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Research Cruise in the Gulf of Ana Maria and Gardens of the Queen

Collaborative Research to Increase Knowledge, Capacity and Science for Healthy Marine Ecosystems In Cuba

OCTOBER 2013

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Research expedition crew

BOAT CREW *Felipe Poey:* Mariel Echevarria (Captain), Desiderio Hernandez (First mate), Aramis Vega (Cook). *Itajara:* Emilio (Millo) de Jesus Fernandeza de la Vega Sanjuan (Captain), Ihovany (Tito) Lopez Gutierrez, and Roy Phillips. **SCIENTIFIC STAFF** *Cuba:* Dr. Fabián Pina Amargos (CIEC), Dr. Roberto González de Zayas (CIEC), Dr. Maickel Armenteros (CIM), Dr. Patricia González (CIM), Leslie Hernández (CIEC), Jessy Castellanos (CIM), Livan Rodríguez (CIM), Evelyn Marichal (CIM), Roamsi Volta (CIM), Lazaro Garcia (CIM), Pedro Reyes (CIM), Héctor Salvat Torres (CIEC), Orlando Perera Pérez (CIM) and Dania Saladrigas Menés (CIM). *USA:* Dr. Kendra Karr (EDF), Daniel Gillon (EDF) and Owen Liu (EDF).

Acknowledgments

EDF would like to thank the Waitt Foundation for its generous support of this project. The Waitt Foundation is focused primarily on protecting oceans from the harmful impacts of overfishing by focusing on 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. In addition to the Waitt Foundation, EDF would like to recognize the following institutions for their generous support of our projects in Cuba: John D. and Catherine T. MacArthur Foundation, the Pew Charitable Trusts, the Christopher Reynolds Foundation, Inc., The Ford Foundation and the Turner Foundation, Inc.

EDF would like to especially acknowledge Dr. Jorge Angulo, director of CIM, and Dr. Fabián Pina Amargos, director of CIEC, for the outstanding on-the-ground efforts in preparation and execution of the expedition. It would not have been a success without their careful planning and coordination.

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

It takes a community, each with specialized expertise and common interests to make this expedition happen. Seen here is the research teams for both legs of the expedition.

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

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Photos by Kendra Karr, Fabián Pina Amargos, Patricia González, Orlando Perera Pérez, Héctor Salvat Torres and Owen Liu

Participating organizations

The Center for Marine Research-University of Havana

The Center for Marine Research (CIM) 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 remains the same. CIM scientists continue to produce research under an integrative approach with the goal of "enhancing teaching through research." This motto has allowed CIM to become a leading marine science institution in Cuba. 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. CIM is interested in expanding these efforts towards the preservation of shared marine ecosystems resources. CIM believes collaboration is key to achieving conservation goals.

The Center for Coastal Ecosystems Research

The Center for Coastal Ecosystems Research (CIEC) was founded in November 1991 by a group of young scientists with the mission of providing critical scientific information for sustainable tourism development in the archipelago Sabana-Camagüey. After more than twenty years CIEC has expanded its mission. CIEC scientists provide scientific information for sustainable tourism development, strengthening protected area systems, improving fisheries performance and sustaining fish populations, physical planning and many other relevant issues in Cuba and abroad. These results have allowed CIEC to become a leading institution in Cuba and the Caribbean in coastal science and management. CIEC has maintained strong collaborations for many years with several foreign counterparts, such as U.S.-based EDF, WCS, TOF, TNC, Mote Marine Lab and several universities, among others, and CIEC is interested in expanding these efforts towards the preservation of shared coastal ecosystems.

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.

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 support from the Waitt Foundation, EDF launched an initiative last year with the University of Havana's Center for Marine Research (CIM) that allowed teams of Cuban, U.S. and Mexican scientists to carry out a series of expeditions to conduct vital new research on Cuba's remarkable—but understudied—marine and coastal ecosystems. EDF provided and will continue to provide scientific expertise by assisting the monitoring of reef fish and shark populations and evaluation of coral reef conditions. We learned a great deal during the expedition, and the following report highlights our journey, experiences and accomplishments.

Coral reefs are some of the world's most imperiled marine habitats. Impacts from climate change, pollution, overfishing and resource extraction combine to threaten reefs all over the world. This is especially true in the Caribbean, where rapid development is underway across the Caribbean Sea, exacerbating the stressors on coral reefs and their related seagrass and mangrove ecosystems.

However, in one special corner of the Caribbean, the Gardens of the Queen archipelago has remained remarkably resilient in the face of this collective pressure. A Caribbean marine paradise, the Gardens of the Queen, consists of more than 600 cays and islands and is home to the largest contiguous marine reserve in the Caribbean at 2,170 square kilometers. It supports a mosaic of mangrove, seagrass beds, patch reefs, fringing red and reef slope and is abundant with fish, sharks and other marine life.

Gulf of Ana Maria and the archipelago, the Gardens of the Queen

Having both clean and clear water are two of the environmental requirements for corals to grow large as seen here in this healthy coral reef with commercially important Hogfish.

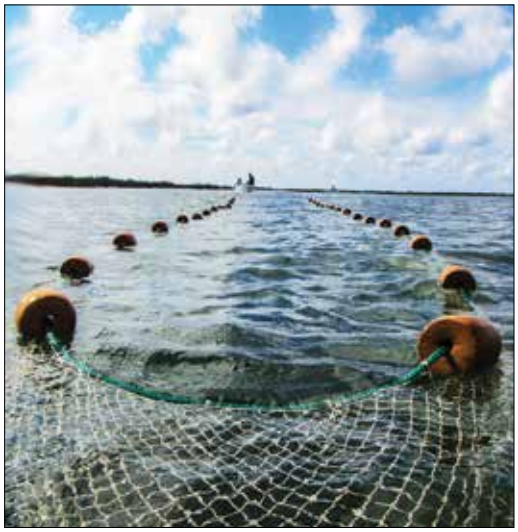
To reach the Gardens of the Queen (Jardines de la Reina) from mainland Cuba, one must bisect the Gulf of Ana Maria (Golfo de Ana Maria), a shallow-water system comprised of mangrove, seagrass and coral reefs. The ecosystems of the Gulf of Ana Maria and Gardens of the Queen together cover more than 10,000 square kilometers of productive habitat, making the entire archipelago a magnet for eco-tourism, including SCUBA diving and recreational fishing. Despite being the centerpiece of a growing eco-tourism industry and offering one of the best examples of a resilient Caribbean reef, much about the Gardens remains a mystery.

We are excited about our partnership with the Center for Marine Research (CIM) and the Center for Coastal Ecosystems Research (CIEC) and about the potential for collaborative scientific exploration to yield foundational data and information that sheds light on the marine habitats of the Gardens of the Queen. Our inaugural expedition (http://blogs.edf.org/edfish/2013/08/05/expedition-cuba-a-tri-national-journey-to-share-science-and-survey-sharks-part-1/) in February 2013 harnessed expertise from a tri-national team of scientists, which shared knowledge and scientific methods while surveying migratory shark populations off Cuba's south coast in the Gulf of Batabanó, to the west of the Gardens of the Queen. In October 2013, scientists hopped aboard the RV *Felipe Poey* and RV *Itajara* to journey to the Gardens reserve itself, and the nearby Gulf of Ana Maria. This 19-day expedition produced new data about the special Gardens ecosystem. The trip also promoted collaboration, increased scientific capacity and forged new friendships as scientists from the three organizations shared their expertise with one another.

Team members worked together to collaboratively achieve multiple objectives, increasing the capacity to assess the status of this region through the development of monitoring programs across the land-sea interface. Main objectives for both legs of the expedition included:

Coral reef ecosystem health objectives

- Collect samples to establish baseline survey sites to measure the health of the ecosystem in the Gulf of Ana Maria and the Gardens of the Queen.
- Characterize the diversity, health, and community structure of corals and other habitat forming species at study sites.
- Characterize the distribution and density patterns of species present in the region.



Researchers from CIEC use a beach seine net, which drags across the bottom habitat and collects every individual encountered, to monitor local commercial fishing targets.

A bucket containing 10 newly hatched green sea turtles collected from the beach of Cayo Caballones in the Gardens of the Queen.

Fisheries objectives

- Meet with fishing vessels to collect data on gear use and species targeted to characterize the fishery.
- Use beach seines and SCUBA transects to establish fishery independent monitoring to evaluate the status of the unfished stock.

Connectivity objectives

- Establish a sampling protocol for biological samples of fish, corals and macroalgae throughout the Gulf of Ana Maria and Gardens of the Queen.
- Conduct preliminary analysis on the isotopic signature of biological samples to determine connectivity and trophic structure.

