

# ARGOS FORUM # 74

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## ESTABLISHING, MANAGING AND EVALUATING MARINE PROTECTED AREAS WITH ARGOS

ENVIRONMENTAL MONITORING

Evaluating spatial effectiveness of  
existing marine zones

# MIGRATORY MOVEMENTS OF SHARKS IN THE GALAPAGOS MARINE RESERVE

By

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**The Eastern Tropical Pacific (ETP)** is home to abundant populations of sharks and other marine predators. At some specific sites – such as the Galapagos, Cocos and Malpelo Islands – they can still be seen in high numbers, close to what would be considered pristine population states. However, unsustainable fishing practices are threatening the collapse of many shark populations in the ETP and worldwide. In order to support conservation efforts in their favor, it is essential to understand the ecology, migratory movements, and spatial dynamics of these species, as César Peñaherrera and his colleagues explain.

Marine Protected Areas (MPA) may offer considerable benefits to pelagic environments. But how do current MPA management models contribute to protection of shark and other apex pelagic species? The creation in 1998 of the Galapagos Marine Reserve (GMR) was expected to have a positive impact on all marine species. However, at the time there was limited technical information regarding the spatial dynamics of migratory species to inform related decision-making and management processes.

## THE GALAPAGOS EXAMPLE

Since 2006, researchers in the Galapagos Islands have been working to assess the abundance trends, site fidelity and migratory pathways of sharks in the GMR. This research program began as a response to growing worldwide concern about the state of shark populations and the need to develop National Plans of Action. The project is a multi-institutional effort by the Galapagos National Park Directorate (GNPD), the Charles Darwin Foundation (CDF) and the University of California–Davis with the collaboration of Stanford University. Results obtained will provide MPA managers and stakeholders crucial biological and behavioral information to support shark management and conservation efforts in the GMR.

## USING ARGOS TO TRACK SHARKS

To date, the satellite telemetry component of the project has tagged 15 hammerhead sharks (*Sphyrna lewini*; classified EN-Endangered on the IUCN Red List of Threatened Species), 11 Galapagos sharks (*Carcharhinus galapagensis*; classified as Near Threatened), 15 blacktip sharks (*C. limbatus*; Near Threatened), seven silky sharks (*C. falciformis*; Near Threatened) and 25 whale sharks (*Rhincodon typus*; Vulnerable). Satellite tags in use by the project are SPOT 5, SPLASH and PAT tags (Wildlife computers), and Sea Tags (Desert Star). Mid-size sharks (1.5 to 3.5 m in total length) are caught using a hook and line, brought onboard a research vessel with a sling, and tagged. The tags are attached to the dorsal fin of sharks with plastic bolts and stainless steel locknuts (Figure 1). Whale sharks are tagged in the water by SCUBA divers using pneumatic spear guns at half the power, and tags are placed in the musculature in the dorsal area in front of the first dorsal fin (Figure 2). All of these procedures were developed under the animal care protocol principles, in order to avoid any damage on the organism of tagged animals.

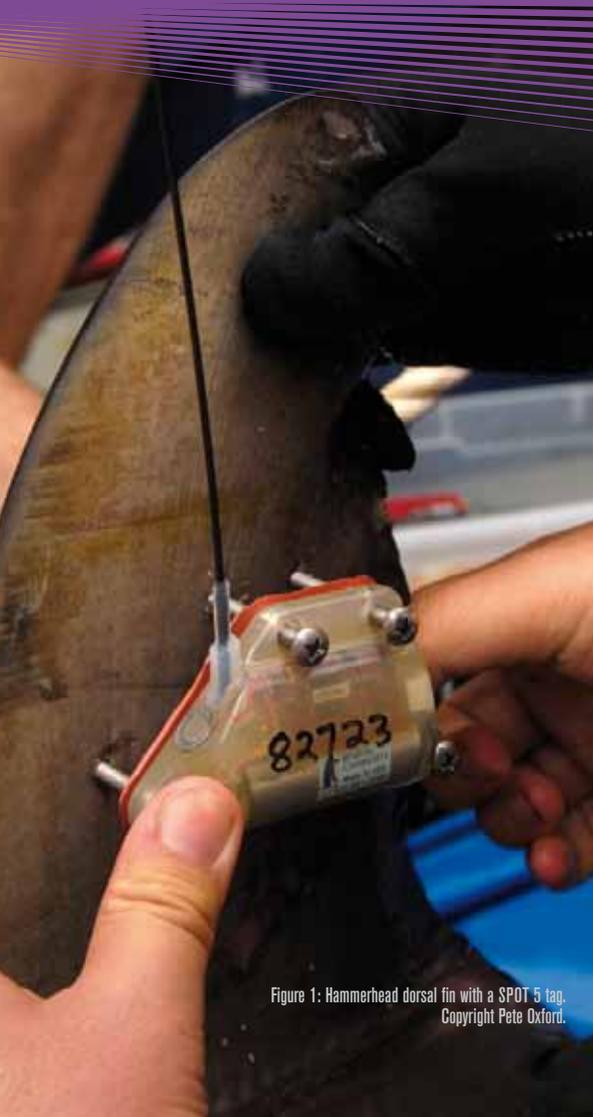


Figure 1: Hammerhead dorsal fin with a SPOT 5 tag.  
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Figure 2: Release of a hammerhead shark  
with a SPLASH tag attached to the dorsal fin.  
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**RESULTS**

