EARTHWATCH INSTITUTE

HELPING ENDANGERED CORALS IN LITTLE CAYMAN

2015
FIELD
REPORT

Helping Endangered Corals in Little Cayman

Dr. Kristi Foster – PI
Central Caribbean Marine Institute
Earthwatch 2015 Summary Report

Earthwatch volunteer helps map corals by searching for new colonies while snorkelling at Point of Sand, Little Cayman. (2015 Team #2)

SUSTAINING BIODIVERSITY THROUGH RESEARCH, EDUCATION, OUTREACH AND CONSERVATION

CCMI

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Dear Earthwatch Volunteers,

Thank you for Helping Endangered Corals in Little Cayman! We could not have done it all without you.

In 2015, Earthwatch volunteers helped the Central Caribbean Marine Institute (CCMI) on four crucial projects to conserve Evolutionarily Distinct and Globally Endangered (EDGE) coral species in Little Cayman. Highlights from these projects include the following:

- CCMI is home to the Little Cayman Coral Nursery, the first staghorn coral nursery in the Cayman Islands. We needed help returning the nursery-reared corals to the wild. Volunteers outplanted 22 new colonies of this endangered species to an area of the reef we now call "Earthwatch Rock".
- We are investigating whether long dead but still standing elkhorn coral skeletons may act as new settlement terrain for the larvae of this endangered species. Volunteers scrubbed 69 coral skeletons to remove algae in preparation for the spawning season. Scrubbing corals is hard work—we appreciate the extra hands and could not have prepared this many skeletons without Earthwatch.
- We need to compare recruitment onto scrubbed elkhorn coral skeletons with natural recruitment onto reefs and overgrown skeletons. Volunteers acted as snorkel scouts and found 20 new colonies and 32 skeletons with elkhorn coral regrowth.
- CCMI is mapping the locations of EDGE corals around the island as a measure of reef resiliency. Earthwatch volunteers mapped 22 elliptical star corals, which will help us determine population demographics. Earthwatch snorkel scouts also found 14 new colonies just offshore of the research station.
- Almost 60% of Little Cayman's corals experienced moderate- to severe-bleaching during the 2015 summertime high temperatures. Severe bleaching can lead to mass mortality. Earthwatch volunteers helped us document the health status of 139 corals two months after the peak temperatures subsided. The initial good news is that <5% of the corals surveyed died while the rest are on the road to recovery.

All of these projects are still in progress, so we are awaiting long-term results. We would have accomplished only a fraction of this work without you. Thank you!

Sincerely,

Dr. Kristi Foster
CCMI Assistant Director of Research
Earthwatch Principal Investigator

SUMMARY

In 2015, the Central Caribbean Marine Institute (CCMI) joined forces with Earthwatch to enlist citizen science volunteers in our effort to help endangered corals in Little Cayman during four week-long expeditions. Together, we helped return 22 nursery-reared endangered staghorn corals to the wild and prepared 69 skeletons from endangered elkhorn corals for a study during the annual larval recruitment event. Earthwatch snorkel scouts found 88 Evolutionarily Distinct and Globally Endangered (EDGE) corals as part of our effort to map EDGE species around the island as a measure of reef resilience. Volunteers helped assess the health status and recovery of 139 corals following the high-temperature induced bleaching event which impacted roughly 60% of the corals in Little Cayman. All of this work were the first steps in long-term projects aimed at restoring EDGE coral populations locally and, ultimately, throughout the Caribbean.

GOALS, OBJECTIVES, AND RESULTS

The overarching goal of this project is to better understand what makes a coral reef resilient to stressful events such as an intense storm, ocean acidification, climate change, and specifically, the global bleaching event of 2015—knowledge that will help researchers support and protect reefs in the Cayman Islands and elsewhere in the world.

As part of our 2015 reef resilience program, we had the following research objectives:

- Mapping—Assess the overall diversity of coral reefs and record the distribution of EDGE species while noting the environmental conditions associated with higher abundances of these corals.
- Expanding Coral Nursery and Outplanting—Expand the colonies of staghorn corals within the nursery as well as on the reefs.
- Monitoring and Surveillance—Determine which factors explain why the reefs at Little Cayman are recovering by assessing the growth rates of corals in the nursery and in the outplanting sites.