Monitoring objectives

- Develop standard survey methodology for monitoring and train local scientists in data collection and management.
- Establish baseline ecological data on ecosystem health, structure and function from fish and coral surveys.
- Characterize infauna (small mollusks, worms, crustaceans) and plankton populations and their habitat associations by sampling sediments across different benthic habitats.
- Survey the abiotic and oceanographic conditions.
- Characterize the distribution and density patterns of species present in the region.
- Survey insect assemblages and distribution patterns.
- Monitor mangrove forest for health and signs of disease.
- Survey local rodent and reptile fauna on islands in the Gulf and the Gardens.

Left: CIM researcher Maickel Armenteros tows a plankton net to monitor the zooplankton community inside of a mangrove system. On the expedition scientists monitored the zooplankton in seagrass beds, mangroves and coral reefs. **Right:** Researchers collect samples of fish, invertebrates, coral and algae to use in their assessment of connectivity.

TRIP REFLECTIONS

Partners gather: reflections on collaborative research

On October 12, 2013, scientists converged on the tiny town of Júcaro, Cuba, to embark on a 19-day research cruise. The American and Cubans scientists brought myriad tools, instruments and gear to assist in their collaborative research. As a result, a pier normally filled with eco-tourism operators, tuna rods and shrimping nets was loaded down by SCUBA tanks, underwater cameras, GPS units, and notebooks and measurement devices of all shapes and sizes. Dr. Fabián Pina Amargós directed traffic on the dock, making sure each instrument was properly positioned, while making last minute course corrections. Fabián, a research scientist at CIEC with an energetic presence and loads of local experience and knowledge, proved indispensable to the expedition. Along with Dr. Jorge Angulo of CIM in Havana and EDF's own Cuba Program Director Dan Whittle, Fabián formulated the objectives and plan in a manner to maximize the limited time of and resources for the expedition.

Meanwhile, other scientists from EDF, CIM, and CIEC checked and double-checked their equipment up and down the dock. It was a diverse group, composed of experts in coral reef and fish biology, as well ecology, marine chemistry, genetics and fisheries science and management. Each scientist brought his or her own expertise, experience and methods, providing the multi-faceted know-how necessary for robust interdisciplinary collaboration and cross-pollination.

The University of Havana and CIM deployed the *Felipe Poey* for the expedition. A converted fishing boat, it was named in honor of one of Cuba's premier and pioneering marine scientists. A solid, functional vessel, the *Felipe Poey* became our home for the expedition. Her captain,

Research vessel, *Itajara* waits for surveys teams to complete sampling.

Mariel Echevarria, has spent his life on the ocean, as a former distant-water fisherman in Cuba's fleet. He and his crew, first mate Desiderio Hernandez and cook Aramis Vega, created an atmosphere of partnership, bonding, and collaboration that was infectious among the expedition members and set a collegial tone for the journey. Mariel, who didn't speak a word of English, nevertheless was able to crack multilingual jokes and warm up the cabin or the deck. At the same time, he was extremely professional, keeping an old boat running smoothly and always getting us to where we needed to go. The entire expedition depended upon his knowledge and competence as a captain, but had fun thanks to his attitude and energy.

The RV *Itajara*, named after the iconic goliath grouper *Epinephelus itajara*, is a smaller boat, a research vessel from CIEC that we used to access shallow reef areas and small inlets that the larger *Felipe Poey* could not. Her crew, Captain Millo, first mate and mechanic Tito, and deckhand and research assistant Roy, was similar in attitude and aptitude to the *Felipe Poey*'s. From one minute to the next Tito and Millo could go from expertly steering the boat or fixing a mechanical malfunction, to setting up dive gear, and even hopping in the water themselves to assist in the scientific process. Overall, the crews of the research vessels on the expedition were essential to its success, and they symbolized the pervasive atmosphere of the voyage: hardworking and productive; but friendly, easygoing, and fun at the same time.

Investigating a resilient Reef

Fabián, Jorge, and EDF's scientists envisioned the October expedition as an opportunity to begin collecting important baseline biological and ecological data to support measures to better conserve and sustainable manage Cuba's marine resources. Overfishing has eliminated many large and vulnerable fish species – groupers, for example - from broad areas of the Caribbean. In Cuba, scientists estimate that more than 40% of commercially valuable fish species are over-fished, posing a major threat to Cuba's fishing industry, food security and marine biodiversity. Cuba's coastal waters are home to spawning grounds for snapper, grouper and other reef fish that are crucial to commercial and recreational fisheries in other regions of the Caribbean.

The Gardens of the Queen, an ecosystem not yet heavily impacted by human activity and resources extraction, provides scientists a unique laboratory to document the characteristics of a healthy Caribbean reef system. They can investigate questions like, how has this coral reef

Left: Research from University of Havana's Center for Marine Research (CIM) and the Center for Coastal Ecosystems Research (CIEC) survey the composition of the bethnic sessile community during the expeditions coral reef health assessment. **Right:** Coral in the Cuba, primarily out in the Gardens of the Queen are full of live, including whip corals, tunicats and large sea fans.

Species of snapper and grunt are seen swimming around the prop root of a cay comprised on mangroves and sandy beaches. Mangroves can serve as a nursery grounds and connect many commercial important species from offshore coral reefs into coastal fishing grounds, such as snappers and grunts.

been resilient to the changes and degradation that we have seen in so many other parts of the Caribbean?

Answers to that question require a detailed understanding of how the different habitats of the Gulf and Gardens are interconnected. Therefore, one of the principal objectives of this cruise was to survey the Gulf of Ana Maria region and collect samples to assess connectivity between the nearshore habitats of the Gulf of Ana Maria and the Gardens of the Queen. Habitat connectivity is traditionally described as the connection and movement of species and nutrients between habitats. For example, some juvenile fish may utilize a nursery habitat like a seagrass meadow until they mature enough to transition into an adult habitat on the open coral reef. Inorganic matter can also display attributes of habitat connectivity: decomposed organic matter from mangroves, for instance, often adheres to coral reefs where it provides an important source of nutrients for the reef ecosystem.

Fish and other species depend upon the services and resources this connected set of marine ecosystems provides. Therefore, understanding how individuals, species and nutrients are distributed, and how they move between the Gardens of the Queen, the Gulf of Ana Maria and nearshore coastal waters of Cuba is a key step towards improving management of fisheries and marine biodiversity in Cuba. Oceanic currents spread larvae, fish and other material from the Gardens of the Queen to other regions of the Caribbean, meaning that management decisions in Cuba have implications for the wider ecosystem of the Gulf of Mexico and Caribbean Sea. Achieving truly sustainable Cuban fisheries requires that management officials recognize this interconnectivity and the underlying support ecosystem for those fisheries.

The expedition departs

Once all the SCUBA tanks had been strapped down, all the scientific gear stowed, and all crew aboard, Mariel's *Felipe Poey* and Millo's *Itajara* departed Júcaro on October 12, heading for the Gardens of the Queen, 50 miles and several hours away. During the course of the next 18 days, the expedition visited more than 30 sites across the expanse of the Gulf of Ana Maria and the Gardens of the Queen, assessing coral reef health, water quality, habitat structure and function, and fish community characteristics. This initial data collection and monitoring provides an essential baseline of knowledge about the ecosystem and fisheries health in the Gardens of the Queen – one we look forward to adding to on a consistent basis.

Collaborative research in the Gulf of Ana Maria and the Gardens of the Queen

Cuba's Centro de Investigaciones de Ecosistemas Costeras (CIEC) field station in the Gardens of the Queen is a cozy lodge in a quiet inlet tucked away on a mangrove-covered cay. Near the Caballones Strait in the middle of the beautiful Gardens of the Queen, the station is a base for Cuban students and researchers studying Cuba's unique coastal ecosystems. On our research cruise in October 2013, scientists from EDF, CIEC, and the University of Havana's Centro de Investigaciones Marinas (CIM) spent a few nights at the station, interspersed along the two week trip. We used the shore time to compile data and organize gear, scramble for a few minutes of (very) limited Internet access to send updates home and simply enjoy a night on dry ground.

Sitting on the dock watching the sun set over the Gardens provided a chance to reflect on the work we were doing, and to ponder about the interconnectivity between the data sets we had collected.

A diversity of data

During the cruise, researchers from CIM, CIEC, and EDF surveyed more than 30 sites across multiple habitat types, both inside and out of the Gardens of the Queen marine reserve.

Left: Inside of a lagoon in one of the many mangrove complexes the expedition encountered, a beach seine is used to monitor the local fish assemblage. **Right:** Setting up a baseline monitoring program involved monitoring multiple aspect of the ecosystem, including those not monitored by other survey methods.

The success of a monitoring program relies on the ability to train the future scientist.

