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Improving Environmental Science in Cuba for Healthy Marine Ecosystems

Research Expedition, Gulf of Batabanó
February 2013

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Environmental Defense Fund
Environmental Defense Fund is dedicated to protecting the environmental rights of all people, including the right to clean air, clean water, healthy food and flourishing ecosystems. Guided by science, we work to create practical solutions that win lasting political, economic and social support because they are nonpartisan, cost-effective and fair.

Cover photo: Shark scientists from Cuba, Mexico, and the U.S. capture and tag a bull shark in the Gulf of Batabanó, Cuba. Left to right: Alexei Ruiz of the Center for Marine Research-Cuba, Ivan Mendez of ECOSUR University-Mexico, Jack Morris of Mote Marine Laboratory-USA)

The complete report is available online at edf.org/oceans/cuba.

Table of contents

Participating organizations 4

Summary 5

Charting new waters: Collaborative research establishes baseline monitoring in Cuba 7

Trip reflection: Scientists partner with fishermen to explore Cuban waters 10

The story behind sharks 13

Science report: Shark research activities 15

Science report: Plankton and benthic research activities 18

Conclusions and what's next 20

Photos by Dr. Kendra Karr and Valerie Miller

Participating organizations

The Center for Marine Research-University of Havana

The Center for Marine Reesarch (CIM in Spanish) was founded in March 1970 by a group of enthusiastic scientists with the mission to build human capacity in the marine sector in Cuba and to conduct state-of-the-art marine research. After more than forty years CIM's mission has not significantly changed. CIM scientists continue to produce research and teaching under an integrative approach, aiming at "enhancing teaching through research." This motto has allowed CIM to become a leading institution in Cuba in marine sciences. CIM has maintained strong collaborations for many years with U.S. and Mexican institutions such as EDF, Mote Marine Lab, ECOSUR, Sea-to-Shore Alliance, and others, and CIM is interested in expanding these efforts towards the preservation of shared marine ecosystems resources. CIM believes collaboration is key to achieve conservation goals.

ECOSUR

ECOSUR (The College of the Southern Frontier/El Colegio de la Frontera Sur) is a scientific research institute with university campuses across southern Mexico. ECOSUR's mission is to contribute to the sustainable development of southern Mexico, Central America, and the Caribbean through the creation of new knowledge, professional development, and linking social and natural sciences. ECOSUR scientists have partnered with EDF to conduct research on shark populations and fisheries in the Gulf of Mexico to advance the work of the tri-national shark conservation partnership.

Environmental Defense Fund

Environmental Defense Fund's mission is to preserve the natural systems on which all life depends. EDF is guided by science and economics to find practical and lasting solutions to the most serious environmental problems, addressing issues related to climate, oceans, ecosystems and health. EDF has worked in Cuba for more than 12 years in partnership with Cuban scientists, resource managers and policy makers to design and advance innovative and effective conservation strategies for important marine and coastal ecosystems. EDF scientists have contributed to the design and implementation of Cuba's ambitious island-wide network of marine protected areas and are working now to identify new strategies for addressing overfishing in a manner that is good for fishermen and fishing communities. EDF is also working to develop a first-of-its-kind shark recovery program in the Gulf of Mexico, bringing together Cuba, Mexico and the U.S. in a comprehensive management strategy.

Mote Marine Laboratory

Mote Marine Laboratory is a leader in marine research and public outreach. Founded in 1955, Mote is a non-profit organization in Sarasota, Florida that manages seven marine research centers and a public aquarium. Mote is dedicated to today's research for tomorrow's oceans with an emphasis on world-class research relevant to conservation and sustainable use of marine biodiversity, healthy habitats and natural resources. Mote scientists have partnered with EDF to better understand the population dynamics of sharks in the Gulf of Mexico.

Waitt Foundation

The primary mission of the Waitt Foundation is to protect our oceans from the harmful impacts of overfishing. The Waitt Foundation's efforts are directed toward facilitating the creation of marine protected areas, engaging stakeholders to improve the management of fisheries, fostering sustainable solutions, and raising public awareness through a network of collaborative NGO's and foundations. Their vision is to restore the seas to full productivity for future generations. The Waitt Foundation supports a variety of national and international programs concentrating on ocean conservation initiatives and marine related issues. By increasing global awareness, their goal is to reverse the current decline of ocean life while inspiring humanity to make informed choices that contribute to a healthy marine ecosystem.

