

UIC is more than
700 miles from the
nearest ocean,
but that doesn't stop
Associate Professor
**JENNIFER
SCHMIDT**
from being one
of the world's
foremost whale
shark researchers

By Steve Hendershot

Seven people in a homemade outrigger boat are peering down into the murky, turbid waters of the Philippine Sea, hoping for a glimpse of a hulking shadow or a giant dorsal fin. For the captain and crew, today's journey is almost routine: every day for weeks now, they've been ferrying groups of eco-tourists along the coast in search of whale sharks, literally the biggest fish in the sea.

Today's passengers are a different lot, though. They are scientists, and in addition to their cameras and sun-tan lotion, they're also carrying six-foot spears tipped with biopsy darts to collect shark skin samples, as well as DNA collection kits. They're here for the same reason as the tourists: the waters off the coast of the fishing village of Donsol are one of the best places in the world to find the giant, but remarkably elusive, whale sharks.

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A diver in a dark wetsuit is seen from behind, swimming in clear blue water. The diver is wearing a blue oxygen tank and has their arms slightly out to the sides. The background is a deep, clear blue, suggesting an underwater environment.



Whale shark and diver,
Ningaloo Reef, Australia



Lloyd DeGrane

UIC Associate Professor Jennifer Schmidt's DNA research subjects range from some of the Earth's smallest to its largest. At her primary lab on UIC's West Campus, she utilizes DNA analysis to study such childhood diseases as hydrocephalus, which is characterized by excess fluid in the brain's ventricles. Defrosted whale shark embryo (right). A biopsy sample (lower right) taken from a whale shark's skin. Spear-guns equipped with biopsy darts (below) are used to collect whale shark skin samples.



Jennifer Schmidt



Jennifer Schmidt



Jennifer Schmidt

Among the scientists is UIC's Jennifer Schmidt, one of the world's foremost whale shark researchers, despite living in Chicago. Her peers work in places such as Perth, Australia, or Seychelles (located off Africa's east coast)—locations where whale sharks congregate. But there are no whale sharks in Lake Michigan, and the closest Schmidt, an associate professor of biological sciences, comes to the wild in her day-to-day routine is walking past stuffed lions on her way to the Field Museum's DNA lab, the Pritzker Laboratory for Molecular Systematics and Evolution.

Her arrangement works because Schmidt is a geneticist, not a field biologist. In fact, she spent years studying whale sharks in the lab, analyzing their skin samples and DNA characteristics, before she ever saw one in its natural environment. Yet her lab work has uncovered much about whale sharks—how they travel, how they mate—data that has eluded field researchers.

Schmidt's work on the "genetics of whale sharks has been fairly pivotal to the direction science has taken," says David Rowat, chairman of the Marine Conservation Society in Seychelles. "Her insights have been a mine of information, filling in gaps that published research papers missed and providing valuable background [information]."

Schmidt is also here, though, in the Philippines on this canoe-like boat called a banca, trolling for whale sharks. It is not strictly necessary for a geneticist to work in the field. She could (and does) rely on colleagues to ship her skin samples, and could unearth a wealth of whale shark knowledge without leaving the lab.

But Schmidt's connection to these animals isn't strictly scientific. "You can't help but be moved by seeing a magnificent species like that in the water," she says.

So when one of the spotters on the boat sees the giant head of the whale shark just beneath the plankton-rich water, Schmidt gets her gear ready and drops off the boat's side.

The spear gun she carries looks intimidating, but considering that a whale shark's skin is eight inches thick, the shark will experience the skin-collection exercise as a sensation akin to getting poked with a pin. Most of the time, the animals don't even react.

But even as the interaction leaves the whale shark nonplussed, Schmidt is deeply impressed.

"I like watching this beautiful animal in its environment, and seeing how it is perfectly adapted to that environment," Schmidt relates. "A whale shark is absolutely effortless in the water. You'll see a bunch of humans struggling to keep up with the whale shark, and then it just flicks its tail and it's gone."

Mythical creatures

It is a testament to the ocean's vastness that whale sharks remain such a mystery. Adult whale sharks can grow to the size of a school bus and live for 100 years, yet scientists don't know precisely where they live, how they relate to one another or how they breed. For decades, whale sharks were practically mythical: gargantuan,

polka-dotted animals that sailors occasionally would happen upon in the open ocean. It wasn't until the 1980s that scientists realized that, if you were at the right place at the right time each year—off the western coast of Australia in May, for example, or Mexico's Yucatan Peninsula in August—you could witness whale sharks arriving in great numbers, sometimes hundreds upon hundreds of them, to feed on plankton. These aggregations are a boon to researchers, but don't form a complete picture of whale shark society, as most of the participating whale sharks are young males.