24 Earthwatch volunteers participated in four fieldings to help endangered corals in Little Cayman. Highlighted results are linked to our research objectives in Figure 1.

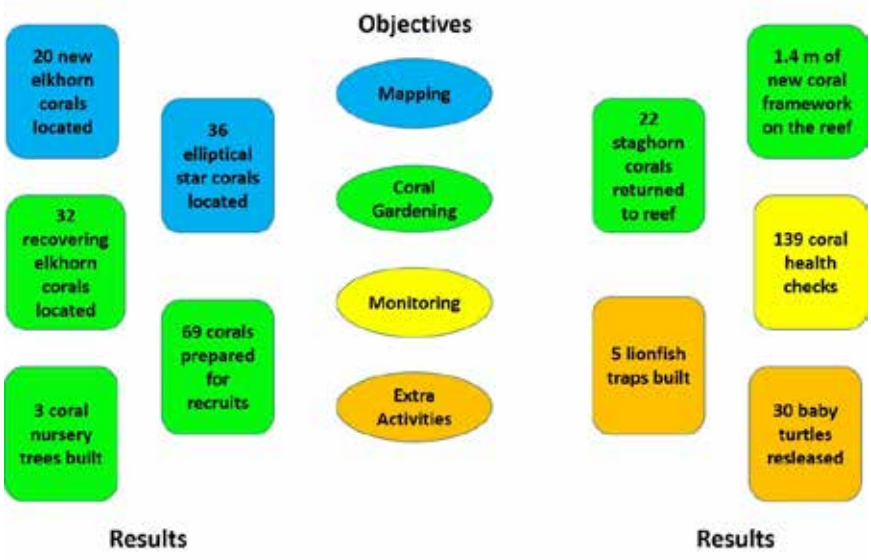

Figure 1. Highlights of research results accomplished by 24 Earthwatch volunteers in 2015. Results (blocks) are color coded to link to the respective research objective (ovals).

MAPPING RESULTS

Elliptical star corals (*Dichocoenia stokesi*) are EDGE coral species; in fact, only a single genus exists in the Caribbean, meaning this coral is evolutionarily distinct throughout its natural range. Elliptical star corals are easy to identify because of the shape of their polyps (Fig 2). Dr. Kristi Foster (CCMI Assistant Director of Research and Earthwatch PI) and her summer mentee, Matz Indergard from Southern Utah University, studied the preferred habitat of this EDGE coral. Earthwatch volunteers acted as snorkel scouts and helped locate 36 corals at two sites. Photos were taken of the elliptical star corals and their nearest neighbors to determine the demographics of the coral communities. Data collected by Earthwatch volunteers were included in a larger study comparing 11 sites around Little Cayman. Statistical analysis indicated that the elliptical star coral "neighborhoods" in two depth ranges were significantly different (Fig 3). Image analysis identified the most common and nearest neighbors (Fig 4). A scientific poster summarizing this project, which may be viewed online, was presented by Matz in February 2016 at the Ocean Sciences Meeting in New Orleans, Louisiana. The results of this mapping effort help us to better understand the natural habitat and community structure around this EDGE species and may be applicable for future conservation actions.

Figure 2. Elliptical star coral (Dichocoenia stokesi) in Little Cayman. The elliptical shape of the coral polyps make this EDGE species easy to identify. *Photo courtesy Brian Griffiths, CCMI REU Student 2015.*