Summary

With generous support from the Waitt Foundation, Environmental Defense Fund (EDF) has launched a new initiative to support collaborative field research with scientists from the University of Havana's Center for Marine Research. This initiative is enabling teams of Cuban, U.S. and Mexican scientists to carry out a series of scientific expeditions aboard Cuban vessels to conduct important new research on Cuba's outstanding—but understudied—marine and coastal ecosystems. This effort will also support year-round port sampling of shark landings in at least four Cuban ports, contributing to EDF's larger tri-national shark conservation efforts throughout the Gulf of Mexico. On our inaugural expedition in February 2013, our tri-national team conducted an exploratory research cruise off of Cuba's south coast in the Gulf of Batabanó to exchange knowledge and scientific methodologies, and to survey migratory shark populations.

Off the southwest coast of Cuba, the waters of the Gulf of Batabanó extend to the Isle of Youth, with several nearby small islands and cays lining the Cuban shelf and into the Caribbean Sea. A team of 16 researchers from Cuba, Mexico and the U.S. boarded the University of Havana's Center of Marine Research (CIM) research vessel the RV *Felipe Poey* at the port of Batabanó for an exploratory nine-day cruise from February 10-19, 2013. Our goal was to conduct plankton and benthic research, and to enhance scientific understanding of the abundance, distribution, and movements of sharks in this region. Over the course of the expedition the team conducted sampling across an array of marine habitats, enabling researchers to share knowledge about shark-habitat associations within the Gulf of Batabanó shelf and flats, as well as inner island

Expedition location: Gulf of Batabanó and Isla de la Juventud (Isle of Youth).

groups near the coast and adjacent coral reefs off the Isle of Youth. The outer reef margin is approximately 65–75 nautical miles (nm) south of the port of Surgidero de Batabanó, where the *Felipe Poey* left dock to explore the waters in the Gulf.

Shark research objectives

- Establish which shark species are present in the region, and characterize their distribution and abundance patterns by searching for hotspots of abundance and tagging sharks for migration studies.
- Train the scientists on-board in shark species identification, catch-and-release methods, tagging techniques and benefits, shark anatomy, data collection and management and other aspects of shark biological research.
- Meet with commercial fishing boats that catch sharks and rays to collect data and information.

Left: The research team learns how to deploy the drumline gear to capture sharks for tagging. Right: Researchers prepare hooks to set a small benthic longline to capture sharks.

Plankton and benthic research objectives

- Characterize zooplankton populations and their habitat associations by collecting samples of zooplankton in the water column across different benthic habitats.
- Characterize macrobenthos (small mollusks, worms, crustaceans) populations and their habitat associations by sampling sediments across different benthic habitats.

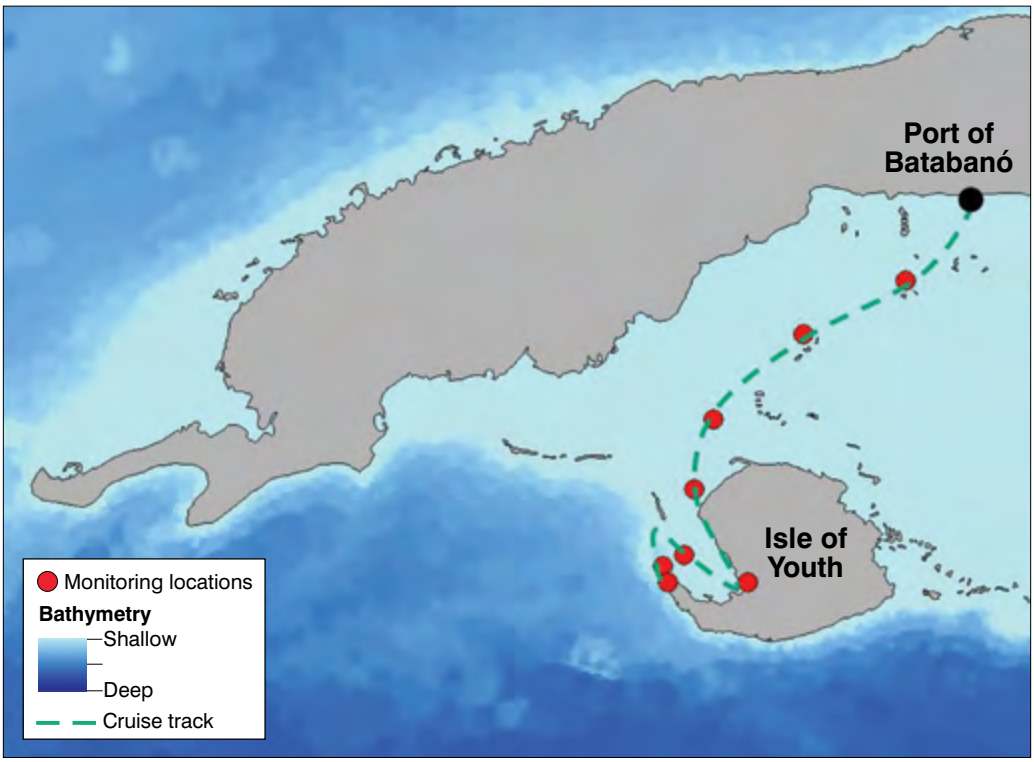
Left: Roamsi Volta uses a plankton net to sample faunal communities in the water column. Right: Dr. Maickel Armenteros and Alejandra Briones store a sediment sample.

