New study shows some sharks follow 'mental map' to navigate seas

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A new study led by a University of Florida researcher uses tracking data of three shark species to provide the first evidence some of the fish swim directly to targeted locations.

Researchers found tiger and thresher sharks showed the ability to orient at large distances, with tiger sharks swimming in direct paths at least 4 miles away and reaching specific resource areas about 30 miles away, said lead author Yannis Papastamatiou, a marine biologist in the division of ichthyology at the Florida Museum of Natural History on the UF campus.

A research highlight of the study in the current edition of the Journal of Animal Ecology will appear in the Thursday issue of the journal *Nature*.

"This study is important because it uses quantitative methods to try to understand the underlying ecological reasons for animal movement," said Kevin Weng, a marine biologist at the University of Hawaii at Manoa. "Studies such as this one are stepping stones to achieving predictive skill for animal movement, and better understanding of navigation, population dynamics and ecology."

Papastamatiou said the study suggests the sharks have developed a 'mental map' of the area.

"There's been several studies that have shown that marine predators, like sharks, penguins, turtles and tunas, move using particular types of

random walks, but there's going to be times when these animals don't move randomly," Papastamatiou said. "This study shows that at times sharks are able to orient to specific features, and in the case of tiger sharks, the distance over which they're performing those directed walks is likely larger than the distance of the immediate range of their sensory systems."

Researchers use the term "directed walk" to describe when a shark is moving toward a known goal rather than randomly swimming.

Researchers re-analyzed tracking data from acoustic transmitters on nine tiger sharks off the south shore of Oahu, Hawaii, in 1999, nine blacktip reef sharks in the lagoons of Palmyra Atoll in the Central Pacific Ocean in 2009, and 15 thresher sharks off the southern California coast in 2010. The animals were followed for at least seven hours and the statistical analysis determined whether the sharks were moving randomly or toward a known goal.

While tiger sharks have acute senses of sight, hearing and smell, their home range covers hundreds of square miles, including resource spots outside their sensory range. As bounce divers, they also almost continuously swim between the surface and about 250 to 330 feet below.

"At times these tiger sharks were swimming across a deep channel, open ocean, often at night," Papastamatiou said. "So the question is, 'What are they orienting to in such a seemingly featureless environment?' It really just highlights how impressive their navigation can be."

Researchers determined adult thresher sharks could orient at greater distances than juveniles, most likely because of their advanced development, Papastamatiou said. The study found blacktip reef sharks only traveled randomly, which has to do with their small home range compared to larger areas covered by thresher and tiger sharks.

Papastamatiou speculated the "mental map" the sharks create may have to do with their ability to sense magnetic fields.

"Probably the most interesting sense and still the most misunderstood is magnetic reception," Papastamatiou said. "There is an increasing amount of evidence that lots of, if not all animals, can to a certain degree detect magnetic fields. That is something that could potentially be used over very large distances because there are gradients in the earth's magnetic field and they could use those as landmarks — so even swimming through open ocean, which seems featureless to us, may not be featureless to sharks if they could detect these magnetic fields."

He said the research would potentially be useful for obtaining accurate population dispersal models for the sharks so that movement patterns can be predicted after changes caused by fishing or the relocation of prey.

Provided by University of Florida