court ruling that levied hefty fines on the companies involved and led to a temporary ban on live captures in Russian waters. Ten of the captured whales were then released back into the wild.

Antarctica

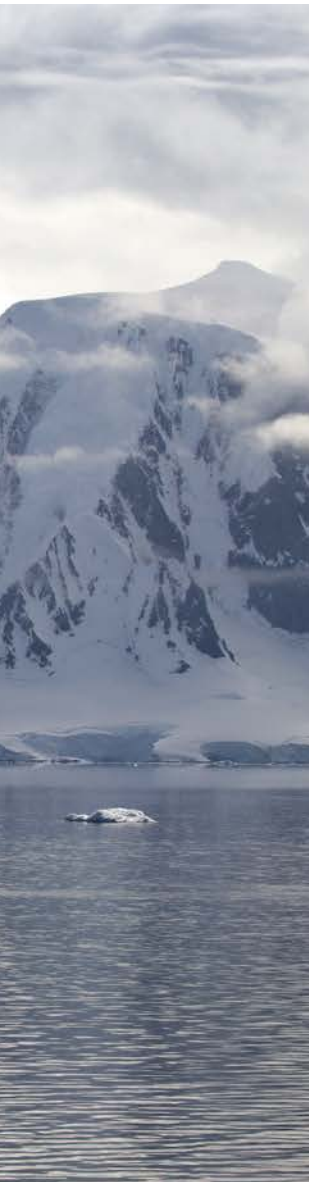
In the early 1980s, scientists working with the Soviet whaling fleet noticed that killer whales in Antarctica did not all look the same. Based on their preliminary observations, they suggested two new species of killer whales—both dwarf forms of the typical *Orcinus orca*. The scientists noted that these forms had a yellowish hue but they didn't mention any other distinguishing features. Ultimately, their proposal for two new species was met with skepticism because they lacked sufficient data and detail to substantiate their claims. Today, scientists recognize that there are at least four different ecotypes in Antarctic waters.

Type As are large and particularly striking black-and-white killer whales, with a medium-sized eye patch. They prefer ice-free water and are found anywhere from the ice edge to the open ocean, where they hunt baleen whales, especially minke whales.

Type B is divided into two subtypes: Type B1 and Type B2, both smaller than Type A killer whales. B1s are charcoal gray instead of ink black, and they sometimes have a yellow or brownish tint. The coloration is likely caused by a buildup of diatoms (microalgae that are particularly abundant in Antarctic waters) on the whales' skin. B1s have large eye patches and a dorsal cape, which is a swath of dark gray that extends from the eye patch to beyond the saddle patch. They live in the pack ice where they specialize in hunting seals, especially Weddell seals. Type B2 is smaller than Type B1, and is less associated with pack ice. The B2s hunt penguins, seals, and perhaps also fish and squid.

While researchers look on, a male killer whale leaps out of the water off the coast of Kamchatka, Russia.

Antarctica is home to several different populations of killer whales.



Type C is the smallest of the Antarctic killer whales. Adult males are only around 20 feet (6 m) long, (whereas Type A males can reach 30 feet (9 m) in length). Type Cs have a small, narrow, and unusually slanted eye patch. Similar to the B1 whales, the Type Cs are associated with pack ice, but instead of feeding on seals they are deep divers and hunt fish. Type Cs can be distinguished by their large group size.

The fourth type, known as the "elusive" Type D (see page 60), ranges farther north into sub-Antarctic waters. Even to the untrained eye, Type D killer whales are odd looking and distinctly different from other killer whales. Their eye patches are tiny, and their heads are bulbous and rounded. They appear to feed primarily on fish. They are the least studied of the Antarctic killer whales.

Although the categorization of these ecotypes was initially based on differences in behavior, diet, and morphology, recent studies have confirmed that the four ecotypes are also genetically distinct from each other. So maybe the Soviets' proposal that there are separate killer whale species in Antarctica has merit after all. But for the time being at least, the ecotype categorization that delineates the role each type plays in the ecosystem stands.

Patagonia

Few killer whales have been featured in as many documentaries as the killer whales of Península Valdés in Patagonia, northern Argentina. The peninsula's sandy beaches and bays are protected by low rocky cliffs and offer good breeding locations for southern sea lions and elephant seals. When the sea lion pups leave the beaches for the water, the surf zone becomes a prime hunting ground for killer whales. The killer whales intentionally beach themselves to grab an unsuspecting sea lion pup and then fling it through the air, pummeling it with powerful strikes from their flukes. Outside the seal and sea lion breeding season, the killer whales prey on dusky dolphins and common dolphins in offshore waters.