Charting new waters

Collaborative research establishes baseline monitoring in Cuba

The tri-national research cruise which began in the port of Batabanó, Cuba, aboard the *Felipe Poey* transected the shallow, soft-sediment habitat that comprises the majority of the Gulf of Batabanó. The cruise destination was the remote and sparsely populated Isle of Youth, which lies in the southwestern waters in Cuba's Gulf of Batabanó, the largest island in the Canarreos Archipelago. Within the Canarreos Archipelago exists a national park and marine protected areas (MPAs), which contain numerous habitats that provide ecotourism opportunities and refuge for ecologically and economically important species such as lobsters, sharks and finfish.

Monitoring activities for the cruise began near the southwestern portion of the island, inside Siguanea Bay and extended around Punta Frances into the nearshore waters facing the Caribbean Sea. This portion of the Isle of Youth comprises a diverse array of habitats, exhibiting some of the healthiest and most intact coral reefs and mangroves in the region, as well as seagrass beds of different densities (i.e., low, medium and high) and soft sediment habitats.



Cruise track and sampling locations for faunal communities in the water column and in benthic habitats from the port of Batabanó to the Isle of Youth

Operating a research expedition that cruises through different habitats provides a unique opportunity to observe the local faunal communities across benthic environments and in the water column surrounding these habitats. The expedition invited two benthic researchers to join the team, comprised mainly of shark scientists, to take full advantage of the opportunity and create a baseline monitoring program of faunal communities across habitats in the Gulf of Batabanó and surrounding waters. The design of the monitoring program was a bi-national effort led by Dr. Ernie Estevez of Mote Marine Laboratory in the U.S. and Dr. Maickel Armenteros of Cuba's Center for Marine Research. Monitoring programs generate baseline information about the status of the area prior to a major change (i.e. disturbance either natural or human-produced), so that comparisons can be made. Having baseline data will help to measure the severity of an ecosystem alteration and aid in the projection of the impacts of various recovery strategies. Additionally, these data may help identify areas that are more or less resilient when monitored over longer periods of time, and the factors that enhance ecosystem health and resilience, as well as the factors that have negative impacts. Monitoring programs that span multiple years are some of the most powerful tools that managers and scientist have to describe and understand ecosystem function, variation and resilience. But long-term datasets are rare and of those that exist, most are limited in their geographic scope.

Top, left: Dr. Ernie Estevez and Dr. Maickel Armenteros collaborate in design and implementation of the sampling protocol for faunal communities in the water column and benthic habitats. Top, right: Cuban and Mexican researchers Alejandra Briones and Ivan Mendez look at a sample that will be analyzed in CIM's lab to assess the faunal communities in the water column. Bottom: Dr. Ernie Estevez deploys the plankton net for sampling.

What's a faunal community and why are they important?