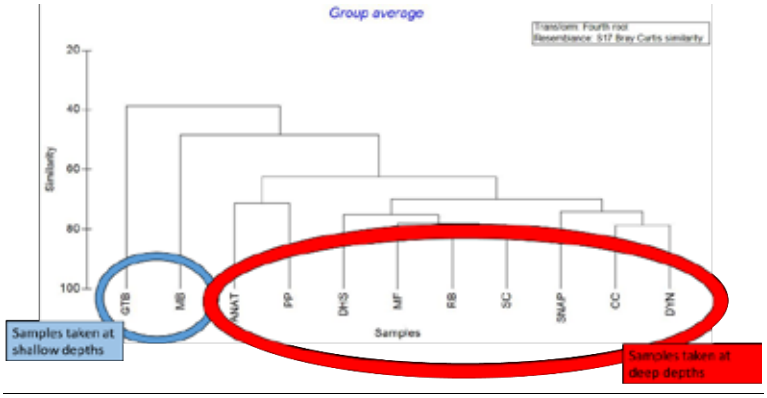

Figure 3. Cluster analysis showing statistically significant difference in elliptical star coral communities based on depth. Image and statistical analyses of coral communities were conducted using Coral Point Count (CPCe) and Primer software, respectively. *Figure courtesy of Matz Indergard, CCMI REU Student 2015.*

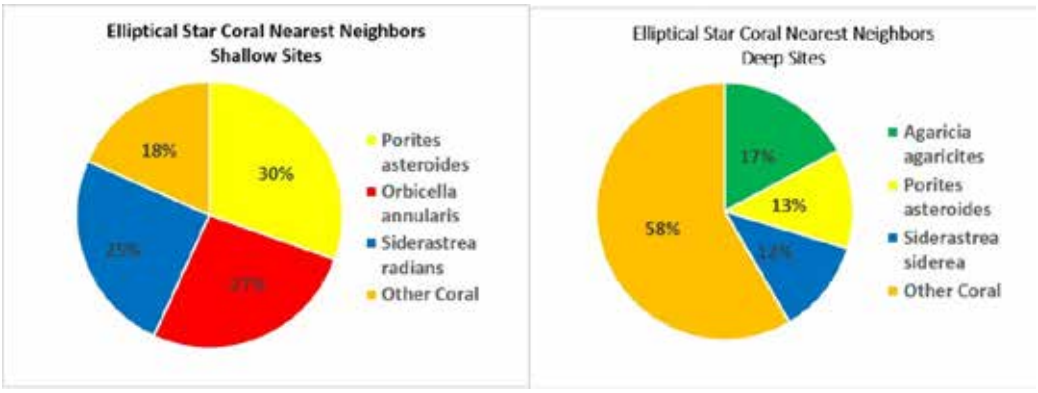

Figure 4. Nearest neighbors in elliptical star coral communities in Little Cayman.

Porites asteroides = Mustard Hill Coral. *Orbicella annularis* = Boulder Star Coral (another EDGE species). *Agaricia agaricites* = Lettuce Coral. *Siderastrea* spp. = Starlet Corals. *Figure courtesy of CCMI.*

Elkhorn coral (*Acropora palmata*) is both evolutionarily distinct and globally endangered (Fig 5). This EDGE coral is one of only two species within its genus throughout the Caribbean. Elkhorn coral is an IUCN Red-Listed species and is on the US Endangered Species List, having suffered >90% loss of its population due to bleaching events and disease outbreaks over the past 30-40 years. CCMI has received permission from the Cayman Islands Department of Environment to add elkhorn coral as the second species within its coral nursery. A preliminary step is to locate elkhorn colonies around Little Cayman as potential donor colonies and to observe preferred, natural habitats for future outplanting of nursery-reared corals. Earthwatch volunteers acted as snorkel scouts and helped locate 20 previously unrecorded colonies. The GPS coordinates of these colonies will be used in 2016-17 as we map the genetic distribution of elkhorn corals. We also plan to monitor the colonies near the research station as part of a stahorn coral recruitment study which is underway.

Figure 5. Earthwatch snorkelers study elkhorn coral (*Acropora palmata*) in Little Cayman.
Photo courtesy of CCMI.