This population of sea-lion-pup-grabbing killer whales has been studied for decades and comprises only around thirty animals. They constitute their own ecotype even though another population of killer whales in the Crozet Islands, a small group of sub-Antarctic islands in

the Indian Ocean, uses the same hunting technique. Because the two locations share similar ecological conditions and prey availability, the same hunting behavior and diet preferences have emerged in parallel in two different populations.

New Zealand and Australia

Killer whales are found year-round in the coastal and offshore waters of both New Zealand and Australia. A small population of fewer than 200 animals roams all around New Zealand, and research that started here in the 1990s has revealed some unique foraging behaviors, such as hunting stingrays in shallow waters.

In Australia, sightings are most frequent off the southern and western coasts and along the Tasmanian coastline. During the summer months, Bremer Bay in Western Australia is a seasonal hotspot for a large aggregation of killer whales. The deep-water canyon there supports a diverse range of prey, including, fish, squid, and other whales.

Eastern Tropical Pacific

In the 2010s, a group of researchers carried out extensive killer whale surveys along the Pacific coast of Mexico. Based on their field observations and the subsequent analysis of morphology and prey preferences, they proposed a new ecotype—the Eastern Tropical Pacific killer whale. Unlike the specialist ecotypes found in British Columbia, Washington state, and Alaska, these newly proposed Pacific killer whales are not picky eaters; they feed on a variety of marine mammals as well as sea turtles, sharks, rays, and bony fish.

The Eastern Tropical Pacific ecotype appears to fit with the pattern of other tropical killer whale populations—such as a faintly defined saddle patch and a more diverse and opportunistic diet. Killer whales in Hawai‘i have almost no saddle patch, and killer whales in Fiji have uniformly black backs with no saddle patch at all. We don’t know much at present about the relationship between the different tropical populations of killer whales around the globe. They may constitute separate and genetically distinct populations, but they might just as likely overlap and interbreed.

Killer whales near shore in Mount Maunganui, New Zealand.

The discovery of the Type D ecotype

On a shelf in the collection room at Te Papa Tongarewa, the Museum of New Zealand, lie two killer whale skulls, cataloged as MM001077 and MM001078. The larger of the two, MM001077, is 38 inches (96.5 cm) long; MM001078 is only 26 inches (66 cm). These whales died in a mass stranding on a beach in Paraparaumu, on New Zealand's North Island, in 1955. Zoologist W. H. Dawbin from Victoria University College in Wellington described the whales as immature, ranging from 8 to 19 feet (2.4 to 5.8 m) in length. For five decades their skulls lay undisturbed on the shelf.

In 2005, killer whale researcher Christophe Guinet brought photographs of some unusual-looking killer whales he had seen near the Crozet Islands, in the Southern Indian Ocean, to a killer whale workshop in Seattle. The whales had small eyepatches—merely a narrow slit—and their heads were bulbous, more similar to pilot whales than typical killer whales. Their dorsal fins were more backswept, narrow, and pointed than usual. Guinet showed the pictures to Bob Pitman, a fellow researcher who often worked in Antarctica. The pictures sparked an immediate flash of recognition. Pitman had seen killer whales like these before in an old black-and-white photograph of a stranding on a beach in New Zealand fifty years earlier.

The waters around Antarctica are home to a diversity of killer whale ecotypes—Type A, Type B1, Type B2, and Type C. Pitman and other researchers began to wonder if these strange-looking killer whales were yet another ecotype. They started asking around and digging through old data, field logs, sighting reports, and photographs, and also kept a sharp eye out when they were at sea. And sure enough, these unusual-looking whales cropped up. A pattern began to emerge. The occurrences were all in sub-Antarctic waters, all the way around the globe. They became known as the Type D ecotype. However, there is speculation about whether they are "just" a new ecotype, or an entirely new species of killer whale.

In 2019, Pitman and his colleagues set out to settle this question and learn more about these elusive whales. Having heard from other scientists and fishermen that the waters south of Cape Horn in Chile could be a promising place to look for Type Ds, Pitman headed there. In the third week of their research cruise, they encountered a group of about thirty Type D killer whales. The team secured photographic documentation of the individuals in the group, recorded underwater footage, and collected skin biopsies for DNA analysis.

A comparison of the Type D DNA with DNA from the two skulls in the Te Papa Tongarewa collection room confirmed they were from the same population. Furthermore, the genetic analysis revealed that the population had the highest level of inbreeding and the lowest level of genetic diversity of any mammalian species. This suggests that the Type D population has either always been very small and over time became inbred, or that the population at some point underwent a significant decline that led to a drastic reduction in genetic diversity. This may not be an immediate threat to the whales, but low genetic diversity and a high degree of inbreeding does make them more vulnerable to disease and susceptible to environmental changes.

