

Restoring Belize's Reef Ecosystem



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Overview

The Queen conch (*Strombus gigas*) is one of the Caribbean's largest marine exports, and the second largest fisheries export in Belize after lobster. An iconic animal in ancient Mayan and modern cultures, it is used in everything from jewelry to cuisine. The Queen conch is also crucial to the health of a reef ecosystem. As grazers, they keep algae in check, while hermit crabs, young groupers, octopuses, and other small creatures find refuge in their shells. However, due to its popularity, overfishing has led to dramatic declines in the Queen conch population, almost to the point of commercial extinction (meaning the species is too rare to catch profitably).

To protect this valuable resource, Marine Reserves have been developed throughout the Caribbean to protect juveniles and breeding-age adults, and promote sustainable harvesting. If successful, these protected populations will grow and spill over into neighboring areas, where fishing is permitted. As such, it is necessary for scientists to monitor conch populations both inside and outside of the protected areas to determine whether each individual Reserve, and the network as a whole, is effective in safeguarding conch population growth.

For Earthwatch project *Queen Conch of Belize*, 2010 was also a significant year for reasons that require an understanding of this project's history. With the assistance of Earthwatch volunteers, Dr. John Cigliano has surveyed Queen conch since 2006 in Belize's Sapodilla Cayes Marine Reserve (SCMR), an area comprising 15,619 hectares. This Reserve, established in 1996, forms part of a UNESCO World Heritage site at the southern tip of the Mesoamerican

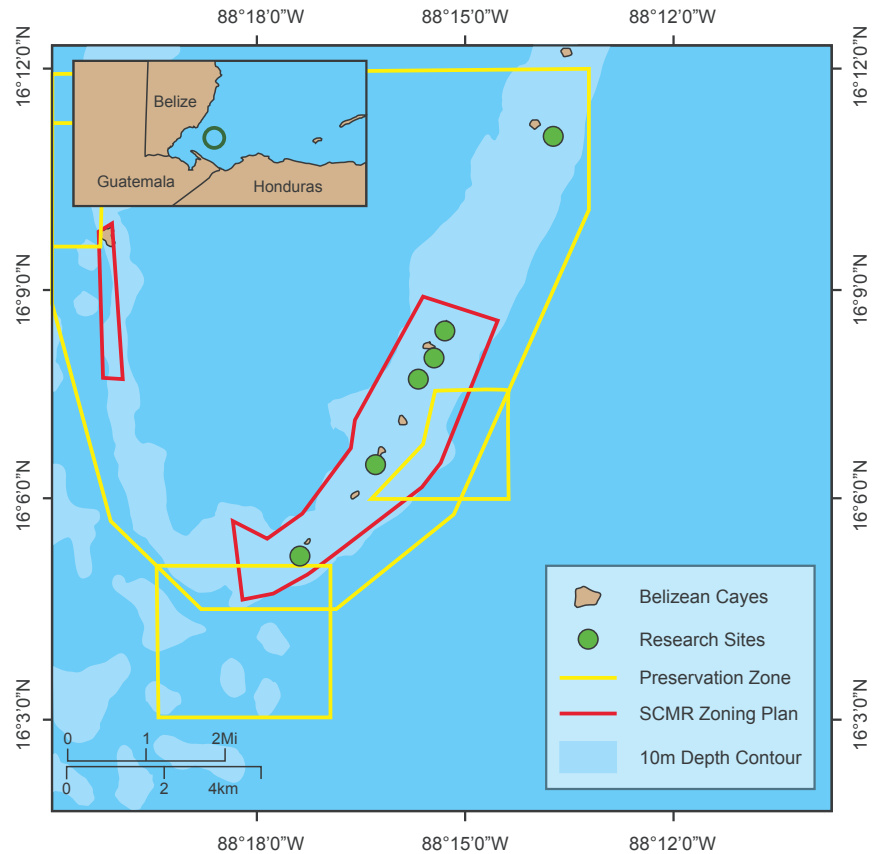


Figure 1: Map of the Sapodilla Cayes Marine Reserve, showing the research sites, within a Preservation Zone, where conch aggregations are mapped and counted.