The team identified planktonic communities in the water column and macrobenthos across habitats as targets because changes in the diversity and abundance of these fauna can be indicators to the health of the ecosystem. Moreover, these communities form the base of the food webs that supports commercially important fisheries in the Gulf of Mexico. Sharks, as apex predators, depend on foraging areas that are highly productive (e.g., dense seagrass meadows), and support abundant amounts of prey, such as larger fish that consume plankton. The team also recorded abiotic environmental variables necessary for the characterization of the habitat and conditions such as temperature, salinity, dissolved oxygen, depth, organic content in sediments and grain size. Without baseline data on local communities, future efforts to end overfishing, protect marine life, and improve the management of marine resources cannot move forward on a scientific basis. This is just one of the ways in which Cuba, Mexico and the U.S. are working together to improve monitoring efforts that will increase data availability and enable a tri-national assessment of shark population status, including an understanding of how variability in abundance of faunal communities and their predators influence foraging behavior and movement of sharks in the Gulf of Mexico.

Trip reflection

Scientists partner with fishermen to explore Cuban waters

When the research team aboard the *Felipe Poey* began the expedition, we spent the entire first day making our way towards the Isle of Youth, and by evening the smooth waters and night sky had merged into one endless black landscape. As a sense of isolation set-in, the boat turned towards some lights and we unexpectedly arrived at a floating lobster station constructed in the middle of the Gulf. After a day crossing the ocean and no land in sight, it seemed strange stepping off the boat and onto the deck at the station. The lobster fishermen, friends of the Cuban scientists on-board, showed us around the facility where they brought their daily catch to store in pens. This short meeting under the moonlight would prove to be the first of many significant meetings with fishermen throughout the journey.

Fishermen and scientist collaboration is key for shark monitoring

Partnering with fishermen was central to accomplishing the objectives of the expedition in relation to both data collection and training. The entire team was trained in shark capture and tagging methods, but since the techniques had never been implemented to monitor

The tuna fishermen crew meeting up with the research team in the Gulf of Batabanó.

populations in the Gulf, we relied on fishermen's knowledge to help us locate sharks. We were fortunate to meet with a Bonito tuna fishing boat on multiple occasions. The tuna fishermen actually follow sharks to locate schools of tuna and sometimes use the sharks to corral multiple schools together and cast their bamboo fishing rods to selectively catch tuna. Fishermen are able to identify sharks from notches previously marked in their fins. One fisherman actually stated, "Without sharks, there is no tuna fishery."

When meeting up with the Bonito fishing crew, we tied our boats together. Several fishermen finished throwing the day's catch on ice while the captain met with the head Cuban scientist on-board and CIM's director, Dr. Jorge Angulo. The old friends were happy to see each other again, and the tuna boat captain discussed where he has seen sharks in the Gulf, suggesting a region called "Los Indios" off the Isle of Youth. We ventured to Los Indios the following day to set our gear. The scientists agreed that this "edge" habitat where the reef meets the sand was more likely to have sharks, whereas much of the Gulf is shallow open water with a soft sediment bottom seafloor, not the usual preferred shark habitat.

Dr. Bob Hueter discusses shark anatomy with researchers and fishermen.

A day's catch creates conversation on sharks

Along with the tuna fishermen, we also met up with a finfish fishing boat. In the mornings, the fishermen picked up researchers to help retrieve the nets set the day before and assess the catch. We all reunited in the afternoon; the fishermen's catch displayed on the deck—a mix of rays and fish—and the researchers had the opportunity to collect data and take genetic samples of the species of interest. The head shark researcher from Mote Marine Laboratory, Dr. Bob Hueter, took advantage of the opportunity to teach shark anatomy using a hammerhead shark caught that day. The other researchers and fishermen gathered around as he quizzed the team on their biological knowledge and helped take genetic samples that could potentially connect Cuba's sharks to known populations in other regions of the Gulf of Mexico.

Our crew and the fishermen dispersed between the two decks of the connected boats to discuss the day's work and the presence of sharks in the Gulf. While the fishermen we met do not direct their fishing towards sharks, they sometimes catch them as bycatch. One fisherman mentioned that they used to catch sharks more often in certain regions but believe that they have been overfished. The scientists on board agreed that the extent of overfishing is difficult to know since there is so little past and present data on sharks in the Gulf.

Learning from the experience of the fishermen, our group hypothesized about the shark populations — where their preferred habitats are located, what time of year they are present

Scientist Anmari Alvarez discusses manatee monitoring with two finfish fishermen.

around the island, where they might migrate and possible locations of nursery habitats. With so many questions unanswered, the work of EDF's tri-national shark conservation program to improve the monitoring of shark populations in Cuba is crucial to ensure that species are managed sustainably.

