



KILLER IN THE KELP

Could a change in the dining habits of orcas crash an ecosystem? **Mark Schrope** reports on a mystery that reveals how little we know of the oceans.

When you're up to nine metres in length, weigh more than an African elephant and can swim at over 50 kilometres an hour, you can expect to be admired for your sheer brawn. Striking black-and-white markings over a sleek, streamlined torso will earn you points for beauty. But orcas, also called killer whales (*Orcinus orca*), can lay claim to brains too. These magnificent creatures have devised cunning methods to earn a top-carnivore's living from the sea. Some force sharks to the surface and club them with their flukes; others hunt the sharks down in underwater gangs. In Norwegian fjords, the orcas herd up herring, while on the shores of Patagonia they all but beach themselves to pick off seals. These differences in hunting practices between the orcas, along with differences in their looks and songs, have led some experts to suspect that the creatures actually belong to several separate species (see 'Species apart').

An abiding mystery, though, is whether a change from one feeding habit to another could profoundly alter the balance of marine ecosystems. In 1998, a team led by marine ecologist Jim Estes at the University of California, Santa Cruz, proposed that just such a shift might

explain an enigmatic and precipitous decline in Western Alaska's population of sea otters (*Enhydra lutris*)¹. The decline was of particular interest because the lack of predatory sea otters caused a boom in the sea-urchin population; the flourishing sea urchins, in turn, laid waste to large areas of kelp forest, thus changing the balance of a whole ecosystem.

Five years later, Alan Springer, a marine ecologist at the University of Alaska in Fairbanks, and colleagues, including Estes, took the hypothesis several steps further. They suggested that the sea otters' demise might be the last stage of a grander collapse in which orcas had shifted repeatedly to new prey as old prey ran low². The cause of this change, they argue, was commercial whaling, which deprived some orca populations of the great whales — such as humpbacks (*Megaptera novaeangliae*) and blues (*Balaenoptera musculus*) — on which they used to feed. The orcas turned instead to smaller sea mammals such as harbour seals (*Phoca vitulina*) and sea lions (*Eumetopias jubatus*), eventually working their way down to the otters and triggering the destruction of the kelp forests. The idea that

whaling could have changed the orca's diets had been suggested before by French researchers³, but this was the first time that it had been linked to wholesale ecological change.

"I'll be the first to admit that it isn't even close to being definitive," says Estes, who came to the story through his studies of sea otters "It was intended to be provocative."

Mission accomplished, judging by the two rebuttals contained in an upcoming issue of *Marine Mammal Science*^{4,5}. "Superficially attractive" is pretty much the nicest term used — "simplistic and highly selective" and "poorly supported" also feature. "It's a beautiful idea. I wish it

were true," says Lance Barrett-Lennard, a biologist studying orcas at the Vancouver Aquarium in British Columbia, Canada. "But it's wrong." Meanwhile, Springer and his colleagues are working on their own rebuttals.

The detractors challenge nearly every link in the chain of evidence that implicates the orcas, starting with whether they ever actually ate many great whales. There is little doubt that they ate whales: Springer, Estes and their colleagues point to historical records from whalers recount-

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Species apart

Rats and humans are said to be the planet's two most widespread mammals, but orcas run a fairly close third. Found in every ocean and in every clime, orcas have a wide range of tastes in prey. Yet ever since Carl Linnaeus gave them the name *Orcinus orca* in 1758, they have been treated as a single species. Now, opinions are starting to change. "Everybody acknowledges we will soon have a revision of [orca] taxonomy," says

Lance Barrett-Lennard, a biologist studying the mammals at the Vancouver Aquarium in British Columbia, Canada. "But if we do it now, we'll make a mess."

One of the potential re-classifiers is Robert Pitman, a biologist with the Southwest Fisheries Science Center in La Jolla, California. After countless hours in helicopters, small boats and ships scouring the frigid waters around Antarctica, he may be close to amassing evidence

that is strong enough to lead his peers to recognize at least one new species of orca.

