Shark biologist teams up with aerospace engineer to discover behaviors of oceanic whitetips

January 12 2018, by Joann C. Adkins

Credit: Florida International University

Oceanic whitetip sharks move with extreme efficiency, exploiting physics to maximize their energy surplus for both hunting and downtime.

A team of scientists that included shark biologists, an aerospace engineer and statisticians spent several years developing precise calculations based on the oceanic whitetip's average size, swimming location, water temperatures, location of prey in the water and daily activities. The team was led by FIU marine scientist Yannis Papastamatiou, who wanted to learn more about the elusive creatures.

Oceanic whitetips reside almost exclusively in open water, making them more difficult to study than coastal sharks. Papastamatiou likens their habitat to the desert, a vast ecosystem where food is sparse. When any animal consumes prey, it gets energy. When it's searching for prey, it's losing energy. Papastamatiou wanted to know what behavior could maximize an animal's energy surplus and if oceanic whitetips behaved as such. He called on Gil Iosilevskii, an aerospace engineer from Technion – Israel Institute of Technology, for some basic calculations. Papastamatiou quickly realized basic wouldn't cut it. Iosilevskii turned to calculations he uses to determine optimal flight performance for planes.

These models predicted the optimal swim speeds for the sharks. They also predicted the sharks should dive at small angles and maintain almost constant speed throughout a dive, yet sharks are negatively buoyant meaning they naturally sink in water when they stop swimming. That makes descending easier than ascending.

The team went to the Bahamas, where oceanic whitetips are known to seasonally aggregate, and tagged several sharks with sensors to measure speed, acceleration and depth. They also attached cameras to two of the sharks they were tracking. The scientists discovered the sharks actually do swim and behave optimally, going so far as to control their speed and remain constant while ascending and descending, the very thing physics

says they should do. The team's findings were published today in *Scientific Reports*.

They were very surprised, however, to discover one of the sharks made an unexpected move when it took off from 160 meters vertically at 4 meters per second and breached the surface. Normal speed for the species is 0.6 to 0.7 meters per second and breaches typically originate from around 10 meters. Papastamatiou says they have no idea what caused the sudden burst of activity. It's possible it was a high-speed ambush of prey, though it's unlikely from such a depth. What they do know is that 40-second breach is energetically equivalent to 50 minutes of swimming for the oceanic whitetip's average cruising speed.

"I can't imagine this shark could see something at the surface from that depth," Papastamatiou said. "It was going full force in a vertical ascent."

Papastamatiou has witnessed similar breaches by oceanic whitetips, once in-person and other times on video. It's something he hopes to explore further as his research on oceanic whitetips continues.

Other than the occasional breaches, oceanic whitetips appear to live a life of minimization. They survive in a food-poor environment by swimming optimally and by keeping their energetic costs low. Papastamatiou says he will continue to combine physics and biology in his research to help uncover the secrets of the large marine predators that have long proven difficult to study.

More information: Yannis P. Papastamatiou et al. Optimal swimming strategies and behavioral plasticity of oceanic whitetip sharks, *Scientific Reports* (2018). DOI: 10.1038/s41598-017-18608-z