Unexpected opportunities in marine conservation

While the main objectives of the expedition focused on understanding shark populations in the Gulf, our interactions with the fishermen included discussions on a variety of marine life. Anmari Alvarez, a Cuban scientist who specializes in manatees, always takes the opportunity to talk about the marine mammal with fishermen. She reviewed a colorful flyer with the details on how fishermen can report a manatee sighting and explained that involving fishermen in monitoring is invaluable to her, as she cannot be in the Gulf every day. In one unexpected opportunity for collaboration, the finfish crew presented the Cuban researchers with a tag they removed from a sea turtle. They had been saving it for months, not knowing to whom to report the inscribed number. It just so happened that the tag was marked with the abbreviation for Quintana Roo, Mexico, and Ivan Mendez, a scientist from Mexico, was on-board to recover it.

Like scientists everywhere, Cuban researchers rely on data from fishermen's catch to monitor fish populations. They have recently expanded their monitoring of shark landings at a couple of ports along the north coast but have had fewer chances to collect shark data in the Gulf of Batabanó. The bonds between the fishermen and scientists proved particularly important for this exploratory cruise—from sharing knowledge of shark habitats to a bi-national turtle tag exchange. There remains much to learn about shark populations in Cuba and throughout the Gulf of Mexico. Our research team is now better trained to collect and organize shark data and looks forward to partnering with fishermen in future expeditions.

The story behind sharks

Sharks are top predators, critical for maintaining the resilience of marine ecosystems. Unfortunately, shark populations are in trouble, primarily because they are harvested at a faster rate than they are able to reproduce and replenish their populations. Across the Gulf of Mexico, migratory species such as sharks are an important source of food and contributor to local economies.

Because they are migratory, sharks travel across political boundaries. This makes monitoring them difficult and creates challenges to rebuilding depleted stocks and creating sustainable shark fisheries. Many shark fisheries are considered data-limited, with little information available to assess the stock, including basic facts on life history, migratory patterns, abundance, and the numbers caught from targeted fishing and bycatch.

Data-poor stocks represent about 80% of all fisheries biomass and the vast majority of stocks in most countries. Fortunately, science exists to help assess fisheries with minimal data. EDF's Oceans science team is advancing assessment methods that use easily gathered data or information already on-hand. The key to assessing data-limited fisheries is to have access to any available fishery data (for example, catch at sea or at a landing site) or to fishery independent surveys (for example, monitoring of shark size, sex and abundance). Depending on the method used, a data-limited assessment estimates the current population's biomass, sustainable yield, risk of overfishing, or stock status relative to specific reference points of stock health. The first step to take advantage of these new data-limited assessment methods is to pull together any available data and improve monitoring.

In the Gulf of Mexico, the lack of data for migratory shark species has made the assessment of shark stocks difficult, but EDF and our partners are taking the first steps to help determine

Pedro Reyes, Alexei Ruiz, and Jack Morris recover a captured bull shark.

Scientists from Cuba, Mexico and the U.S. share experiences and knowledge about shark monitoring in the Gulf of Mexico. Left to right: Roamsi Volta, Ivan Mendez, Dr. Bob Hueter.

the status of populations. Toward this end, EDF established a tri-national partnership for monitoring and management of shark fisheries among scientists in Cuba, Mexico and the United States. Scientists are working together to collect and organize information on shark catches from fishing ports and aboard fishing vessels, as well as conducting fishery independent monitoring surveys across a diverse array of habitats. The partnership has reached agreement with INAPESCA, Mexico's national fisheries research institute, to standardize shark monitoring methods across all Gulf States. Scientists from Cuba's Center for Marine Research (CIM) are building a shark database and working with partners in Mexico to incorporate their data. All of these steps will aid in future assessments, setting conservation goals and achieving sustainable management of shark fisheries in the Gulf of Mexico. These efforts are the backbone of a successful shark recovery program in this region.

One of the main objectives of this cruise was to survey the region for sharks in order to establish present species, search for hotspots of abundance, and tag sharks for migration studies. Additionally, researchers shared information about catch records from fishing ports in the Northern portion of Cuba. Dr. Bob Hueter and Jack Morris from Mote Marine Laboratory trained the other scientists in shark species identification, shark capture-and-release methods, tagging techniques and other aspects of shark biological research.