CORAL GARDENING RESULTS

Staghorn coral (*Acropora cervicornis*) is both evolutionarily distinct and globally endangered). Like its “cousin”, elkhorn coral, staghorn coral is an IUCN Red-Listed species and is on the US Endangered Species List. In 2012, CCMI established the first staghorn coral nursery in the Cayman Islands in collaboration with the Department of Environment and University of Miami. Two years later, a National Coral Nursery Policy was passed which opened the door for more nurseries to be established throughout the country. In 2015, the first citizen scientists were allowed to participate in coral gardening in the Cayman Islands (Fig 6). Earthwatch volunteers transplanted 22 nursery-raised corals into the wild as part of a study to determine the optimal depth ranges for outplant survival (Fig. 7). After securing the colonies to their new homes, volunteers measured each branch to calculate the total linear extension (TLE), a proxy for the increases in the staghorn population and reef framework. Earthwatch contributed 144 cm of framework to the reef. While not all transplants will survive, those that do will continue to

grow, provide structure for reef inhabitants, and hopefully re-establish the population of this endangered coral species. Outplants will be monitored for five years, so future volunteers can help track the progress of our restoration efforts (Fig. 8).

Figure 6. Citizen scientists return a nursery-reared staghorn coral (*Acropora cervicornis*) to the wild. *Photo courtesy of CCMI.*

Figure 7. A recently outplanted nursery-reared staghorn coral colony in Little Cayman. *Photo courtesy of CCMI.*

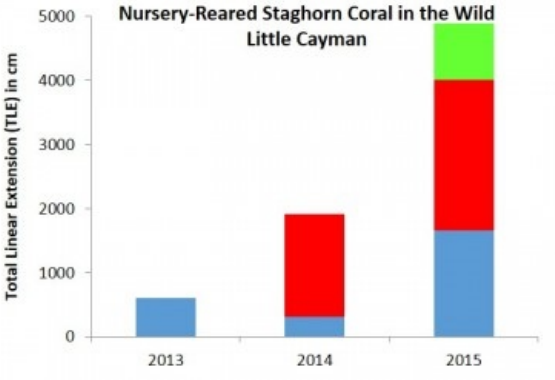

Figure 8. Total Linear Extension (TLE) of nursery-reared staghorn corals returned to the wild around Little Cayman. Colors represent the year during which colonies were outplanted Blue = 2013; red = 2014; green = 2015. In 2015, Earthwatch volunteers outplanted 144 cm of staghorn coral. *Figure courtesty of CCMI.*

Earthwatch volunteers also helped to build three PVC coral nursery trees (Fig. 9) which were later installed underwater. Each tree has the capacity to hold 100 small coral fragments. Citizen scientists threaded monofilament lines through holes which were drilled in the pipes, attached colored plastic beads, and crimped everything in place. The fishing line is used to secure coral fragments to the nursery trees (Fig. 10). Colored beads track the genotypes of the fragments which is important for monitoring biodiversity within the nursery and when returning corals to the wild.

Figure 9. Earthwatch volunteers assemble PVC trees for the Little Cayman Coral Nursery. *Photo courtesy of CCMI.*

Figure 10. Staghorn coral (Acropora cervicornis) fragment attached to PVC tree by monofilament line within the Little Cayman Coral Nursery. *Photo courtesy of CCMI.*

CCMI is investigating an alternative way to propagate elkhorn corals outside of the nursery. Preliminary studies have shown that long dead standing skeletons of elkhorn corals may be preferred recruitment sites for newly settled coral larvae. But, algae can overgrow the bare skeletons and compete with baby corals for space. Earthwatch volunteers acted as snorkel scouts and helped CCMI Education Coordinator, Tom Sparke, and locate 32 elkhorn skeletons which are “resheeting” with new coral tissue. These colonies, plus 37 others, were scrubbed to remove the algae which form a barrier on the skeleton and prevent tissue from covering the entire surface (Fig. 11). CCMI will revisit the colonies in 2016 to measure the amount of new tissue growth. If successful, this method could be a better way to help Nature nurture itself and promote regeneration of this EDGE coral species.

Figure 11. Earthwatch volunteers scrub long standing elkhorn coral skeletons to help recruitment and restoration of this endangered species. *Photo courtesy of CCMI*.