Right: The skull of a Type D killer whale that stranded on Paraparaumu Beach, New Zealand, in 1955.

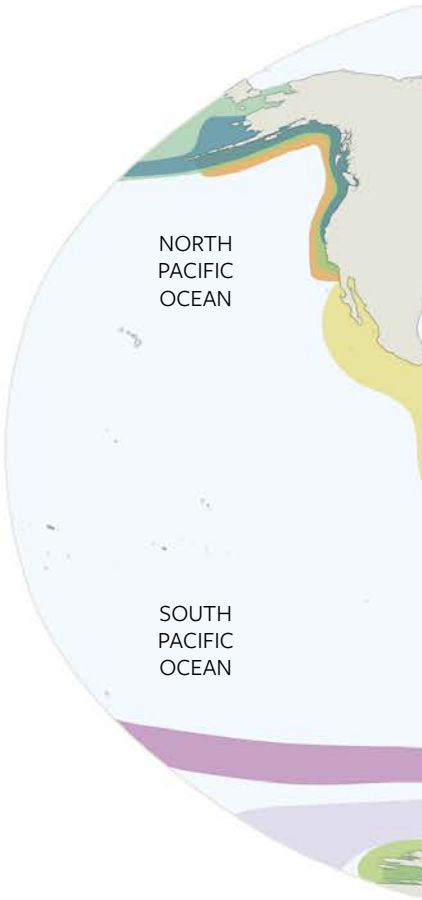
Below: All seventeen killer whales that stranded on Paraparaumu Beach had bulbous heads and small, slit-like eyepatches.

Out of sight

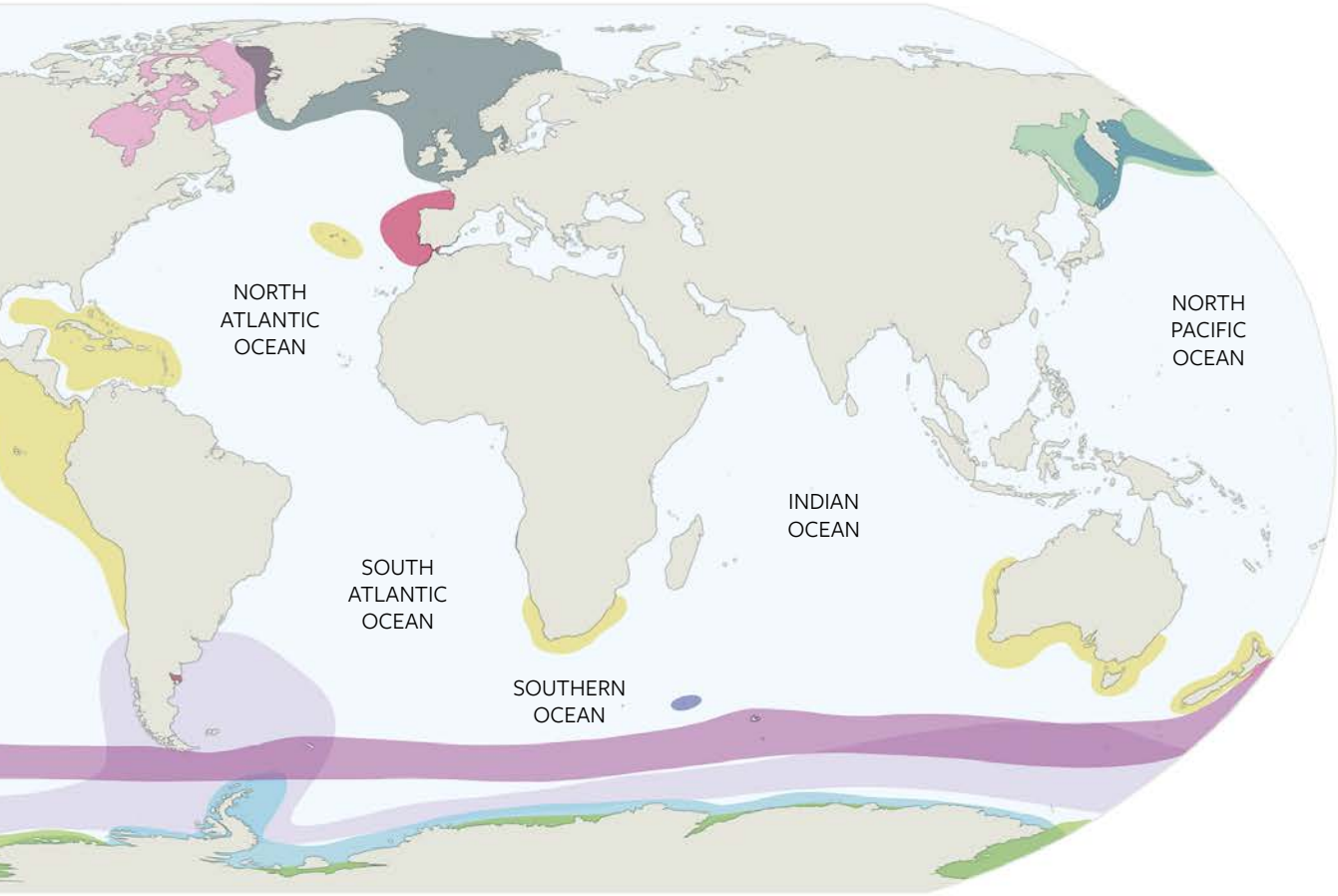
Our knowledge of killer whale distribution around the world is patchy and incomplete. For instance, killer whales are known to inhabit the waters around Japan, particularly near Hokkaido and further north toward the Russian Kuril Islands, yet we know very little about them. Similarly, killer whales are common around New Zealand and Australia, but they haven't been the focus of extensive research. Occasionally, reports emerge of killer whales in the Indian Ocean, in the warm waters of the Persian Gulf, around Sri Lanka and the Andaman Islands off the coast of Myanmar, or in the Channel Islands of Mayotte between Mozambique and Madagascar. However, sightings are sporadic and little is known about these whales' behavior, ecology, or population sizes.