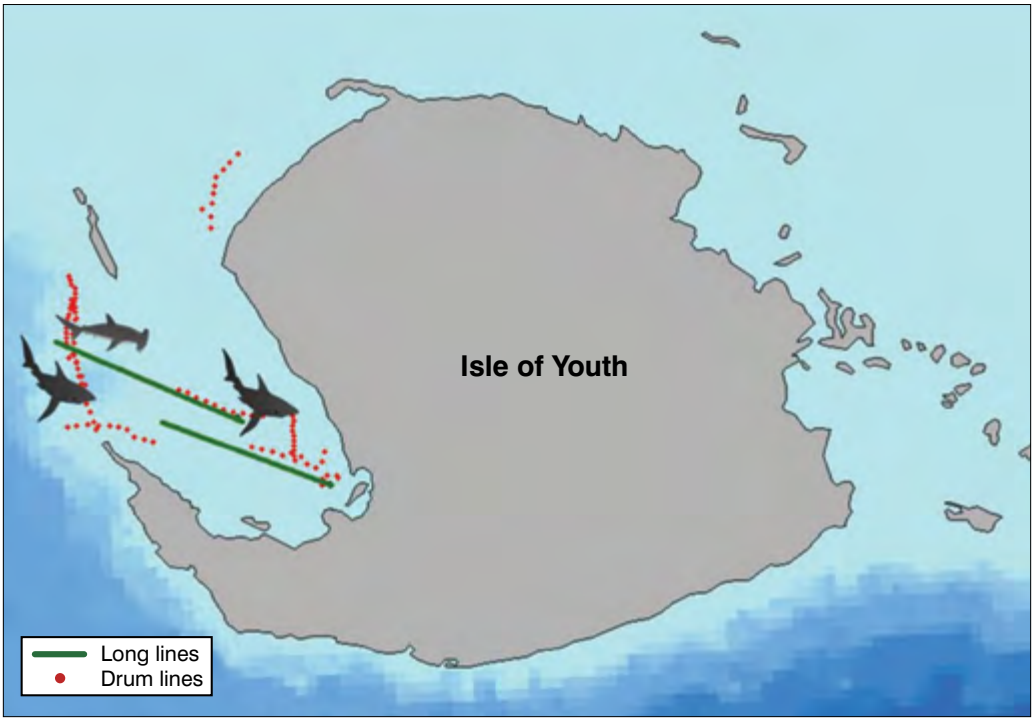
SCIENCE REPORT

Shark research activities

Overview

Led by Mote Marine Laboratory's Dr. Bob Hueter and Jack Morris and CIM's Dr. Jorge Angulo and Alexei Ruiz, our team set baited hooks over the course of the expedition to survey the shark population and tag sharks. Acquisition of bait is challenging in Cuba due to its scarcity and high value as food for the Cuban human population. Nonetheless, we were successful in obtaining fresh fish comprising bonito, snapper, mackerel, barracuda, stingrays and other species, sufficient for catching large sharks. Our accomplishments included:

- confirming that the CIM research boat Felipe Poey was suitable for safely deploying and retrieving both gear types for catching sharks—single-hook drumlines and multi-hook bottom longlines
- setting 95 drumlines and two bottom longlines along the western coast of the Isle of Youth, a total of 208 baited hooks over the course of the expedition
- catching three large sharks: two bull sharks (Carcharhinus leucas) and one great hammerhead (Sphyrna mokarran)



Map of fishing effort around the Isle of Youth. Location of individual drum lines, set in groups of ten, and the location of longlines are shown. The three sharks caught are depicted where they were recovered.

Scientist spotlight: Alexei Ruiz

Alexei Ruiz is a lead shark researcher with Cuba's Center for Marine Research (CIM) of the University of Havana, currently handling port sampling along the north coast of Cuba, where he meets with fishermen to monitor shark catch. He has taken a unique route to arrive in that position: He conducted his master's research on marine nematodes, a group of primitive, wormlike animals. Alexei's research encompasses microscopic creatures all the way to the top predators in the ocean, giving him a well-rounded knowledge of marine biology that benefits the project. Alexei's positive spirit is also an asset, and his contagious energy kept the whole crew working as a team. During the Isle of Youth cruise, Alexei ensured that all of the researchers learned and carried out the capture and data collection methods. Alexei has a bright future ahead of him and his work is already having a big impact on the tri-national shark project. We look forward to continuing our work with him.