Schmidt observed the phenomenon at its most extreme last summer in Mexico. She'd seen plenty of whale sharks before, but here she saw 200. "I was used to having to search for them and chase after them a bit, but there, you just hang out and wait for one," she says. "There were dorsal fins everywhere."

Whale sharks are gentle, move slowly and generally seem to enjoy interacting with humans. But when they gather in giant feeding aggregations, humans should prepare to feel ignored; then, it's all about the plankton.

Whale sharks are filter feeders, meaning they eat by opening their large maws ("a mouth as big as a double bed," says Marie Levine, executive director of the Princeton, N.J.-based Shark Research Institute), consuming everything nearby, then expelling all the water—leaving behind a still-giant mouthful of plankton to enjoy.

Schmidt recalls the first time she saw a whale shark, in the Philippines; she was scanning the murky, plankton-rich water, when she spotted an enormous head coming her way.

"They're right at the surface, vacuuming the surface of the water, totally engrossed in feeding," she says. "If you jump in right next to them, they couldn't care less. It's, 'Don't get in front of me or block my food source, and I'm good with it.'" Whale sharks have never killed a human, and although Schmidt has felt the gentle pull of a whale shark's open mouth, she says it's easy enough to get out of the way.

Secrets of the "Pupsicle"

Schmidt has thus far used genetics to investigate two whale shark mysteries. The first involved taking skin samples from whale sharks around the world to determine whether they are world travelers or if there are distinct, local whale shark populations in certain oceans or areas.

Through the use of GPS, researchers had independently determined that whale sharks are capable of traveling long distances, even crossing from one ocean to another. Schmidt's DNA research revealed no substantive genetic differences relating to regional traits, indicating that there is probably one global population of whale sharks, all of which are more or less alike.

That data supports the GPS findings, as well as anecdotal reports of whale sharks beaching themselves in South Africa, where the water is too cold for their taste, but a necessary evil if they want to swim from the Atlantic to the Indian Ocean.

For conservationists, this reach is worrisome because it means that all whale sharks are threatened by active fisheries in nations such as

In Their Defense

Jennifer Schmidt's DNA research may help whale sharks and their cousins earn additional environmental protection

Whale sharks "look like they were designed by Walt Disney, have never harmed a human and you can scratch their bellies," according to Marie Levine, executive director of the Shark Research Institute in Princeton, N.J. "They are amazing creatures with gentle dispositions. They are curious about people and apparently enjoy gently interacting with them."

Indeed, whale sharks anchor growing eco-tourist industries in nations such as the Philippines and Mexico.

But in other parts of the world, primarily Asia, whale sharks are hunted.

"Shark populations, including whale sharks, are threatened by the brutal practice of finning. A live shark is caught, its fins are sliced off and the animal is

thrown back into the water to die. The fin is a shark's most valuable part and finning feeds a lucrative trade in countries where shark fin soup is popular," says Jennifer Schmidt.

Shark conservation in general suffers compared to efforts directed at other species. But Schmidt's DNA research may help save the whale sharks.

As the SRI lobbies for additional protection for whale sharks, Levine says that Schmidt's research "gives us the ammunition we need. We can't expect protection just because whale sharks are wonderful and gentle; we need hard science proving that these animals are threatened. [Schmidt's] research provides that, which is one reason why what she's doing is so important." —S.H.



A hammerhead shark after being "finned" by fishermen.



Fred Bauwandam/Getty Images



Jennifer Schmidt



Eison Aca

Clockwise from the top: Whale sharks are filter feeders. They open their large maws, consuming everything nearby, then expel all the water, leaving a mouthful of plankton to consume. Paper-mache-decorated boats taking part in the annual Butanding (local term for whale sharks) Festival in Donsol, Philippines. The smallest free-swimming whale shark pup ever recorded. Schmidt scuba diving during a recent whale shark expedition.



Steve Simon

China and Indonesia. It's illegal in many countries to hunt whale sharks, but not all, and if they all must pass through territorial waters with active fisheries, it could devastate the global population.

Schmidt's research "has really provided us some insights into the likely inter-relationships between these different [whale shark] aggregations," says Mark Meekan, principal research scientist at the Australian Institute of Marine Science, located near Perth. The research demonstrates "that their conservation needs to be at a global scale."