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Barrier Reef (the second largest barrier reef in the world). It wasn't until April 2010, however, that the Reserve was enforced—meaning fishing was not permitted in certain areas. Therefore, Dr. Cigliano can now compare his four years of pre-enforcement data on habitats and populations, with data collected post-enforcement—enabling him to analyze the restriction of fishing activities inside and outside of the areas where fishing is banned. He's conducting this work under the new Earthwatch project title *Restoring Belize's Reef Ecosystem*.

The goal of the project is to determine whether the Sapodilla Cayes “no-take” Marine Reserve (meaning fishing is

banned) is indeed benefiting Queen conch populations as hypothesized. Baseline knowledge to be gained through this study includes the understanding of where adults and juvenile conch in this area are recruited from, what their dispersal patterns are, how quickly they grow, what sizes and ages breed most successfully, and what the overall population size and age structure is.

The results of this study will continue to be shared via meetings and publications with all stakeholders of the Reserve: in particular, the fishers, local community members, and the Department of Fisheries—who with the local government would be required



to approve changes at the SCMR. The team works closely with the non-governmental organization (NGO) that manages the Reserve—first the Toledo Association of Sustainable Tourism and Empowerment (TASTE) and now Southern Environmental Association (SEA), an NGO that resulted from the merger of TASTE and Friends of Nature. The Earthwatch researchers continue to present their findings and share raw data with both organizations. SEA is in the process of updating the Reserve’s management plan and the scientists aim to inform the plan using results from the pre-enforcement surveys. The conclusions they draw will be applicable to Marine Reserves around the world.

The research objectives are:

- To determine the effectiveness of Sapodilla Cayes “no-take” Marine Reserve in protecting and replenishing Queen conch populations

- To provide information for adaptive management of the Marine Reserve
- To build capacity in all stakeholders to ensure the long-term success of the Reserve

Outcomes

In July and August 2010, volunteers snorkeled to survey, tag, and monitor Queen conchs in critical coral island areas (cayes) and other areas within the SCMR.

Conch population assessment: The data collected in 2010 formed the first post-enforcement survey of the study. Teams counted and measured shell lip thickness and total length of 545 conch. They tagged around 400 of them. To date, Earthwatch teams have sampled over 3,800 and tagged over 3,000 conch.

The scientists mapped nine shallow-water Queen conch “aggregations” (dense collections of individuals) throughout the Reserve, in both protected and

unprotected areas. These aggregations were found with the help of local conch fishers, and all but one has been sampled by Earthwatch researchers since 2006. Teams also conducted random surveys throughout the Reserve to locate and map any unknown aggregations. They found conch in seven areas, four of which might be true aggregations.

Through scuba diving, the team surveyed two deeper sites (~six to seven meters) in 2010, which had been traditional conch fishing grounds and had been reported by two local fishermen as having been depleted. A female conch was observed spawning at one of these sites.

The scientists also added two new research sites this season to re-balance the experimental design when the Reserve was re-zoned in 2010. The 222 hectare “no entry zone” (Preservation Zone)—that scientists were permitted to survey—had been moved from its original designated site as part of the



Figure 2: Volunteers snorkel seagrass beds to locate and identify Queen conch, before tagging, and measuring them, to monitor conch populations.



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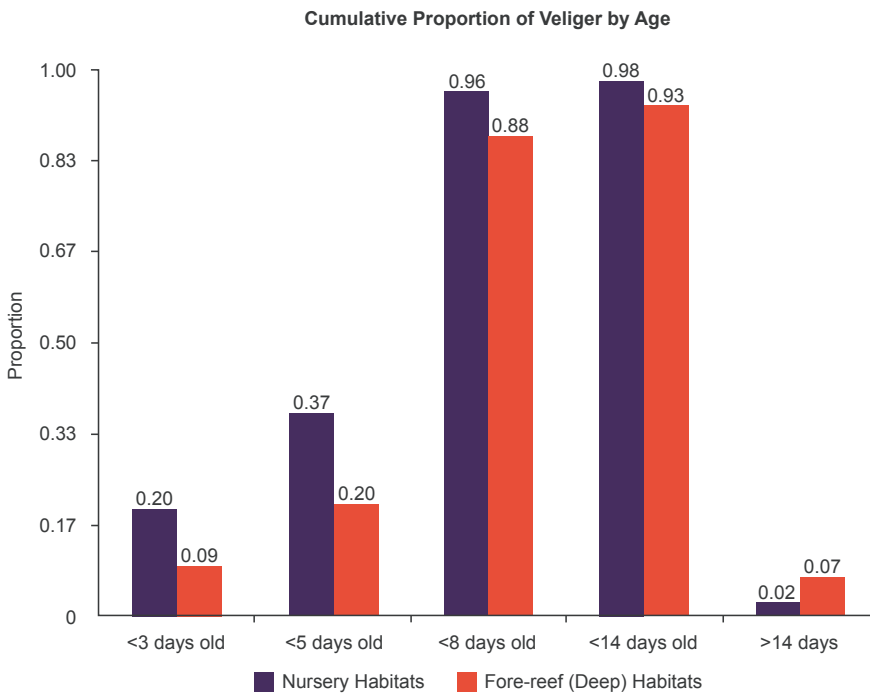