Preliminary results show an intense use of the GMR especially by hammerhead, silky and blacktip sharks (Figure 2). Tracked hammerhead sharks have displayed interesting movements around a central foraging area, with long excursions into the high seas. One individual went as far as 1400 km from the GMR, traveling Northwesterly when the device stopped sending signals. The longest track recorded for an individual lasted up to four months, and showed an elevated use of both the internal and near external areas of the reserve. In contrast, blacktip movements are constrained within the boundaries of the GMR, with a major use of coastal areas surrounding the islands. The individuals tracked sent signals from four days up to two months. Silky, Galapagos and whale shark data are still under analysis. It is expected that silky sharks will migrate back and forth from the GMR much like the hammerheads, as they are known to spend most of their lifetime in oceanic waters. Galapagos sharks are more coastal patrols, feeding and breeding near insular waters. Tracks observed to date for this species have shown few movements and are very restricted to near-coastal waters, similar to what has been observed for blacktips during their movements in the first days.

Results from whale sharks are still in the first phase of filtering and analysis. Only one track is presented and showed extensive north to south movements inside the marine reserve, though its tag fell off in less than one month after application.

**DOES THE MARINE RESERVE SERVE ITS PURPOSE?**

As the project is in an early stage, more data is needed to properly respond to the question of whether GMR boundaries provide enough protection to the core activity areas of the shark species under assessment. We anticipate integrating movement datasets from other pelagic fish species, including yellowfin and bigeye tuna, wahoo, striped marlin, and manta rays. Our ongoing pelagic species tracking and monitoring efforts, coupled with the integration of remotely-sensed environmental datasets, will be essential for informing and improving management and conservation efforts within the Galapagos and other MPAs across the ETP.

*About the Galapagos Marine Reserve (GMR)*

The Galapagos Marine Reserve covers an area of approximately 133,000 km<sup>2</sup> and is one of the 10 largest marine reserve in the world. Created in 1998 by the government of Ecuador, it is home to nearly 3000 species of marine plants and animals. In 2001, the GMR added to the list of World Heritage Sites, in recognition of its enormous ecological, cultural, and economic value for the conservation and maintenance of unique species in the world.

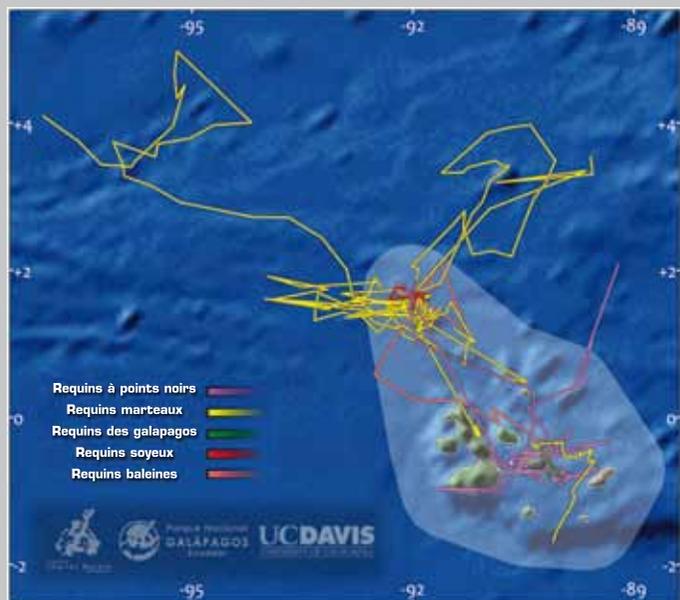


Figure 2: Selection of shark track data collected by this project. Tracks are colored depending the species (see color guide inside).

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Cesar Peñaherrera-Palma is an Ecuadorian Marine Biologist working at the Charles Darwin Foundation as an Associated Researcher, but also a student of the Quantitative Marine Science PhD by Research Program of the University of Tasmania. Cesar has worked for almost seven years in Galapagos in marine fisheries ecology projects, like assessing the Ecological Risk of the Effects of Fisheries in the Galapagos, and leading, for CDF, telemetry and population studies on sharks. Nowadays he is working on assessing the population size and structure of sharks, their migratory movements in relation to environmental cues and determining their economic value for the Galapagos Marine Reserve.

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