Sea Grant California

FISHERIES RESEARCH & DEVELOPMENT

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Movement Patterns and Bioenergetics of the Shortfin Mako Shark

Jeffrey Graham

University of California, San Diego—Scripps Institution of Oceanography

Background

The mako shark (*Isurus oxyrinchus*) is the quintessential shark—an awesome swimming machine, spectacularly acrobatic, fast, sleek and muscular, with a mouthful of razor sharp teeth. As with tunas, makos maintain body temperatures in their locomotor muscles above ambient water temperatures. This regional endothermy, as it is known technically, is believed to enhance muscle power and efficiency while swimming.

Tagging technique developed by trainee Chugey Sepulveda; shortfin mako shark voluntarily swallows a mackerel containing an acoustic transmitter. Photo: David Itano, Joint Institute for Marine and Atmospheric Research, Hawaii

Fishery

In the Southern California Bight, the indentation along coastal Southern California that extends about 100 miles into Baja California, Mexico, mako sharks are a secondary target of the swordfish and thresher shark drift gillnet fisheries. Although larger mako sharks have commercial value, smaller ones are often discarded. Many blue sharks are also caught inadvertently and discarded as bycatch.

Because sharks are exceptionally vulnerable to fishing pressure and the bight is a nursery ground for newborn and juvenile sharks, biologists have expressed concerns that gillnetting might cause the mako shark population to crash suddenly and remain chronically suppressed. These concerns were heightened recently with the passage of a new regulation banning drift gillnetting north of the Southern California Bight, a measure taken to reduce bycatch of endangered leatherback sea turtles. Some biologists are concerned the regulation will heighten fishing activity in the bight, further intensifying pressure on mako sharks. Given the expected southward shift in fishing effort, it has become even more important to understand the movements and preferred habitats of both target and bycatch species.

Project

California Sea Grant funded fish physiologist Jeffrey Graham and graduate student Chugey Sepulveda to track and study the movements and bioenergetics of mako sharks in the bight, the main goal being to identify habitats essential to the animals' growth and survival. This information will better equip fishery managers to craft regulations that could ensure the long-term sustainability of sharks and thus the health of the marine ecosystem in which these top predators play a key role.

During the course of the grant, the biologists tracked eight juvenile makos tagged with acoustic transmitters that emit electronic signals of water temperature and depth (pressure). Seven of the sharks were tagged within fives miles of the Scripps Pier in La Jolla. One was tagged near Carlsbad Canyon about 15 miles north of La Jolla. The sharks were tracked between eight and 56 hours. Tagged sharks ranged from 75 centimeters (the length of a newborn) to 150 centimeters (the length of a two- or three-year-old) and weighed between 6 kilograms and 45 kilograms. (Adult female makos, which are bigger than males, can grow to be more than 4 meters and 500 kilograms.)

Tagging Technique

As part of the project, Sea Grant Trainee Chugey Sepulveda developed a tagging technique in which a transmitter—about the size of a small pencil—was inserted into a dead mackerel. By chumming with ground-up fish, Sepulveda attracted makos to the boat. He was then able to get a mako to voluntarily swallow a mackerel—and hence a tag.

Placing tags inside the makos was an important part of the project because it allowed researchers to record stomach temperatures, believed to reflect the animals' feeding behavior.

Findings

Data from the eight tagged sharks showed that juvenile makos spend about 80 percent of their time within 12 meters of the surface; 15 percent of their time between 12 and 24 meters' depth, and five percent of their time at depths greater than 24 meters.

Body size (and hence age) was positively correlated with maximum

swimming depth—larger, older sharks spent relatively more time at greater depths than smaller, younger ones. Sharks were also observed to continue foraging after being tagged, suggesting the tags had not altered normal activity—a concern when basing scientific findings solely on observations of tagged animals.

Four of the eight tagged sharks were lured back to the boat, captured and brought to a laboratory for further tests. Necropsies confirmed that shark stomachs contained prey, suggesting that abrupt drops in stomach temperature observed in the tracking record were associated with feeding.

Implications and Applications

Under current regulation, drift gillnets can only be set at night and nets must be submerged at least 12 meters beneath the surface to reduce the risk of entangling whales, dolphins and other marine animals.

Based on the findings of this California Sea Grant project, this same regulation is likely reducing the risk to juvenile mako sharks, too. This information has been shared with NOAA Fisheries, the federal agency which manages highly migratory shark species.

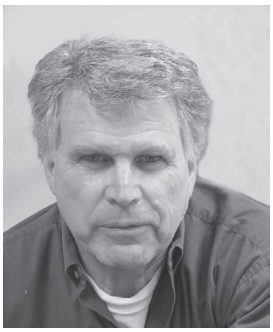
Since completing their tagging study, the scientists have received a second grant from California Sea Grant to conduct a similar study of thresher sharks in the bight. This project will add to what is known about the essential habitat requirements of two commercially important sharks in the region. A goal is to identify the relative amount of time different age-groups of sharks spend in the depths that make them vulnerable to gillnetting.

"In the bight, the mako is overfished," Graham said. "Both young and old sharks are targeted, particularly the young. Sharks take a long time to reach sexual maturity. By removing large numbers of young sharks, a serious detriment to the future population is occurring. We have no basis yet of knowing the size of this detriment for makos and threshers. However, we could be moving toward a time when the adult makos become very rare and the population crashes."

Although mako sharks were observed to spend most of their time above the minimum-depth requirement for gillnets, Graham emphasized that sharks still dive to deeper depths regularly. During these times, he said, they are at risk of being caught. If fishing pressure (i.e., gillnetting) were to intensify significantly, the depth-minimums would offer progressively less protection from overfishing because there would be more nets in the water to ensnare sharks going up and down, Graham said.

The data from these two projects will contribute to a number of ongoing projects and federal initiatives, namely the Fishery Management Plan for Highly Migratory Species Fisheries off the West Coast, the National Plan of Action for the Conservation and Management of Sharks, the Census of Marine Life program and its pilot project, Tagging of Pacific Pelagics.

Findings will be shared with NOAA Fisheries, the California Department of Fish and Game and university scientists, and disseminated to recreational fishing groups such as the United Anglers Association and commercial organizations such as the Western Fishboat Owners Association. In addition, project results will be shared with fisheries scientists in Mexico to give its resource managers access to the most current scientific information.



Fish physiologist Jeffrey Graham.

Sea Grant trainee Chugey Sepulveda. Photos: Christina Johnson, California Sea Grant

Collaborating Institutions

California State University, Fullerton
California State University, Long Beach
NOAA Fisheries, La Jolla

Trainee

Chugey Sepulveda

Presentations

Sepulveda, C.A., S. Kohin, R. Vetter, and J.B. Graham. Movement patterns, depth preferences and stomach temperatures of free swimming juvenile mako sharks, *Isurus oxyrinchus* in the Southern California Bight. 54th International Tuna Conference, Lake Arrowhead, California, May 21–24, 2003.

For more information:

Dr. Jeffrey Graham
Department of Marine Biology
Scripps Institution of Oceanography
Tel.: (858) 534-8044
Email: jgraham@ucsd.edu

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