MONITORING RESULTS

Scientists predicted that the 2015 severe El Niño event would result in the third global-scale coral bleaching event on record (Fig. 12). Dr. Kristi Foster, Earthwatch PI, implemented a rapid coral health survey protocol to monitor the status of Little Cayman corals before, during, and after exposure to the elevated seawater temperatures. Earthwatch volunteers participated in the post-stress surveys in December, two months into the recovery period. Citizen scientists stretched transect lines (aka measuring tapes) across the reef. For each coral directly under the transect, volunteers took photos and recorded colony dimensions and health. Color charts (similar to paint swatches from home improvement stores) were used to quantify the outward signs of bleaching, paling, and healthy corals. Earthwatch conducted 139 coral health assessments at five snorkel sites in the shallow lagoons around Little Cayman. Full colony bleaching was observed in <5% of the surveyed corals, suggesting that mortality associated with the elevated temperatures may be limited to a small fraction of the population.

Data collected by Earthwatch were combined with that from our June-November surveys. CCMI was able to determine which coral species were susceptible, resilient, and resistant to the elevated temperatures. Susceptible species paled, bleached (turned white), and died. Resilient species showed signs of stress by paling or bleaching but quickly regained color once the temperature stress subsided. Resistant species remained the same color throughout the disturbance event. An example of a resilient EDGE coral is the Mountainous Star Coral (*Orbicella faveolata*): under normal conditions, about 18% of this taxa has a pale coloration (Fig. 13). By October, 74% of the star corals were pale or fully bleached. However, by November after the peak in the high ocean temperatures, 21% of the star corals were pale, similar to the pre-bleaching population in June. Colonies continued to darken through December, indicating this species is recovering from the event.

CCMI's Research Technician, Hunter Hughes, presented the data from this project at the Benthic Ecology Meeting in Portland, Maine in March 2016. CCMI will continue its long-term monitoring of coral health and recruitment over the next few years as delayed responses to stresses may take several years to manifest within the coral community.

Figure 12. Elkhorn coral (*Acropora palmata*) showing signs of early bleaching during 2015 elevated ocean temperatures. Healthy elkhorn corals are brown. The white patches on the coral colony are bleached—the symbiotic algae, which give the

coral its color and provide 90% of the coral's energy supply, have been expelled from the tissue as a stress response. During bleaching, the colony is susceptible to starvation, disease, UV radiation, and mortality. *Figure courtesy of CCMI.*

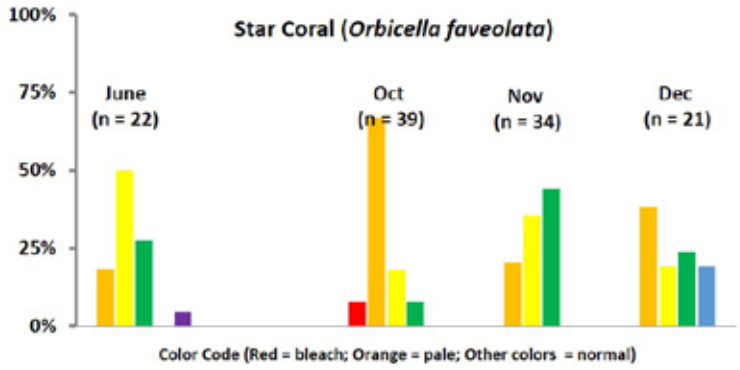

Figure 13. Color distribution chart for Mountainous Star Coral (*Orbicella faveolata*) before, during, and after 2015 coral bleaching event. Red and orange bars indicate colonies under stress. Yellow, green, and blue bars indicate colonies with healthy color. *Figure courtesy of CCMI.*

EXTRA ACTIVITIES RESULTS

Each Thursday, Dr. Allison Candelmo performs dissections on invasive lionfish which are culled from the reefs around Little Cayman. Earthwatch volunteers observed the dissections and learned about the cascading impacts of invasive lionfish on the coral reefs and reef inhabitants (Fig. 14). During free time, Earthwatch volunteers helped build 5 lionfish traps which were deployed in a shallow lagoon to test the effectiveness of catching juvenile lionfish compared to other methods. Unfortunately, the traps were less effective than hand-netting. But, we won't give up. Efforts continue around Little Cayman and throughout the Caribbean to mitigate the lionfish invasion.