The discussions of a potential new species of orca go back to at least the 1980s, when two separate teams of Russian scientists attempted to describe a new species in Antarctic waters^{8,9}. The work was generally discounted because of insufficient data, and in one case because samples were apparently lost in a museum flood

in Vladivostok. But Pitman, who was already involved in Antarctic surveys for the International Whaling Commission, thought there might be something to the Russian claim. "I started looking for differences," he says, "and found evidence fairly quickly that there were at least three different recognizable types down there." Ingrid Visser, founder of the Orca Research Trust in Whangarei, New Zealand, has also observed distinct populations around Antarctica, as have other researchers.

Not so black and white

One form, type A, has the classic black-and-white look, is typically found in open water, feeds mainly on minke whales (*Balaenoptera acutorostrata*), and has males that are 7–8 metres long. The other two forms have distinctive songs, are smaller than type A, and are found near shore in pack ice. Type B feeds on seals, and possibly also on larger whales, whereas type C seems to feed exclusively on the Antarctic toothfish (*Dissostichus*

Sharp shooting: blubber samples taken from the orcas' sides with a crossbow could provide proof of a species divide.



R. PITMAN

ing orca attacks. Television viewers around the world have seen the harrowing sequence of a grey-whale calf being eaten by orcas that featured in the documentary series *Blue Planet* — not an uncommon occurrence. In fact, the very name 'killer whale' may be a confused translation of the old Spanish term *asesina ballenas*, or whale killer.

Biting attacks

The problem is that in some of the places where whale populations have rebounded since commercial whaling stopped, biologists have yet to see any orca attacks on whales. "We can be out there on the water day after day with literally tens if not hundreds of humpbacks, and we just never see attacks," says Paul Wade of the National Marine Mammal Laboratory in Seattle, Washington. But whales are sometimes found with scars from orca bites. "If they aren't eating them, why are they biting into them?" asks Estes. Although no current population of orcas has been seen harassing humpbacks, he says, that doesn't mean that they aren't doing so — or did not in the past.

There is also a possibility, raised by Hal Whitehead of Dalhousie University in Nova Scotia, Canada, that whaling helped the orcas,

rather than cheating them of their food. Harpooned whales that were left floating on the surface were often partially eaten by orcas, he and his colleague Randall Reeves note in their paper on the subject⁶. In the heyday of whaling, harpoon shots may have sounded like dinner bells to orcas' ears, announcing a big fresh meal that required no hunting. In this version of the hypothesis, the end of whaling changed the orca's diet not because the number of humpbacks hit an all-time low, but because whalers stopped providing orcas with ready-to-eat meals.

The next step in the cascade is no less controversial. Wade points out that although populations of harbour seals crashed around the Aleutian Islands off Alaska in the 1970s and 1980s, they were stable in parts of the Bering Sea where commercial whaling had been just as heavy. And questions remain as to whether the seals and sea lions declined species by species or all at once.

At least as far as the North Pacific and Bering Sea are concerned, Estes agrees that the issue of sequentiality is important. Sequential collapse would point very specifically to the orcas,

whereas simultaneous collapse might reflect human exploitation of the fish that all the mammals prey on. But simultaneous collapse does not rule out variants of the hypothesis. At the other end of the world, Terrie Williams, also of the University of California, Santa Cruz, and her colleagues have proposed that the simultaneous collapse of the southern elephant seal (*Mirounga leonina*) and southern sea lion (*Otaria flavescens*) populations in the Southern Ocean might have been caused by orcas finding new prey after the end of whaling⁷.

The 'fewer sea otters more sea urchins' link in the chain is not quite as controversial. Orcas have been seen to eat sea otters, in one case sweeping a group off the ice it was lying on to catch

the otters in open water. But the evidence that enough of this sort of thing goes on is only circumstantial. Proponents point to observations that populations of sea otters have declined in areas of open water that contain orcas, but not in nearby orca-free lagoons, for instance. "There's nothing wrong with circumstantial evidence," says Wade. "You just have to be clear that it is circumstantial evidence, not direct evidence."