In the future, these sites will offer a baseline measure of connectivity between the offshore environments and nearshore fishing grounds. During the expedition, researchers collected samples from commercially-valuable fish species, corals, sessile and mobile invertebrates and macroalgae.

All of the samples will undergo an independent stable isotope analysis, which allows researchers to quantify the relative contributions of individuals from each region/site to the fishing grounds and identify migration corridors among important habitats. In short, it will help determine where an individual fish, coral colony, etc. originated from. Combined with oceanographic and abiotic data collected during the expedition (for example, nutrients and sediments in seawater; tides, currents and waves), this information will reveal a more complete picture of interconnectivity between the various marine habitats in this unique region of the Caribbean.

We used a variety of methods to gather data. To assess coral health, researchers used SCUBA to get close enough to the reef to document the diversity of species at each site and look for signs of degradation or disease. To study which fish used shallow seagrass-mangrove habitats as either nursery grounds or as adult habitats, we used a beach seine net from the shoreline to corral, count, and measure individual fish. By seeing which species of fish utilized the nearshore mangrove and seagrass beds, and then counting the fish on the nearby coral reefs with a visual transect method, we could begin to see, literally, the biological connections between these distinct habitats. As some researchers were in the water, counting fish or documenting coral health, others collected water samples for chemical analysis or hauling in a sampling net.

Collaboration is key

Although we shared common goals, each scientist or team had their own objectives and unique areas of expertise. Sharing that expertise and contributing to scientific capacity building among all three organizations was a major goal of the expedition. By feeding into in each other's research and teaching new research and data aggregation methods to others, we accomplished this goal. Where EDF offered a data collection method, the Cuban scientists provided extensive knowledge of appropriation research locations and species identification. When the coral research group needed more hands, EDF scientists rolled their sleeves up. The cruise's success was a result of the teamwork from members of all three institutions.

Left: A seine is seen sampling across seagrass beds. **Right:** One of the smallest of the three research vessel utilized for surveys throughout the Gulf of Ana Maria and the Gardens of the Queen.

A great example is handling the beach seine net. Operating the net effectively requires several people to ensure the gear is taut and evenly spread out, so fish cannot escape. EDF staff brought the net and the "know how," and the Cubans the essential "know where." The Cuban team proved a quick study, deploying the seine net at each cay surveyed over the course of the expedition. The cooperative use of the net provided the expedition with important new data about the composition of seagrass and mangrove fish communities.

Conservation efforts in the Gulf of Mexico and Caribbean require collaboration from numerous stakeholders to maximize effectiveness. Working with Cuban researchers enabled us to collect a broad array of information that will allow us to develop a better understanding of fisheries and to innovate management programs that protect species, fishing communities and fishermen's livelihoods

Establishing baselines of Cuba's coastal ecosystems

One morning we awoke to a small tuna boat pulling up alongside the RV *Felipe Poey*. The crew of the *Unidad '77* had been targeting bonito, a small tuna-like fish, south of the Gardens of the Queen marine reserve. EDF scientists were eager to tap into the captain's localized knowledge, and peppered him with questions that were ably translated by CIM's Patricia González. The captain described his fishing grounds, proudly displayed his catch and explained how his crew times their trips to coincide with certain phases of the moon.

A scientific baseline for management

Vessels like *Unidad '77* are common in Cuba: small boats that work for the state, the livelihoods of their crews dependent upon a stable resource base. This and future expeditions will synthesize scientific findings to inform the management of Cuba's marine resources. While our voyage was one of discovery, there were practical benefits too; the datasets we initiated will ultimately increase understanding of how ecosystems in Cuba work, which is essential to developing its coastal fishing economy in a sustainable manner.

Long-term monitoring programs are some of the most powerful tools that managers and scientists have to track and gauge ecosystem performance, variation and resilience. They generate baseline information about the status of a target species or ecosystem. In many cases, baseline information is used to analyze an impacted region after a major change (such as a

Left: Roamsy Volta Rodríguez of the Center for Marine Research (CIM) records coral recruitment during the coral reef health surveys. **Right:** One of the 10 newly hatched green sea turtles; this individual was later released into a shallow seagrass meadow; to increase its chance of survival into adult habitat.

disturbance either natural or human produced), or as reference data to compare between areas of interest; for example, to compare Cuba to other regions of the Caribbean that have been heavily impacted. Well-designed programs aid in evaluating impacts and help tailor recovery and management strategies. Additionally, long term monitoring data helps to identify areas that are more or less resilient to change over time. We can identify factors that enhance ecosystem health and resilience, as well as factors that have negative impacts.

But long-term fishery datasets are rare, and of those that exist, most are limited in their geographic scope. The data collected during this expedition and future trips represent a significant step forward for Cuba. Additional trips are planned in other regions of the country, alongside annual sampling across all of the monitoring regions including the Gardens of the Queen.

Data for sustainable fisheries management

Like *Unidad '77*'s crew, fishermen across Cuba rely upon on finite marine resources to survive. Better management, fortified by sound science, is essential to sustain livelihoods from the sea. These jobs are a critical component in any coastal nation's economy. Unfortunately, across the Caribbean and in Cuba, commercially valuable fish stocks are in jeopardy. By better understanding fish populations, EDF can assist Cuban scientists, managers and fishermen in developing science-based recommendations for sustainable fishery management policies, such as cooperatives and other catch shares.

To inform management efforts, fishery data and fishery models are used to generate stock assessments which can provide estimates of the current population size of species, rate of fishing, time trends, and optimum levels of population size and harvest rates. In addition, the existing fishery dependent data can be used in combination with the fishery independent monitoring to provide stronger stock projections. Our October expedition focused on using fishery independent visual surveys, and began developing a fishery independent monitoring program using beach seine. Combining different fishery independent monitoring methods enables a full view of the assemblage of fish that would otherwise be difficult to sample without the use of fishing gear—for example, fish that exist in shallow, sandy nearshore habitats.

Balancing livelihoods and conservation

The same day we met the crew of *Unidad '77*, two CIEC researchers returned to *Felipe Poey* toting 10 newly hatched green sea turtles they removed from the beach of Cayo Caballones in the Gardens of the Queen. Releasing the turtles over the shallow seagrass beds where the *Felipe Poey* had anchored would help them avoid predation by iguanas and seabirds that roam on their natal beach.

After spending the day endlessly counting fish and filling in reams of data sheets, the turtles were a welcome reminder of why we do the work we do.

The Gardens of the Queen and Gulf of Ana Maria are a unique ecosystem, a mosaic of dense mangrove forests, bordered by extensive seagrass meadows and beautiful coral reefs. The Gulf and the Gardens exhibit a delicate balance between humans and marine organisms that depend on the same resources. A bonito fisherman's livelihood depends on a healthy, resilient ecosystem just as much as a newborn green turtle does.

We watched as the young turtles made their way into their new surroundings, cautiously venturing into the underwater world of the Gardens of the Queen. They are entering a world undergoing change, as Cuba rapidly develops and opens gradually to increased tourism, even in remote places like the Gardens. With our October expedition, scientists from EDF, CIM, and CIEC planted the seeds for continued collaboration and the creation of a robust scientific monitoring program for Cuba's coastal ecosystems and fisheries. The baseline of biological and ecological knowledge formulated from expeditions like ours, and those planned for the future, will help ensure that fishermen and marine species alike can continue to coexist in a prosperous ecosystem.