Figure 14. Earthwatch volunteers observe Dr. Allison Candelmo perform dissections on invasive lionfish. *Figure courtesy of CCMI.*

The Earthwatch teen fielding occurred at the same time as sea turtle hatching on Little Cayman (Fig. 15). Scientists from the Department of Environment invited CCMI and Earthwatch to assist during the nighttime release of 30 hatchlings. The baby turtles are easily disoriented so observers formed a perimeter around them and helped redirect those going the wrong way on the beach. Artificial lights confuse the turtles; therefore, volunteers had to track the hatchlings in the moonlight to verify that all found their way to the ocean.

Figure 15. Sea turtle hatchling making its way across the beach to the ocean on Little Cayman. *Figure courtesy of CCMI.*

PROJECT IMPACTS

1. **Increasing Scientific Knowledge**
    a. Total citizen science research hours—CCMI estimates that each Earthwatch volunteer spent an average of 6 hours per day assisting with our research. The time estimate includes training, project mobilization and demobilization, traveling to/from the field, data collection, and data entry.
    b. Peer-reviewed publications—No articles are currently in preparation or under review. CCMI anticipates that several publications may be possible in the next 2-3 years for the above mentioned research efforts. Earthwatch will be acknowledged at those times.
    c. Non-peer reviewed publications (books and book chapters)—Not applicable
    d. Non-peer reviewed publications (other)—CCMI acknowledges Earthwatch on several of its webpages. A summary of the work conducted in 2015 by Earthwatch volunteers may be viewed at http://reefresearch.org/research/citizen-science/earthwatch/looking-back-on-earthwatch-2015/
    e. Presentations—Data collected by Earthwatch volunteers have been included in two oral presentations given at scientific conferences. Earthwatch was acknowledged in both talks.
        i. Indergard M, Foster K (2016) The preferred habitat of Elliptical Star Coral (Dichocoenia stokesi). Association for the Sciences of Limnology and Oceanography Multicultural Program, Ocean Sciences Meeting, February 2016, New Orleans, LA.
        ii. Hughes H, Foster K (2016) Hot, but not bothered: resilience of Little Cayman corals during the 2015 ENSO. Benthic Ecology Meeting, March 2106, Portland, ME.
2. **Mentoring**
    a. Graduate students—Not applicable for the 2015 Earthwatch projects at CCMI
    b. Community members

Name of school, organization, or group	Education level	Participants local or non-local
Young Environmentalist Leadership Course, "YELC" (CCMI education program)	High school seniors	Local (Caymanian)
Cayman Islands Nursery Managers	N/A	Local (Caymanian and Ex-patriot)

Details on contribution(s)/activities

- YELC is aimed at students who plan to pursue careers in the environment, sustainable tourism, watersports, or marine-based mechanics. Students are given an introduction to marine conservation theory, the marine environment and tourism and current threats to the environment. To see how conservation and tourism work in practice, students are given the opportunity to spend time with the Department of Environment and local businesses. At CCMI, participants spend time with our researchers to understand the importance of science and how it contributes to local conservation management. In 2015, YELC students were trained in coral nursery maintenance techniques, including cleaning the PVC trees which Earthwatch volunteers helped build.
- CCMI conducts all of the research related to coral nursery practices in the Cayman Islands. We share our best practices with and provide training for the local nursery managers via workshops and

regular communications. The long-term results of (i) staghorn coral shallow-water outplanting, (ii) elkhorn coral mapping and subsequent genotype distribution, and (iii) elkhorn coral skeleton scrubbing and recruitment, projects for which Earthwatch volunteers collected data, will be shared with the nursery managers to help optimize coral restoration and regeneration efforts across all three islands.

3. **Partnerships—Active partnerships that contribute to the Earthwatch-related projects include the following:**

Partner	**Support Type(s)**[1]	**Years of Association** (e.g. 2006-present)
Cayman Islands Department of Environment	Permits, collaboration, logistics on sister islands	1998 - present
University of Miami	Technical support, genetic analyses, field support, training for the coral nursery project	2012 - present
National Science Foundation	Funding for Research Experience for Undergraduates which included Matz Indergard and the Elliptical Star Coral Population Study in 2015	REU: 2014 - present
Art and Phyllis Grindle Foundation	Funding for CCMI's intern program which included support for Hunter Hughes who participated in all 2015 Earthwatch fieldings	2013 - present
Edmund F. and Virginia B. Ball Foundation; Carnival Foundation; Consolidated Water; Dart Foundation; Darwin Plus; Disney Conservation Fund; Stuarts, Walker, Hersant, Humphries law firm; National Fish and Wildlife Foundation, and private donors	Funding for CCMI's coral nursery, long-term monitoring, CREWS environmental data collection, EDGE, and resilience projects	Various start dates - Present