Meanwhile, in the sub-Antarctic regions—places like the Crozet Islands, the Falkland Islands, the Kerguelen Islands, and Macquarie Island—killer whales seem to be more common. Although research has been carried out in these areas, there is still an incomplete picture of population sizes, long-term presence, diet, hunting behavior, and how many different ecotypes exist.

There are undoubtedly places where killer whales roam, but no one is there to observe or record their presence. In some regions, they may be common for a period of time and then disappear. Therefore, our knowledge of killer whale distribution, population size, behavior, and ecotype will always be somewhat shaped by where humans choose to observe and study them. Killer whales in the middle of the ocean, such as the ones that the crew onboard *Katla* saw, could perhaps be more common than we think.



Known global ranges of killer whale populations



- Bigg's (North American and Russian Far East populations)
- Residents (Northern, Southern, Southeast Alaskan, and Russian Far East populations)
- Offshores
- Canadian Arctic populations
- Northeast Atlantic populations
- Gulf of Cadiz and Strait of Gibraltar populations
- Patagonia's Punta Norte population
- Crozet Islands population
- Type As
- Type Bs (*core range only*)
- Type Cs (*core range only*)
- Type Ds
- Other areas of regular occurrence

Chapter Three

IN THE FIELD

Researchers Mike Bigg and Graeme Ellis take ID photographs of Northern Resident pod A-5 in the very early years of research off Vancouver Island, British Columbia.

Bob Pitman stands at the edge of the ice shelf in a black knit cap, dark wraparound sunglasses, and a bulky black jacket. His signature gray moustache is so thick it probably helps keep his face warm in the frigid air. Out of the pocket of his left thigh sticks a carbon-fiber arrow and under his right armpit is a crossbow. He looks like a hitman.

The killer whale surfaces close enough that he can see its massive form under the water; its warm breath fogs his glasses. He raises the crossbow to his shoulder and through the sights traces two cycles of surface-dive at intervals as smooth as a waveform. The white eye patch, pale saddle patch, and two-tone gray body match the grayscale color palette of this gloomy Antarctic day. On the next surfacing, Pitman aims at the middle of the dorsal fin and pulls the trigger. Bingo!

Pitman, a now-retired marine ecologist with Oregon State University, studied killer whales for over twenty years. He often spent six to eight months a year in the field and has worked on research vessels in the tropical Pacific, Indian, and Atlantic Oceans, the Bering Sea, and in Antarctica. From 2000 to 2019, his particular interest was the Antarctic killer whales.

The carbon-fiber dart bounces off the whale's dorsal fin and leaves a matchbox-sized electronic transmitter attached by two 2½-inch (6 cm) prongs. Over the following weeks and possibly months, every time the whale comes to the surface to breathe, the tag will transmit data to the Argos satellite system and Pitman will track the whale's movements and dive patterns until the tag falls out.