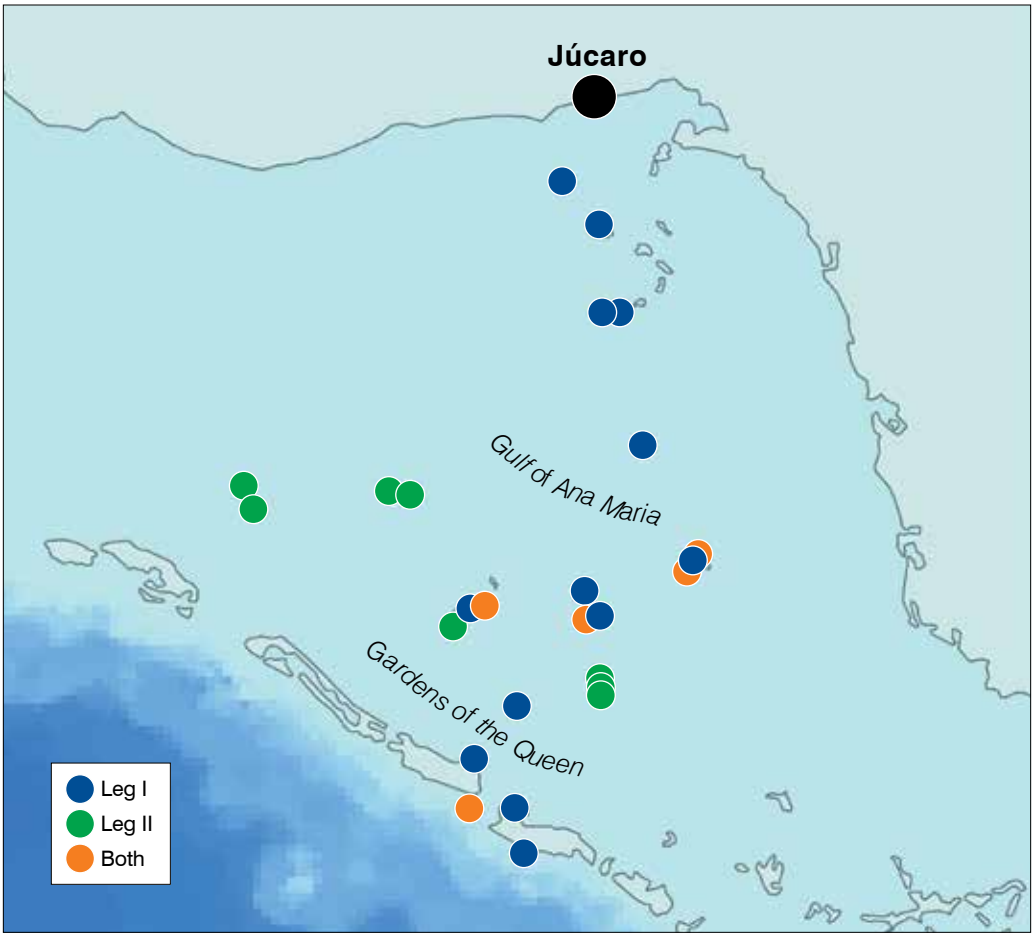
SCIENCE REPORT

Introduction and field observations

Led by CIM's Maickel Armenteros and Patricia González and CIEC's Fabián Pina Amargos, the expedition team members surveyed sandy bottom, coral reef, seagrass and mangrove habitats from the Golfo de Ana Maria (Gulf of Ana Maria) into the Jardines de la Reina (Gardens of the Queen). Surveys were comprised of visual census transects on SCUBA, live animal capture, collection of biological material both on land and under water and measurement of the abiotic and chemical nature of the water across survey sites. Team members worked together to collaboratively achieve multiple objectives, increasing the capacity to assess the status of this region through the development of a monitoring program across the land-sea interface.

Sites surveyed over each section of the expedition

across the Gulf of Ana Maria and into the Gardens of the Queen



Accomplishments for both legs of the expedition include:

- **Surveyed 32 sites total.** 22 were surveyed for coral reef health (e.g. coral recruitment, assemblage composition, health), 17 were surveyed to assess the fish assemblages, 12 were surveyed for benthic macroinvertebrate infaunal communities, 12 were surveyed to measure water quality and abiotic condition of the local region and multiple beaches were surveyed using the beach seine across 10 cays.
- **Collected large amount of data and samples.** Much of that information is still being processed and assembled by scientists at EDF, CIM, and CIEC, but included in this report are general field observations and site characterizations captured in expedition members' field journals, along with a more detailed description of each category outlined above and their associated preliminary findings.
- **Achieved interdisciplinary collaboration.** Expedition members combined institutional, professional and personal relationships to promote the objectives of multidisciplinary and multi-institutional programs for healthy reef and sustainable fisheries in Cuba, the Gulf of Mexico and western Caribbean.

FIELD OBSERVATIONS Gulf of Ana Maria

Sites surveyed: Punta Arena, Cayo Algodón Grande, Cayo Flamenco, Cayo Manuel Gómez, Cayo Cuervo, Cayos Guinea, Obispo and Obispito, Cayo Bergantines, Cayo Palomo and Cayo Rabihorcado.

Punta Arena

Here we observed mostly juvenile fish and very few larger individual or adults across the two sampling sites (coral reef and mangrove complex). Across the two sites, we measured high species richness of Haemulidae (grunts) and Lutjanidae (snappers). The most abundant species were *Haemulon sciurus*, *Haemulon parra*, *Lutjanus jocu* and *Lutjanus griseus*. The coral reefs were in shallow, sandy waters.

We sampled the infauna in heterogeneous sandy-seagrass (*Thalassia testudinum*) habitat; the seagrass beds had short leaves and a very dense web of roots.

Left: In the turbid waters of the Gulf of Ana Maria staghorn coral is making a recovery, with dense healthy fields and new recruitment. **Right:** Coral reefs comprised of large colonies of *Montastrea annularis*, *Porites astreoides* and *Montastrea faveolata* surrounded by sand and seagrass.


Left: Numerous species of commercially important fish use mangroves throughout the Gulf as nursery habitats. **Right:** We encountered several fields of healthy staghorn corals on the expeditions, many with new recruitment.

Cayo Algodón Grande

In the southern portion of the cay, the coral reef was comprised of multiple species, with colonies of *Montastrea annularis*, *Porites astreoides* and *Montastrea faveolata* surrounded by sand and seagrass. We also observed high densities of *Echinometra lucunter*.

In the northern portion of the cay, sand surrounded corals that were widely spaced apart. We observed several healthy patches of *Acropora cervicornis* and *Millepora alcicornis*, but the majority of corals and recruits were *A. agaricites* and *P. astreoides*. Both the invertebrate grazers *E. lucunter* and *E. viridis* were abundant.

Overall, these reefs had low richness of fish species but high density of the species that were present. Common families were Haemulidae and Lutjanidae, with four species each. The species with the highest density were *Haemulon aurolineatum* and *Scarus iserti*; however, the total biomass of these was medium to low, because most individuals were juveniles. We also noted the presence of species *Lachnolaimus maximus* (hogfish), *Sphyraena barracuda* (Great barracuda) and *Lutjanus jocu*—all highly valued commercial targets.

Our team sampled the mangrove channels for benthic infauna and plankton as well as the beaches (1.5 meters deep) using a beach seine net.

Cayo Flamenco

This site was comprised of a mangrove complex with high diversity and abundance of commercial fishery targets, primarily from family Lutjanidae. Most of the individuals observed were large adults.

Cayo Manuel Gómez

We observed coral reefs at Manuel Gómez in water 5–11 meters deep, with coral heads as tall as 3 meters. Even though this site had turbid water, there were relatively high levels of coral recruitment and high abundance of sponges and gorgonians. In general, fish species richness was low, the most common families being Haemulidae and Lutjanidae. The species with the highest density was *Haemulon aurolineatum* followed by *Scarus iserti*, and over 90% of all observed individuals were smaller than breeding adults.

We sampled the mangrove system at Manuel Gómez, which contains a lagoon with seagrass (*Thalassia* spp.) lined by mangroves, for benthic infauna and plankton. Additionally, we used the beach seine to sample the fish assemblage; the most common specimen was *Archosargus rhomboidalis* (sea bream).

Cayo Cuervo

Our team observed many colonies of *Millepora alcicornis* and *Siderastrea sidereal* at Cayo Cuervo, with colonies of *S. sidereal* up to 2 m in diameter and height, all in good health. We also observed many juvenile parrotfish (Scaridae), grunts (Haemulidae) and bar jacks (*Caranx ruber*). The species with the highest density and biomass were *Lutjanus griseus* and *Haemulon plumierii* (white grunts). We noted an abundance of the invasive lionfish (*Pterois volitans*) at this site.

For the connectivity study, we collected biological samples from plants (*Thalassia testudinum*), macroalgae (6 spp.) and invertebrates (11 spp.). The team also conducted beach seine surveys across six beaches; most of the beaches were approximately 1 meter deep x 30 meters long in Thalassia beds.

Cayos Guinea, Obispo y Obispito

Using the beach seine, we only sampled these cays for fish assemblage. *Archosargus rhomboidalis* was the most abundant, followed by *Eucinostomus* spp. (mojarras) and *Calamus penna* (sheepshead porgy), among others.

Cayo Bergantines

Here we observed reefs comprised of small coral heads at Bergantines surrounded by sand and seagrass. The reefs were very isolated and basically formed by colonies of *Millepora squarrosa*. Overall, Bergantines had healthy corals and high levels of coral recruitment. We observed a high density of large gorgonians and a few sponges. Other corals present were *M. annularis*, *Diploria strigosa* and *Siderastrea sidereal*, all large in size. Also present was a high density of invertebrate grazers, primarily urchin species from the genus *Echinometra*.

The team observed a diverse fish community at Bergantines, with a mixture of juvenile and adult species of parrotfish (Scaridae), grunts (Haemulidae), and hogfish (*Lachnolaimus maximus*), among others.