- tagging one of the bull sharks with conventional visual tags on the fin and body and releasing the shark
- collecting genetic samples from the three sharks plus additional samples from 19 spotted eagle rays (Aetobatus narinari) that were caught by a cooperating fishing vessel
- training the Cuban and Mexican students in shark anatomy and tagging techniques
- discussing and designing modifications to gear and methods that will optimize shark research efforts aboard the Felipe Poey on future expeditions
- forging new institutional, professional and personal relationships that promote the objectives of multidisciplinary and multi-institutional shark research for the Gulf of Mexico and Caribbean Sea

Key findings

Despite round-the-clock fishing effort, good quality bait and gear, and the use of local knowledge of Cuban fishermen, the resulting catch rate was extremely low: only 1.44 sharks per 100 hooks. As a comparison, a reasonably expected catch rate under similar conditions on the Florida west shelf of the Gulf of Mexico would be 5-10 sharks per 100 hooks and sometimes higher. It was clear that abundance of large sharks in the Siguanea Bay area was extremely low in mid-February, potentially due to both seasonal variation in abundance and overfishing.

The three sharks we caught were: 1) a mature male bull shark 223 cm (7.3 ft) total length (TL) tagged with a rototag on the fin and a dart tag in the body, and released in good condition; 2) a mature male great hammerhead 305 cm (10.0 ft) TL , retrieved dead; and 3) a mature male bull shark 250 cm (8.2 ft) TL, also retrieved dead. The scientists conducted a complete dissection on the hammerhead to educate the crew and local fishermen in shark anatomy and physiology. The loss of the two dead sharks was regrettable but not uncommon in shark field research; we adjusted gear set time to minimize trauma to caught animals.

The tri-national team of shark scientists discuss their research efforts (left to right): Dr. Bob Hueter, Jack Morris, Alexei Ruiz, and Ivan Mendez.

Next steps

The scientists made water quality measurements (salinity, temperature, oxygen) at each fishing station, adding to oceanographic data for the area. We left the electronic meter to make these measurements with CIM to conduct future surveys. We also left shark genetic samples with CIM for future analysis by molecular geneticists. The team discussed next steps and future shark research cruises in Cuba. Due to the low catch rate at the Isle of Youth the group felt the next area to survey should be the deep waters off the northern coast of the main island, where fishermen catch pelagic sharks.

Preliminary data from CIM had shown that sharks are present in the upper Gulf, as well as around the Isle of Youth, but more monitoring across different habitats throughout the year is needed to assess current species abundance. Researchers from the University of Havana are monitoring Cuba's shark populations along the Gulf Coast and will continue to census sharks in and around the Gulf of Batabanó. In the meantime, Mote Marine Laboratory researchers are assessing populations of sharks off Florida's west coast, and partners in Mexico are expanding research to study shark nursery areas, shark catch and migration patterns in coastal waters off Mexico. All of these monitoring efforts will improve the quantity and quality of data and enable a tri-national assessment of shark population status, including mapping migration routes throughout the Gulf of Mexico and Caribbean.

Conservation efforts in the Gulf and Caribbean require the collaboration of the United States, Mexico and Cuba. Scientists—not just sharks—are crossing borders. The collecting and sharing of data among these countries is critical to developing a better understanding of fisheries and to designing innovative management programs to save these species and improve the livelihoods of fishermen and fishing communities in each country. EDF and are partners look forward to strengthening and expanding our partnership in the coming years.