Figure 3: Graph showing the proportion of early, mid and late stage veligers found in nursery habitats and deep fore-reef habitats.

new management plan. The other three new zones consisted of a “General Use” zone—the largest area within the Reserve (13,145 hectares) where recreational use, research, and fishing are allowed in accordance with regulations—and two “Conservation Zones” of 263 hectares and 1,988 hectares, designed for recreational use, with the latter allowing catch and release fishing and restricted subsistence fishing. This made it necessary to add “White Reef”—a control (unprotected) site—to the study area.

Breeding ecology: Observations by the teams indicate that conch do not spawn in shallow-water aggregations in the “no-take” zone. In fact, only 54 out of 3,022 individuals in the aggregations were sexually mature, and were never observed spawning. Spawning was, however, observed in three aggregations located in deeper water (15 meters and below). This indicates a need for deeper water to be included in marine reserves that are created with an aim to restore conch populations.

Preliminary analyses of the data from tagged individuals indicate that deep-

water conch do not migrate, whereas shallow-water conch use two “cuts” in the reef as primary migration routes. Shallow-water conch appear to have strong site fidelity, either not leaving the aggregation at all, or returning to it on spring migrations from deep-water wintering sites. Overall, there appears to be little post-settlement migration (“spillover”) from protected to unprotected areas. This might change, however, if densities in the “no-take” zone increase and is an important trend to monitor, as support of Marine Reserves by the fishing community often relies on the assumption that spillover will result in improved fishing outside of the Reserve.

The scientists continue to sample the age and size structure of Queen conch veligers (young conch) from four different nursery aggregations and on the reef slopes (fore-reefs) of the associated reef cuts. Analyses are preliminary, but very young veligers (one to five days old) have been found in both shallow nursery habitats and deeper sites. Results suggest that the veligers come from eggs

laid within or adjacent to the Reserve. Because egg-laying has not been observed in shallow areas, it is likely that the young veligers found over the nursery habitats have come from the adjacent deep-water sites.

A new and worrying finding from the new surveys has been the documentation of lionfish (*Pterois spp.*) throughout the Reserve. Lionfish are invasive predators originally from the Pacific that are decimating fish populations across the Caribbean. There is evidence that these aggressive predators are displacing native predators and are significantly reducing the populations of their new prey species. The ripple effects of this could seriously impact the Reserve ecosystem, and will need monitoring and careful management.

This year wraps up merely one season of data collection in the Sapodilla Cayes Marine Reserve—not enough to determine if the “no-take” zone is protecting and replenishing Queen conch populations. More lipped conch were found in some aggregations than had been documented previously, suggesting that enforcement might have had an immediate effect, but the team does not know if this will be long-lasting. They need at least two to three years of surveys to be able to confirm or deny its success. The findings will be added to the four years of pre-enforcement data before the researchers make any conclusions on the success of the “no-take” Marine Reserve on the population recovery of an important reef species.

Recent Publications

Cigliano, J.A., Dewey, S. and Duffey, C. (2010) Possible Self-Recruitment of Queen Conch (*Strombus gigas*) in the Sapodilla Cayes Marine Reserve, Belize. 24th Annual Meeting of the Society for Conservation Biology, 3-7 July, Alberta, Canada

Cigliano, J.A., Sandridge, M., Skinner, D., Vereneck, R., Bugler, B., Ridlon, A. and Kliman, R. (2008) Pre-enforcement population assessment, movement, and genetic connectivity of Queen conch (*Strombus gigas*) populations in Belize. 22nd Annual Meeting of the Society for Conservation Biology, 13-17 July, Tennessee, USA