Genetics lab unravels mystery killing at sea

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In this image, killer whales cruise past the scene of their attack on another whale, spotted by a NOAA Fisheries research survey late last year. Scientists pieced together the species involved through genetic studies of leftover lung tissue. Credit: Paula Olson/NOAA Fisheries

Observers on a NOAA Fisheries marine mammal survey some 200 miles off the coast of Central California had spotted the telltale signs of a killer whale attack through high-powered binoculars a few miles away. Frenzied swimming churned the ocean surface. Geysers of bloody water sprayed into the air. Hungry seabirds circled in search of leftovers.

But by the time the large research ship arrived at the scene, all biologists could find was a slick of oil from the vanished victim. That, and the

unidentified animal's lungs and heart.

Which was all the evidence Brittany Hancock-Hanser needed.

A research biologist in the Marine Mammal Genetics Group at the Southwest Fisheries Science Center in La Jolla, Calif., Hancock-Hanser and her colleagues tease information from the tiniest traces of life. Their target is the DNA that holds every creature's genetic code, defining an animal's species, identity, evolutionary lineage, family relationships and more.

In the case of the recovered lungs and heart, those secrets would provide new insight into the animal the killer whales had attacked.

"We didn't know what that animal was," Hancock-Hanser recalls. "But given the capacity of our lab and how much work we've done on cetaceans, we knew we had a pretty good chance of figuring that out."

Hungry albatrosses jockey for a share of the whale lung left from a killer whale attack off the California Coast. Biologists later recovered the lung for genetic study. Credit: Paula Olson/NOAA Fisheries

Searching the genetic library

The Southwest Fisheries Science Center houses one of the largest collections of tissue and DNA samples from marine mammals and sea turtles in the world, all preserved in giant freezers. It includes about 175,000 tissue samples from roughly 145,000 unique animals and more than 60,000 samples of DNA representing virtually every known species of marine mammal and sea turtle.

Every sample has a unique barcode linked to a database with details about where it came from and how it has been studied.

The size of the collection makes it a powerful genetic tool. The more examples of DNA that are available, the better chance Hancock-Hanser would have of matching DNA from the recovered heart and lungs to a known species and, in turn, determining what kind of animal they came from.

"We've worked with pretty much every cetacean species there is, so we can compare the genetics to this enormous library of material and learn a lot that way," says Phillip Morin, a research molecular biologist in the Marine Mammal Genetics Group. "From a sample not much larger than the head of a pin we can learn a great deal both at the individual and species level."

Finding the genetic fingerprint

The SWFSC Marine Mammal and Turtle Molecular Research Sample Collection houses over 70,000 DNA samples. The samples are stored in several freezers held at a constant temperature of minus 80 degrees Celsius. Credit: Paula Olson/NOAA Fisheries

Back in the lab, Kelly Robertson, another member of the genetics team, began analysis of the recovered heart and lung. First she extracted the DNA with enzymes that permeated the lung tissue and opened its cells. Next she cleaned the DNA through a series of alcohol washes over a few

days. Then she and her colleagues used specialized enzymes to replicate the DNA over and over, providing enough copies for them to analyze in the laboratory.

A robotic system then examined a particular part of the DNA sequence known to distinguish different marine mammal species, displaying the results as a series of peaks in the concentrations of molecules that are the building blocks of DNA. The whole process took a little over a week and gave the team part of the genetic fingerprint of the animal that fell prey to the frenzied killer whales far out at sea.

The computer compared the genetic sequence to the database of whale species curated by the Marine Mammal Genetics Group and quickly identified the prey: a pygmy sperm whale. This species of small whale, not much larger than many dolphins, is rarely seen and is known largely through analysis of the few that occasionally strand on shore.

Indeed, the finding is also revealing in terms of killer whales, which had not been documented as preying on pygmy sperm whales in the Pacific Ocean. The new evidence that they do underscores their position as top predators that can kill almost any other marine mammal given the chance.

"We weren't able to get there soon enough to see just what was going on," Hancock-Hanser said. "But through genetics we could piece together what happened and learn something new from the result."

Provided by NOAA National Marine Fisheries Service