Cayo Palomo

Here we observed isolated *Montastrea annularis* corals among sand, seagrass and algae. Coral cover was minimal, with many gorgonians and urchins. We also noted the presence of a high density of healthy *Acropora cervicornis*.

The fish community at the survey sites in Cayo Palomo was dominated by juvenile striped and princess parrotfish (*Scarus iserti* and *Scarus taeniopterus*, respectively). The team observed groups of juvenile grunts and some snappers. In general, the area had a high density of sub-adult fish.

Cayo Rabihorcado

We noted relatively high diversity of corals along the reef crest, with only four colonies of *Acropora palmata*. However, of the *A. palmata* present, all colonies were in good health and showing signs of recovery. The team also observed other corals including *Porites astreoides*, large colonies of *Montastrea annularis*, *M. faveolata*, *Siderastrea sidereal* and *Diploria strigosa*. Where these corals were absent, gorgonians covered the benthic substrate. Finally, we also observed grazers, such as *Tripneustes ventricosa* (the West Indian sea egg, an urchin species).

As with other sites, Scaridae and Haemulidae species dominated the coral reef fish community at Cayo Rabihorcado. We also noted the abundance of both adults and juveniles of french, white and caesar grunts (*Haemulon flavolineatum*, *H. plumierii*, *H. carbonarium*) at this location.

FIELD OBSERVATIONS Gardens of the Queen

Sites surveyed: Cayo Caballones (north and south), Cayo Anclitas (north and south) and the channel between Caballones and Anclitas.

A small subsample of the dense fields of healthy Elkhorn coral along the east crest.

Cayo Caballones

In the south, near Pipin's Avalon diving site, we observed corals in a rocky shelf with relatively small coral heads. The density and biomass of herbivores (Scaridae) and carnivores (Lutjanidae and Haemulidae) was high. *Sparisoma viride* and *Scarus iserti* were the most abundant herbivores, while *Lutjanus apodus* (schoolmaster), *Haemulon plumierii* and *H. flavolineatum* were the most abundant carnivores.

The crest in the south of Cayo Caballones was typical of the crests in this region of the Garden, with high coral mortality. However, in the east close to the channel, we found a live patch of *Acropora palmata*. These colonies of *A. palmata* were extremely healthy (low incidence of mortality and no disease). Additionally, we observed many individuals of *Diadema antillarum* throughout the crest and determined that this patch could sustain a reef rehabilitation project in the Gardens of the Queen.

In the north, the survey sites had a high amount of suspended sediment, making the water extremely turbid. Despite this, we observed a high diversity and abundance of healthy corals and recruits. We also saw many large individuals of the family Lutjanidae, with the highest biomass of *Lutjanus jocu* (dog snapper), *L. cyanopterus* (cubera snapper), *L. analis* (mutton snapper) and *Haemulon plumierii*. In contrast, the team observed a low abundance of herbivores, mainly *Sparisoma aurofrenatum* and *Scarus iserti*, the majority of which were juveniles.

Lastly, we collected infaunal and plankton samples from both the north and south survey sites.

Cayo Anclitas

In the south, we observed a reef slope of ~90 degrees at the survey site, with many well-developed coral heads (including *Dendrogyra cylindrus*, the Pillar coral), gorgonians and sponges. We noted a high density and biomass of herbivores and carnivores, with many parrot fish (Scaridae) and several carnivorous fish families (Lutjanidae, Serranidae and Haemulidae) present. *Scarus iserti*, *Sparisoma aurofrenatum* and *Sparisoma viride* were the most abundant species of herbivores, while *Lutjanus apodus*, *Haemulon plumierii* and *H. flavolineatum* were the most abundant carnivores. Additionally, we observed several large groupers, e.g., *Epinephelus striatus* and *Mycteroperca bonaci*. We also noted the presence of the invasive lionfish *Pterois volitans* in the south of Anclitas.

In the north, the reefs were expansive, covering as much as 20 meters but comprised of short coral heads. We observed macroalgae and turf algae covering the substrate, but the corals still displayed high recruitment, even in the turbid waters. The team noted many *Porites astreoides* colonies, all with high mortality. We also noticed a high abundance of large predatory fish, including *Lutjanus griseus*, *Lutjanus cyanopterus* and *Haemulon flavolineatum*. While the richness of herbivorous fish was low, we observed a large number of juvenile *Sparisoma aurofrenatum* and *Scarus isertii*.

Additionally, we sampled the mangrove system within the Guasa estuary (a channel fringed by red mangrove, *Rhizophora mangle*) for benthic infauna and plankton. The team also collected infaunal and plankton samples from the northern coral reef survey site.

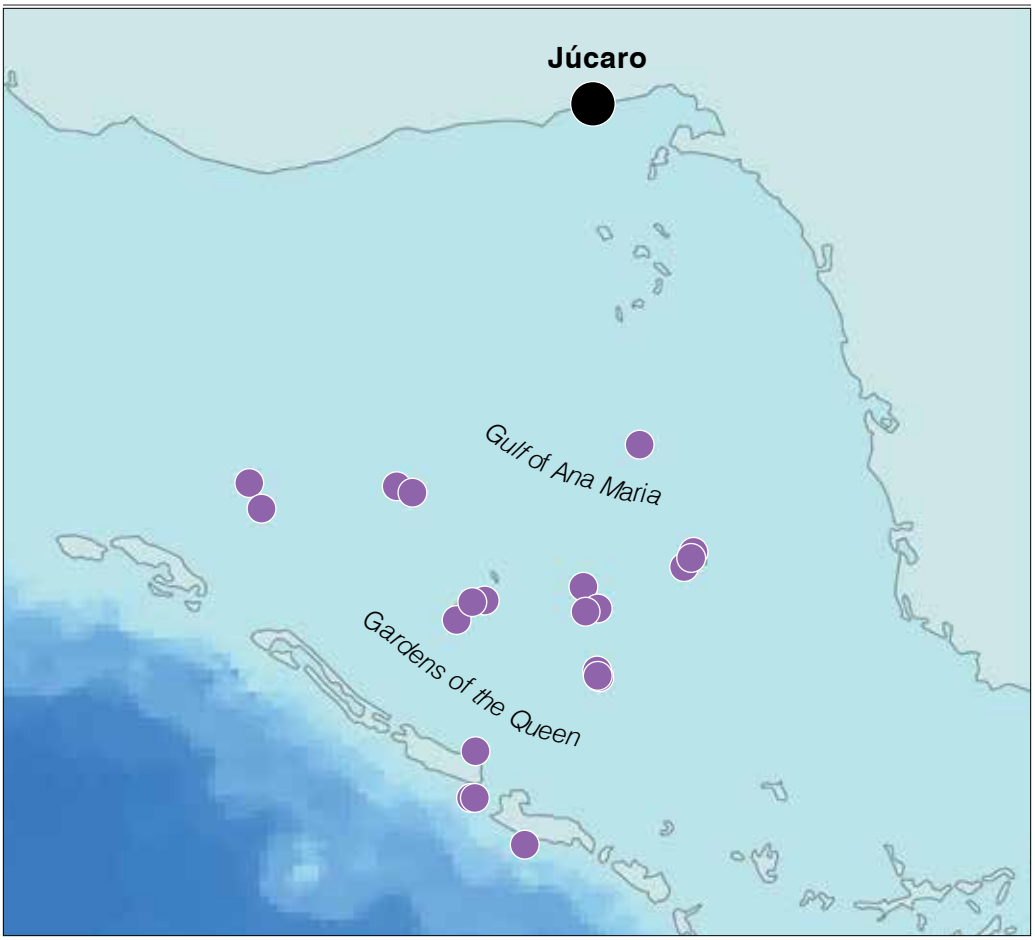
SCIENCE REPORT

Coral reef health research activities

CIM's Patricia González and Orlando Perera Pérez designed a monitoring protocol to assess the current status of coral reefs in the Gulf of Ana Maria and in the Gardens of the Queen, including assessment of recruitment, coral cover, diversity, assemblages of the benthic community and coral health (i.e. disease or mortality). According to the survey design, three SCUBA divers conducted coral recruitment surveys at each site using 100 individual ¼m^2 quadrats to count recruits at the species level. SCUBA divers monitored coral health and the sessile community simultaneously, recording disease, recent and old mortality and the composition of the coral assemblage. For the sessile community surveys, teams of two divers used 30 1m^2 quadrats to