Killer whales may be easy to recognize but they are often hard to find, follow, and study at sea. They can travel over 150 miles (240 km) a day and keep going through the night. When we do see them, we see only snapshots of their complex lives when they come to the surface to breathe. Most of the action takes place underwater, so whale scientists have had to devise all kinds of inventive ways to research these animals—some borrowed from other fields, some state-of-the-art and some not, such as the almost-medieval crossbow, duct tape, cable ties, and a good sense of humor. The marine environment does not favor the researchers: long wet days, seasickness, weeks of work derailed by storms, cold spray over the bow, uncooperative whales, and the incompatibility of expensive equipment and corrosive salt water.

A Type C killer whale swims through an opening in the fast ice in McMurdo Sound, Ross Sea, Antarctica.

Left: A Type C calf takes a good look at whale researcher Lisa Ballance in McMurdo Sound, Antarctica.

Below: Researcher Tatiana Ivkovich (right) and assistant Ivan Nikolayev (left) collect fish scales in Kamchatka, Russia, to identify prey.

Many whale scientists have become experts in skills way beyond what they probably imagined they'd need when they started out in the profession. Job descriptions can often read more like a role in an action movie than a science project. Researchers have become archers, acousticians, engineers, drone pilots, photographers, videographers, and dog trainers. Thanks to their ingenuity, the allure of these animals, and years of dedicated work, we now have an impressive body of work that reveals just how remarkable killer whales are.

Photo identification

On August 8, 1970, a team of whale catchers chased eighty killer whales into Penn Cove on the east side of Whidbey Island in Washington state. Boats roared across the water, setting nets to block the killer whales' escape. The whales were herded and maneuvered into small nets and pens and sorted based on size. In the process, four whales drowned. Seven were captured and removed in canvas slings. The rest were released. The captured seven were sold and sent to marine parks in Texas, Florida, France, Japan, Australia, and England. At the time, this kind of live capture for the aquarium industry was big business. Between 1962 and 1973, 263 killer whales were captured in Washington state and British Columbia. Fifty were kept and sold to oceanaria, twelve died during the captures, and the rest either escaped or were released back into what was assumed to be a huge population.

But how many killer whales were there, actually? Hundreds? Thousands? Who knew? No one. Because no one had counted them. In 1971, as head of the Pacific Biological Station in Nanaimo on Vancouver Island, operated by Canada's Department of Fisheries and Oceans, marine mammal biologist Michael Bigg took on the job of answering this question. In so doing, he not only established that there were not enough killer whales to sustain ongoing capture and removal, he also pioneered a field technique that continues to be the foundation of killer whale research all over the world. Due in part to his research, killer whale capture was subsequently banned in North America in 1976.

Bigg started out by launching a massive public sighting survey. He sent thousands of postcards to fishers, ferry and tugboat captains, as well

as anyone who might be out on the water and asked them to count how many killer whales they saw on a particular weekend. He repeated this effort for three years in a row, and based on the responses he made his first estimate: 200–350 killer whales. But as Bigg spent time counting and watching killer whales, he began to realize that he could identify individual whales.

The idea that some animals had a major scar or deformed fin or some other conspicuous identifier wasn't new. But what Bigg discovered is that he could identify every single whale from a decent photograph of its dorsal fin and saddle patch. Once he figured this out, he spent as much time as he could in his 16-foot (5 m) research boat, responding to calls from volunteer observers who alerted him when they spotted killer whales. Using a 35 mm SLR camera with a 300 mm telephoto lens and Kodak 1200 ASA film, he snapped thousands of pictures of the whales: his identification (ID) shots were of the whales' right sides, taken perpendicular to the dorsal fin from about 100 feet (30.5 m) away. From the photos, he studied the dorsal fin shape (rounded, pointy, falcate, or erect) and size, the saddle patch shape (closed and teardrop-shaped, or open and S-shaped), as well as nicks and tears in the fin and scars on the saddle patch. He gave each animal an alphanumeric identifier, such as adult female A1. He teamed up with colleague Ken Balcomb, who started photographing the right sides of killer whales around the San Juan Islands in Washington, and the two would talk on the phone in the evenings after long days on the water and compare notes about which whales they had seen on the water and where.

Once Bigg could identify the whales, he began recording births, deaths, behaviors, and movements; and he began to notice stable associations between individuals. The same individuals traveled together year after year and he classified these as a "pod." He established that pods belonged to one of three distinct communities that overlapped in range but did not appear to mix: there were two fish-eating populations (northern and southern), and a marine-mammal-eating "transient" population. By 1974, the first census for the Southern Residents was complete: Bigg counted seventy-one individuals in three pods. By 1979, the first census for the Northern Residents was complete: he counted 140 individuals in twelve pods.

(continued...)

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