The danger is amplified by the fact that whale sharks don't become sexually mature until they are 25 or 30 years old. In that regard, whale sharks are unlike smaller fish species. "If you fish down faster-reproducing species, then in 10 years, they will

have begun to replenish their stock,” explains Schmidt. “If whale sharks [become] depleted, it would take hundreds of years for the species to come back.”

Schmidt’s second whale shark genetics project focuses on breeding and reproduction. The current lack of data makes this project much more complex. As previously noted, few female whale sharks attend the coastal plankton feasts, and while they are common in places, such as the Galapagos Islands, male and female whale sharks are rarely spotted together.

In 1995, a Taiwanese fisherman caught a pregnant female whale shark. He alerted biologists at National Taiwan Ocean University in Keelung, and handed over the animal. (Whale shark fishing is now prohibited in Taiwan, but was legal then.)

Biologist Shoou-Jeng Joung laid out the whale shark’s pups in a grid on a dock. There were 304 embryos in all, the largest shark litter ever recorded. Most of them were discarded, but 29 were frozen together in a giant block of ice until Schmidt visited Joung’s laboratory in 2009. It took her four hours to thaw what Meekan had dubbed “the pupsicle,” after which she took DNA samples from each pup.

How much can you learn about the breeding and birthing patterns of an entire species from a single animal’s litter? Plenty, as it turns out. Schmidt focused on determining the pups’ paternity for clues about whale shark mating habits. Some shark species are communal breeders, and pregnant females carry developing offspring from several males simultaneously.

That wasn’t the case with the whale sharks: all the pups had the same father. But they were at very different stages of development—meaning that either a whale shark pair had mated repeatedly, or that the female stored sperm from a single encounter and then fertilized the eggs one at a time over the course of many months. Indeed, the latter option is Schmidt’s hypothesis, because no shark species is known to form long-term pairs.

Childhood diseases by day

Schmidt conducts her research on whale sharks as an offshoot of her main research goals.

Her primary lab is on UIC’s West Campus, and it buzzes each day with the activity of her undergraduates, grad-student researchers and even a colony of mice. Here, Schmidt studies the genetic basis of childhood diseases.

So when the Shark Research Institute’s Marie Levine calls Schmidt “the most outstanding whale shark researcher in the world today,” it’s a testament not only to Schmidt’s skill as a researcher, but also to her time-management mastery, and perhaps most impressively, her intellectual flexibility.

Compared to Schmidt’s on-campus study of human diseases, in which she hones in on isolated genetic variables and relies on fully sequenced human and mouse genomes, the ambiguity of her whale shark research could be overwhelming. But she insists that it’s not.



Schmidt’s DNA research has helped determine that whale sharks are of one global population, which complicates conservation efforts.

“It’s different in every way except technically,” she explains. “The techniques are very similar. It comes down to DNA, which will tell you everything about a species if you know how to read it, whether you’re using it to learn about human disease patterns or whale shark development.”

Easy for a geneticist to say. And modest. Her peers, though, are impressed.

“These are vastly different projects, and they require a different mindset, a different angle,” says **Kevin Feldheim, PHD ’02 LAS, ’92 UI, MS ’95 UI**, manager of the Field Museum’s Pritzker Laboratory. “She’s going from something that’s known to something that’s completely unknown, which can be very exciting, but also frustrating.”

Unsolved mysteries

There’s plenty left to learn about whale sharks. In fact, one of Schmidt’s most pressing questions is, “Where, exactly, are all the young whale sharks?” If a litter contains 300 pups, as the one in Taiwan did, shouldn’t the oceans be teeming with whale shark pups? But few have been spotted, even though healthy numbers of older, adolescent males turn up each year in eight to 10 coastal aggregations around the world, such as the one in the Yucatan Peninsula, for the plankton feeds.

Schmidt travels to whale shark havens three or four times a year, and plans to devote even more of her sabbatical leave from UIC in 2011-12 to traveling around the world to be with whale sharks. One of Schmidt’s trips will be to Djibouti, a small African nation with an annual aggregation that includes many young whale sharks—some only eight or nine months old.

It could be that the population of young whale sharks is severely depleted. Or it could be that large numbers of whale sharks are thriving either far from shore or deep beneath the ocean’s surface.

Jennifer Schmidt will work to ensure that the number of whale sharks remains healthy and that the number of whale shark-related variables and unknowns steadily dwindles. If a leading whale shark researcher can be based in Chicago, anything is possible.

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