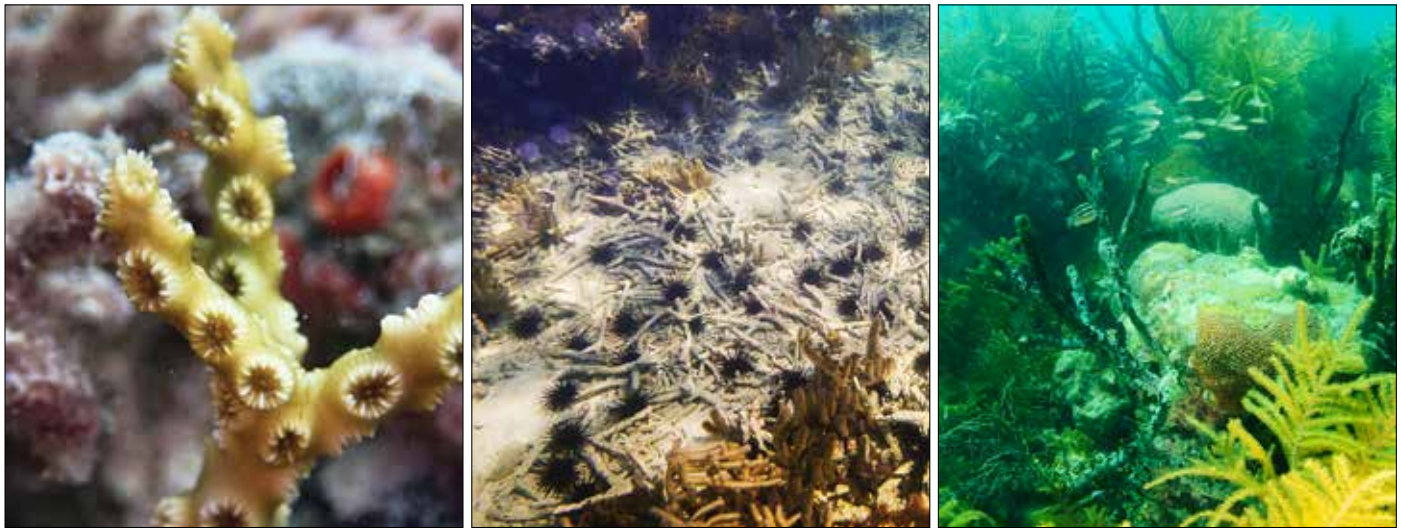
Monitoring sites

for coral reef health research activities for both legs of the expedition



count individuals to the species of sponges, corals and algae. Several objectives were achieved over the expedition, including:

- **Monitored 22 sites to assess coral reef health.** Some sites required multiple dives to complete the surveys due to high coral cover, diversity and recruitment. On average, each site required nine SCUBA divers simultaneously to complete the survey.
- **Confirmed new coral colony growth.** In the south of Cayo Caballones, we observed a live, healthy patch of Acropora palmata on the reef crest. In comparison to surveys conducted last year, the colonies have demonstrated new growth. These colonies will be useful in a local restoration project, at least in the Gardens of the Queen.
- **Identified areas of high coral density.** The team recorded a high density of healthy Acropora cervicornis in Cayo Palomo.
- **Increased coral research capacity.** Together, we trained CIM staff and new members of CIEC's research crew in monitoring methods; thereby, increasing the science capacity for monitoring coral reefs in Cuba.



Left: Close-up of a new coral. New coral growth signifies highly successful recruitment across many species in both the Gulf of Ana Maria and the Gardens of the Queen. **Center:** Urchin presence in an old staghorn coral bed helps control macroalgae abundance which creates room for new coral recruits. **Right:** With varible levels of turbidity and nutrietns, some of the monitoring sites in the Gulf of Ana Maria have less intact coral reefs.

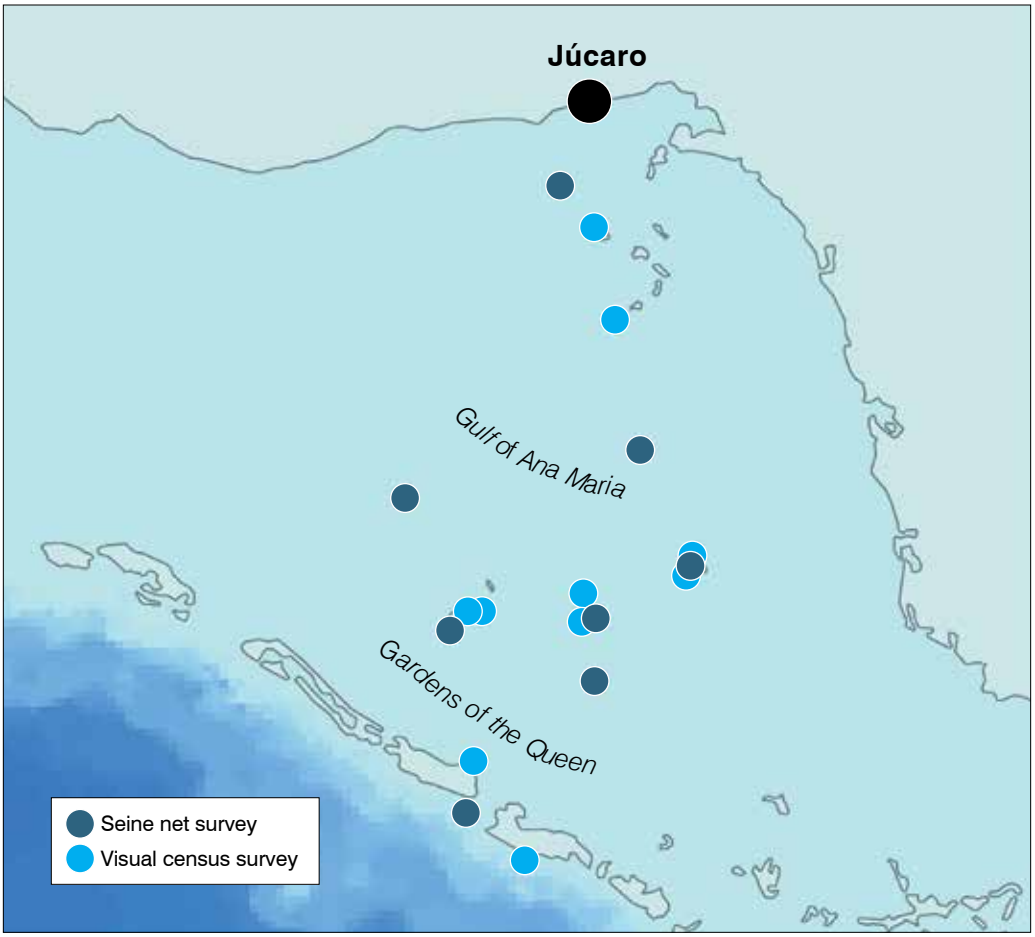
SCIENCE REPORT

Fisheries research activities

CIEC's Fabián Pina Amargos and EDF's Kendra Karr are working together to develop a monitoring program for commercially-valued species from the coastal waters of southern Cuba, into the Gulf of Ana Maria and out into the Gardens of the Queen. The recent expedition offered a unique opportunity to assess the status of fished stocks across multiple habitat types (e.g., seagrass beds, mangroves, patchy coral reefs and contiguous coral reefs) and management zones (e.g., MPAs vs. no management or fishing). Over the course of three weeks, we conducted fishery-independent monitoring via visual censuses on SCUBA at each coral reef monitoring site. We also conducted fishery independent sampling of lagoons with a beach seine at several

Survey sites

for fishery-independent visual census surveys and sampling with a seine net



beaches in the Gulf and in the Gardens. Lastly, when the opportunity arose the team interviewed fishermen. Accomplishments of these efforts include:

- **Increased fisheries research capacity.** Together, we trained CIM staff and new members of CIEC's research crew in fisheries monitoring methods, thereby increasing the capacity of data collection in the Gulf of Ana Maria, Gardens of the Queen and throughout Cuba.
- **Improved replicable scientific data collection methods.** Staff of CIEC and CIM became familiar with sampling gear and methods, and utility of fishery independent monitoring, including beach seine surveys, measurements and data collections. These same data collection methods can be extended to other regions of Cuba, as they can be replicated more frequently, and eventually help establish a fishery-independent monitoring program throughout Cuba's waters.
- **Identified need to diversify sampling gear.** The team collected data across a representative set of beaches within the study areas, which was productive but also revealed the need to diversify sampling gear. It became clear as the research progressed that beach seines were not optimal for sampling across all the habitats present in the region (i.e. coral reefs or regions with abrupt or sloping bottom habitats, deeper seagrass meadows, deeper muddy habitats). In the future, we should implement the use of otter trawls, seine nets, traps and other sampling gear that replicates that used by fisherman of the region (e.g. fishing communities of Júcaro, Playa Florida, and Guayabal) to increase the capacity of fishery independent monitoring.
- **Completed fish surveys and fishermen interviews.** We sampled a total of 10 cays with the beach seine, surveyed 20 coral reef health monitoring sites for fish assemblage, and interviewed the crew of one fishing boat.
- **Built social capital.** Participants forged new institutional, professional and personal relationships that promote the objectives of multidisciplinary and multi-institutional programs for sustainable fisheries in the Gulf of Mexico and Caribbean Sea.