SCIENCE REPORT

Plankton and benthic research activities

Mote Marine Laboratory's Dr. Ernie Estevez and CIM's Dr. Maickel Armenteros designed two community ecology projects to conduct during the cruise. One project made collections of the ichthyoplankton community (fish eggs, larvae, juveniles) and the other collected samples of benthic macroinvertebrate infaunal communities (mollusks, worms, crustaceans). Among the projects' accomplishments:

- Students and staff became familiar with major themes in community ecology related to plankton and benthic infauna, and the potential value of community-level ecological studies in the Gulf of Batabanó, Siguanea Bay, and other waters on Cuba's Caribbean coast.
- Students and staff developed a working familiarity with sampling gear and methods, sample preservation and processing, and sample custody and curation.
- Students and staff collected a representative set of samples across the spatial and oceanographic dimensions of Siguanea Bay, with other samples collected in the Gulf of Batabanó.
- Participants forged new institutional, professional and personal relationships that promote the objectives of multidisciplinary and multi-institutional programs in plankton and benthic research for the Gulf of Mexico and Caribbean Sea.

Dr. Maickel Armenteros and Eloisa Rojas from CIM prepare sediment samples for preservation on the *Felipe Poey*'s platform.

Scientifically, the most interesting aspect of the benthic and plankton efforts is that two stations where samples were collected were only 20 km apart and yet represented dramatically different conditions with respect to geology, hydrology, physical oceanography, water quality and ecological conditions. One station, on the west coast of Punta Frances, was just a few kilometers from the continental shelf break and was exposed fully to the Caribbean Sea. Participants took samples in the vicinity of a fringing coral reef, back-reef, and sand-dominated beachfront. The other station, about one kilometer into the mouth of the Rio San Pedro, was situated at the downstream end of the large wetland ecosystem comprising the southern end of Isle of Youth. This sampling area was dominated by a fringing and overwash mangrove forest, primarily the red mangrove Rhizophora mangle, dissected by distributaries of the Rio San Pedro. The area was a wave protected environment subjected to tidal currents along the channel axis and characterized by dissolved, suspended and settled organic matter. A special examination of red mangrove prop roots confirmed that neither green mussels (Perna viridis) nor wood-boring isopod crustaceans (Sphaeroma terebrans) had established a presence in this environment.

The team made water quality measurements at each station. They collected and specially preserved sediment samples so that resident nematode species and communities can be characterized, adding to CIM's ongoing comparative studies of nematodes as indicators of ecosystem health in Cuba's coastal and estuarine waters. The team returned ichthyoplankton and benthic samples to CIM for curation and processing by faculty, students or visiting scientists to determine: diversity of ichthyoplankton and invertebrate species; relative abundance of dominant and rare species; proportion of pelagic versus neritic fish species, and indicators of ecosystem health. The preserved materials will be available to CIM as reference samples, and to museums and research programs for other studies. The collections will also be valuable for subsequent ecological studies in the Gulf of Batabanó and Siguanea Bay, and for biogeographic studies across the Caribbean Sea.We sent to CIM a collection of literature pertaining to the sorting and identification of ichthyoplankton samples. We held preliminary discussions on prospects for another 2013 cruise with similar collaborative missions to the Gulf of Ana María, Cuba.

Conclusions and what's next

Some have called Cuba the black hole of marine science, because there is still so much to learn about Cuba's abundant and diverse marine and coastal areas. Cuba has world-class marine scientists yet, over the last two decades, field research has been limited because of insufficient funding and constraints on scientific collaboration resulting from the lack of diplomatic relations between the United States and Cuba. Fortunately, over the last few years, that has changed thanks in large part to policies in both countries that open up new opportunities. Since 2009, for example, scientists from Cuba and the United States have initiated new collaborative projects (in both the US and Cuba) on a range of issues, including fisheries science and management, marine protected areas, endangered species, sea level rise, and climate change.

Our collaboration on migratory sharks in the Gulf of Mexico is one example of the type of new collaborations that advance scientific knowledge—and ultimately management and policy—in both Cuba and the United States, as well as in Mexico and other countries in the region. We all benefit from better science.

Funding for scientific research is still in short supply, however, and we are grateful to the Waitt Foundation for providing crucial funding and establishing itself as a philanthropic leader. The Waitt Foundation is a leader in global oceans conservation and has supported critical marine science studies all over the world. With this new initiative, the Foundation is enabling pioneering new research in Cuba at a time when natural and man-made threats to coastal and marine ecosystems are unprecedented.

This fall, again with the support of the Waitt Foundation, EDF will partner with the Cuban Center for Marine Research and other Cuban institutions in a research expedition off the southern coast of Cuba. This time scientists will conduct important ecological baseline studies in the Gulf of Ana Maria and in the Gardens of the Queen National Park, the Caribbean's largest marine protected area.

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