"The debate basically just highlights how difficult it is to study these animals."
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A, B, C: illustrations of the three orca populations.

U. GORTER

mawsoni). Both type B and type C are more grey and white than black and white. The habitats of all three orcas overlap to some extent during the summer — although their movements across the year are largely unknown — but no evidence has been seen of interbreeding between the three populations.

In a paper to appear in the *Journal of Mammalogy*, Pitman and his colleagues describe a helicopter survey of 221 type-C orcas — the population they think is the most likely to be recognized as a separate species given the information gathered so far. For more evidence, though, the team is finishing genetic analyses of more than 50 tiny blubber samples that have been pulled from orcas' sides with a crossbow. If the genetics prove their point, then type-C orcas will become the first new whale species named since 2003 (ref. 10).

This would not be a purely academic point. Commercial fishing for Antarctic toothfish is expanding, and if it proves to be the only known prey for a new species of orca, then that would have implications for conservation. Although orcas are treated as 'conservation dependent', they are not considered endangered. But a relatively small population newly classified as a species might be.

You are what you eat

The need for genetic data is universally agreed, as neither behaviour nor size is a sure guide. Take, for example, the question of fish eaters versus mammal eaters. In the North Pacific Ocean and the southern Bering Sea, two groups of orcas live near the shore, one of which eats mammals, the other mainly fish. The same distinction is seen in the Antarctic. For a

while, says Barrett-Lennard, a similar distinction at both ends of the world made it seem possible, even likely, that the behaviours were those of two different species. But the genetic tests said no. "We went, 'Holy smokes! Our mammal-eaters here are not genetically related to mammal-eaters elsewhere'," says Barrett-Lennard. That pretty much ended any hopes that behavioural differences would be enough to define and separate orca species. "The search right now is for consistent, deeper divisions," Barrett-Lennard stresses, pointing to the need for data from less-studied areas such as the central Indian Ocean and the Japan Sea.

Pitman, for his part, says that his group will make conclusions based only on what the data tell them. Still, he argues that Antarctic orcas

are a special case, in part because populations there are the only ones known that can be easily separated even by untrained observers. "I think Antarctica is particularly interesting because the morphology of the whales is so divergent," he says. Visser agrees. "It is just so graphically, graphically clear," she says. "I knew when I saw them the first time."

Results of the genetic tests are due any day now. And whatever those tests find, they should help to move the debate onward. "Come on," says Visser, "it's time that we take a step forward." **M.S.**



Look out for orcas: Western Alaska's sea otters may be a new and vulnerable prey.

also be seen as a strong argument to continue the whaling moratorium — although some fishermen have argued that the orcas should be culled. The debate is likely to continue for years, meaning that orcas will remain a symbol of how much remains unknown about the oceans. "You have to have the debate and you have to have people thinking creatively, and then, ultimately, you'll come down to the truth," says Williams. "It will happen — we just don't have the information now to know what the truth is." ■

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That said, you don't need many orcas eating otters for the effects to be felt. As big, fast, warm-blooded creatures, orcas need a phenomenal amount of energy. Williams calculates that relying on sea otters for even a fraction of that energy would mean eating a great many of them. But orcas eating otters would not prove that the cascade effect suggested by Springer and Estes exists. Wade thinks that a turn to sea otters as food would not require a collapse in the stocks of other possible prey. Hunting practices are learned, so if, for example, an injured mother decided to eat sea otters because they were easier to catch, that behaviour could spread in a

population irrespective of what other food was available. This might also reconcile the possibility that orcas used to feed on humpbacks with the claim that they no longer do.

Williams, like some other participants, has been surprised at how long the debate has gone on. "It basically just highlights how difficult it is to study these animals," she says. Clearly, one of the reasons that the arguments have been so heated is that the conservation stakes are high. The domino effect from whales through seals to sea otters as a potential explanation for the declines in marine mammals could take some of the pressure off commercial fishing. It might

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