Preliminary findings

Preliminary findings include a general summary of the size structure, trophic assemblages, abundance and species richness for both fishery independent monitoring methods. It is important to note that the summary of beach seine surveys are under-representing the fish assemblage in the Gardens of the Queen. As noted previously, the beach seine net was not the appropriate gear to use across all of the monitoring sites, as several of the sites were coral reefs, often with sloping benthic habitat and deeper than the shallow beaches in the Gulf of Ana Maria. Due to the variability of habitat in the Gardens of the Queen, only three areas were sampled, two areas around Cayo Anclitas and one in Cayo Caballones. The species richness, total abundance and mean abundance of the Gardens of the Queens sites were lower than the sites in the Gulf. Interestingly, the species that were caught in the beach seine net at sites in the Gardens of the Queen were above average for the average total length (145 mm) of fish caught across the Gulf of Ana Maria, at 152 mm, 257 mm and 211 mm, respectively (Figure 1, page 26). The cays with high species richness and abundance were Manuel-Gomez, Obispo and Palomo; all with above-average sized fish. In general, carnivores, particularly snappers and grunts, dominated the catch from the beach seine (Table 1, page 23), as the most abundant and common species of fish in Cuba are carnivores.

Initial results from the visual survey monitoring also summarize the size structure, abundance and species richness of fish. We collected data from 20 sites, 13 from the first leg of the expedition and 7 from the second. Four of the sites surveyed during the first leg, and only one from

Left: On board the University of Havana's *Felipe Poey*, researchers identify and measure fish caught with the beach seine using both total length and standard length. **Right:** Scientific technicians deploy the seine across seagrass beds in a shallow lagoon.

the second leg, were in the Gardens of the Queen. All of the survey sites from the Gardens of the Queen had higher than mean total length (184 mm) and species richness (17 species; Figure 2, page 28). Interestingly, the total abundance (359 individuals) and mean abundance (40 individuals) was low in the Gardens of the Queen sites. The fish assemblage in the Gardens of the Queen is comprised of few-large fish, whereas the Gulf of Ana Maria is comprised of many-small fish. Indicating that each areas supports different life stages that ontogenetically shift from the shallow nursery-grounds of seagrass bed and mangroves in the Gulf of Ana Maria to the adult habitat available in the Gardens of the Queen. For future assessments, converting the density per site to total biomass will help to clarify some of the other differences in the abundance and size structure across sites.

Researchers on the second leg of the expedition were fortunate to encounter one fishing vessel, and though the vessel was not necessarily representative of the complete fishing fleet, the encounter was an opportunity to begin the process of characterizing fisheries in the Gulf. The boat was a bonito tuna-fishing boat, using handline and pole/hook-and-line gear. On this particular voyage, the vessel was heading to the areas around the Gardens of the Queen (but not inside the MPA) to find the small tuna species. In general, the catch on a two- to three-week trip for the medium-sized vessels is around 2 tons, which the boat then sells to the Cuban state primarily for export markets, but also local consumption. After the interview, expedition members traded some cooking oil for fresh-caught bonito.