4. **Contributions to management plans or policies**

Plan/Policy Name	Type[2]	Level of Impact[3]	New or Existing?	Primary goal of plan/policy[4]	Stage of plan/policy[5]	Description of Contribution
National Coral Nursery Policy	Policy	National (Cayman Islands)	Existing	Species conservation (*Acropora cervicornis* and *A. palmata*); natural resource conservation (coral reefs)	In progress—our results will be incorporated into the policy by the Cayman Islands Department of Environment	• Results from our shallow water outplanting study will help determine the depth range to which nursery-reared staghorn coral may be transplanted (national contribution) • Results from the elkhorn mapping project will be used to locate potential donor colonies for the genotype distribution study and for parent colonies for nursery propagation (local and national contribution) • Results from the elkhorn scrubbing and recruitment projects, if successful, will be used to draft propagation techniques

5. Conserving natural and sociocultural capital
    a. Conservation of taxa
        i. List of focal study species not listed in most recent proposal—Not applicable
        ii. Conservation or restoration of species populations of conservation significance

Species	IUCN Red List category	Local/ regional conservation status	Local/ regional conservation status source	Description of contribution	Resulting effect[6]
Acropora cervicornis (staghorn coral)	CR—Critically endangered	CR	IUCN, United States Endangered Species Act	Outplant depth studies for optimal survival and growth of nursery-reared corals when returned to the wild	Population increase, improved population structure, increased breeding success, enhanced genetic diversity
Acropora palmate (elkhorn coral)	CR—Critically endangered	CR	IUCN, United States Endangered Species Act	Location of wild colonies to serve as donors for coral nursery; alternative recruitment and propagation techniques	Improved habitat for species, population increase, improved population structure, increased breeding success, enhanced genetic diversity

b. Conservation of ecosystems

Habitat type	Habitat significance[7]	Description of contribution	Resulting effect[8]
Coral reefs	Nursery, breeding ground, summer/fall range	The Little Cayman Coral Nursery will propagate staghorn and elkhorn coral; nursery-reared corals will be returned to the wild; corals create reef framework/structure for reef inhabitants (fish, invertebrates); coral outplant sites also serve as breeding grounds for staghorn and elkhorn corals during spawning season; the minimum depth range for outplant survival and growth is based on stress responses to the elevated temperatures and increased UV radiation which occur during the late summer/early fall	Restored and expanded sections of reef, improved connectivity, improved resilience

c. Ecosystem services—Not applicable. CCMI is not directly studying the listed ecosystem services in our Earthwatch-related research.
d. Conservation of cultural heritage—Not applicable. CCMI is not directly conserving or restoring the listed cultural heritage components in our Earthwatch-related research.

ACKNOWLEDGEMENTS

CCMI thanks all of the Earthwatch volunteers, facilitators, and staff who assisted with our 2015 research program. The Cayman Islands Department of Environment issued the permits required to manage the Little Cayman Coral Nursery, outplant the nursery-reared staghorn corals to the local reef, and conduct the elkhorn coral recruitment study. Funding for the Earthwatch-related research projects was provided by the Edmund F. and Virginia B. Ball Foundation; Carnival Foundation; Consolidated Water; Dart Foundation; Darwin Plus; Disney Conservation Fund; Art and Phyllis Grindle Foundation; National Fish and Wildlife Foundation; National Science Foundation; Stuarts, Walker, Hersant, Humphries law firm; and private donations to the Cayman, US, and UK CCMI Research Fund. Special thanks to DoE scientist Lucy Collyer and CCMI's Dr. Allison Candelmo for inviting Earthwatch volunteers to observe and participate in the sea turtle hatchling release and lionfish research, respectively.

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