FIGURE 1

Fish caught in the beach seine net at each of the sampling areas

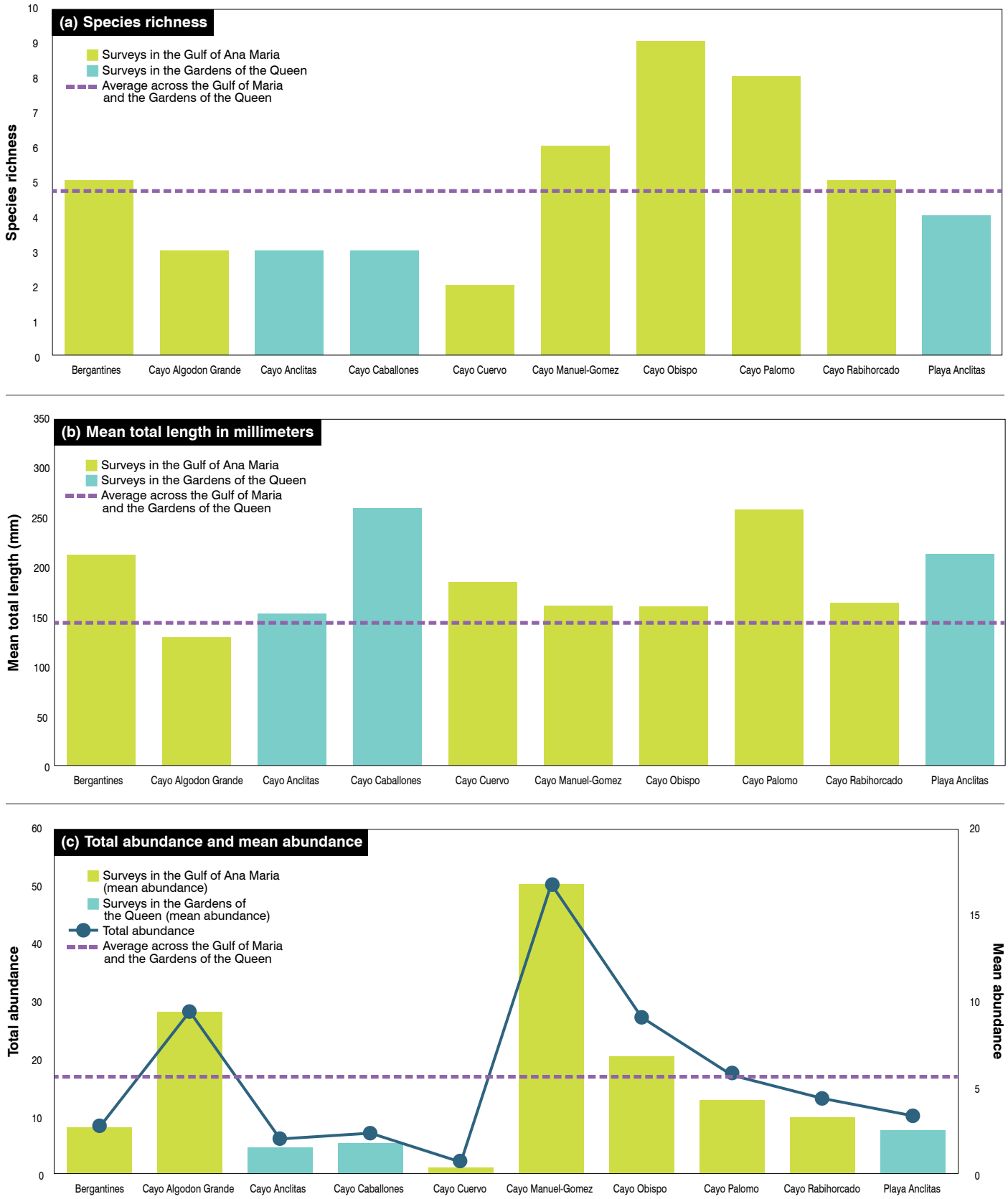


TABLE 1

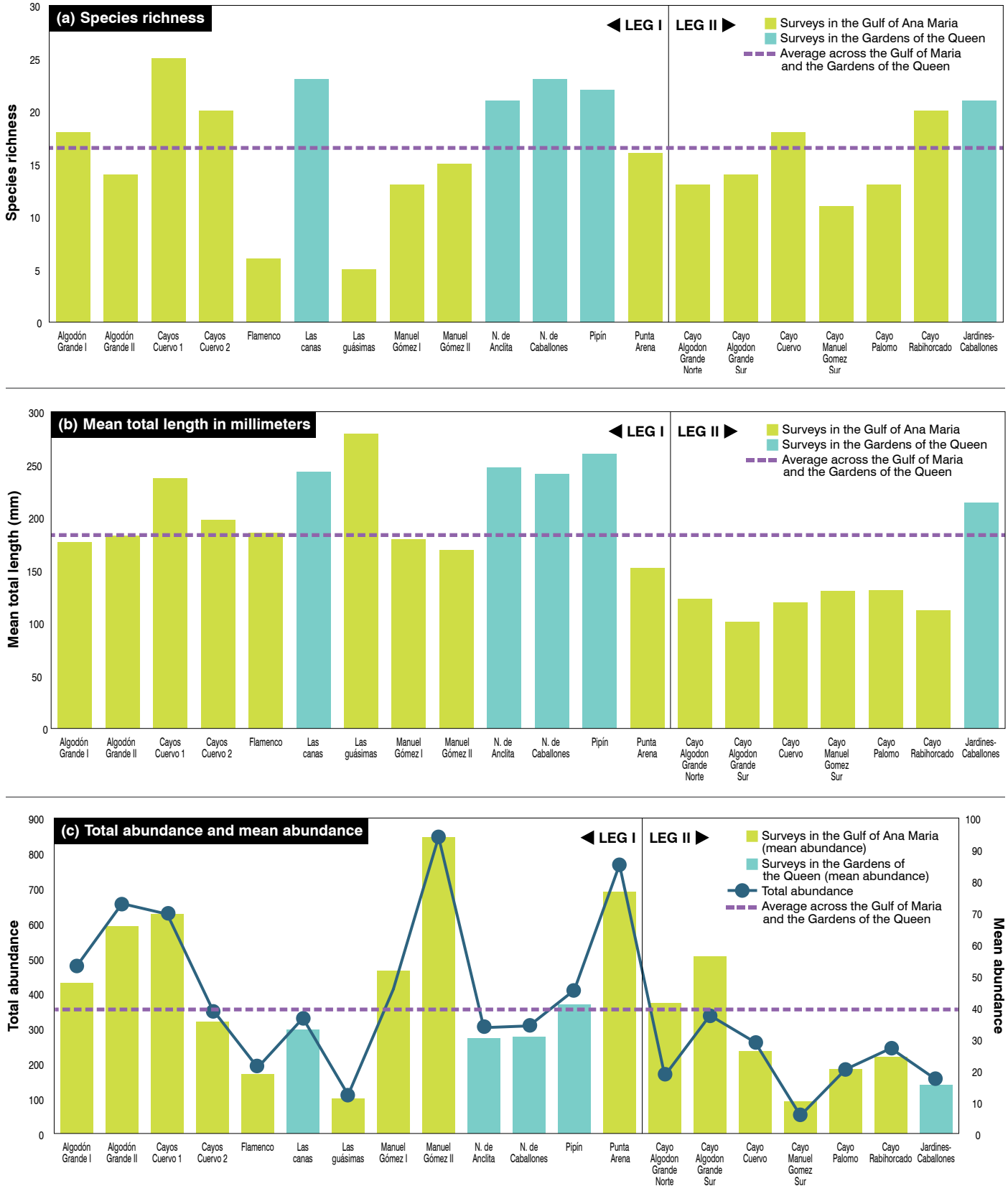
Fish assemblage structure

Mean total length (mm) and functional group of the catch from beach seining by species across the Gulf of Ana Maria and Gardens of the Queen

Common name	Species name	Local name	Mean total length (mm)	Functional role
Barred longtom	*Ablennes hians*	Agujón	476	carnivore
Honeycomb cowfish	*Acanthostacion polygonia*	Torito hexagonal	90	invertivore
Sea bream	*Archosargus rhomboidalis*	Chopa	97	omnivore
Sheephead Porgy	*Calamus penna*	Pez de pluma	184	invertivore
Flagfin mojarra	*Eucinostomus melanopterus*	Mojarra	87	invertivore
Mojarra general	*Eucinostomus spp.*	Mojarra	106	carnivore
White grunt	*Haemulon parrai*	Ronco	115	carnivore
French grunt	*Haemulon flavolineatum*	Ronco condenadi	100	carnivore
White grunt	*Haemulon plumieri*	Ronco arará	100	carnivore
Bluestriped grunt	*Haemulon sciurus*	Ronco amarillo	167	carnivore
Ballywhoo	*Hemiramphus brasiliensis*	Escribano	278	omnivore
Buffalo trunkfish	*Lactophrys trigonus*	Chapín de lunares blancos	88	omnivore
Schoolmaster	*Lutjanus apodus*	Cají	100	carnivore
Gray snapper	*Lutjanus griseus*	Caballerote	192	carnivore
Lane snapper	*Lutjanus synagris*	Biajaiba	120	carnivore
Tilefish	*Monacanthus tuckeri*	Lija	64	omnivore
White mullet	*Mugil curema*	Liseta	162	herbivore
Keeltail needlefish	*Platybelone argalus*	Agujón	324	carnivore
Bucktooth parrotfish	*Sparisoma radians*	Lorito	115	herbivore
Checkered Puffer	*Sphoeroides testudieneus*	Tom or Tamboril	170	invertivore
Barracuda	*Sphyraena barracuda*	Barracuda	325	carnivore
Houndfish	*Tylosurus crocodilus*	Agujón	486	carnivore
Yellow-spotted stingray	*Urolophus jamaicensis*	Tembladera	460	invertivore

FIGURE 2

Fishery-independent visual survey across the sampling region



SCIENCE REPORT

Connectivity and monitoring research activities

During the expedition, researchers from CIM and CIEC, led by CIM's Maickel Armenteros collected biological samples across multiple trophic levels, with the intent to study the connectivity between and among mangroves, coral reefs and seagrass from the coastal water out to the Gardens of the Queen. All of the samples will go through an independent stable isotope analysis. This technique uses chemical signatures to allow researchers to quantify the relative contributions of individuals from each region/site to the fishing grounds and identify migration corridors among important habitats. This information will be combined with oceanographic and abiotic data collected during the expedition (e.g., nutrient fluxes and sedimentation rate; tides, currents and waves) to illuminate a complete picture of this unique region of the Caribbean. This process has two parts, the first of which has been completed:

- Collected biological samples of fish, corals and macroalgae throughout the Gulf of Ana Maria and Gardens of the Queen.
- Next, scientists will assess the isotopic signature of each biological sample. Samples from different sites with similar chemical signatures are a good indication that the sites are connected. Additionally, chemical signatures can help to define the trophic pathway at each site.

Left: CIM researchers Maickel Armenteros and Pedro Reyes assess the zooplankton from a recent plankton tow. Tow nets are used to monitor the zooplankton community inside of seagrass beds, coral reefs and mangroves. Right: Field teams collect mangrove (*Rhizophora mangle*) leaves to assess the status of the red mangrove popualtion across the region.

Cuba has world renowned marine ecologists, but the capacity for large scale field research and monitoring programs has been limited because of insufficient funding and constraints on scientific collaboration outside of Cuba. Our collaboration not only advances local knowledge about the ecosystems in the Gulf of Ana Maria and the Gardens of the Queen, it ultimately contributes to increased capacity for science, management and policy through the development of scientific understanding of the region. We all benefit from better science. This expedition, which monitored from the nearshore waters of the Gulf of Ana Maria, throughout the Gulf and into the Gardens of the Queen, was the first of its kind in Cuba both in scale and overall objectives. Much of these waters and surrounding islands support nationally important commercial and artisanal fisheries. Through the knowledge gained from this expedition and future research expeditions in this area and around the country, we will increase the capacity to manage for healthy reefs and sustainable fisheries throughout Cuba. Specifically, on this expedition we:

- Assessed the health of the coral reef, seagrass and mangrove ecosystems in the Gulf of Ana Maria and out in the Gardens of the Queen across 32 sites.
- Strengthened social capital: Expedition members combined institutional, professional and personal relationships to promote the objectives of multidisciplinary and multi-institutional programs for healthy reef and sustainable fisheries in Cuba, the Gulf of Mexico and western Caribbean.

Next steps

This cruise is the first of many such joint expeditions that CIM, CIEC and EDF hope to carry out in the future, depending upon funding and approvals from both the Cuban and U.S. governments. Current policies in both favor scientific exchange and collaboration between the US and Cuba, but legal and regulatory requirements in both countries place restrictions on access to areas, transfer of technology needed for research, and funding of expedition costs. EDF and other institutions in both countries are working to identify obstacles to joint research and suggest policy changes needed to overcome them.

Multiple years for data collection are needed in order to develop a database for comparison in future years. The monitoring program for the Gulf of Ana Maria and the Gardens of the Queen has been designed as a model to strengthen the management and monitoring systems throughout Cuba. This international partnership is but one example of new bi-lateral and multi-lateral collaborations that are advancing scientific knowledge—and ultimately resource management and policy—in both Cuba and the United States, as well as in Mexico and other countries in the region.

Funding is in short supply for scientific research in Cuba and we are grateful to the Waitt Foundation for providing crucial funding for to get this important project off the ground. Through this expedition, the Waitt Foundation continues its legacy of supporting critical marine science worldwide and has once again demonstrated itself to be a philanthropic leader in global oceans conservation. With this new initiative, the Foundation has enabled pioneering research in Cuba at a time when natural and man-made threats to coastal and marine ecosystems are unprecedented. EDF and our partner institutions will seek funding from additional sources so that we can continue to conduct important ecological baseline studies in the Gulf of Ana Maria and the Gardens of the Queen, with the ultimate goal of increasing the capacity to manage healthy reefs and sustainable fisheries throughout Cuba.

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