CCMI

CENTRAL CARIBBEAN MARINE INSTITUTE

2016 ANNUAL REPORT

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CHRISTOPER HUMPHRIES
CHAIRMAN

CHAIRMAN'S REPORT

Having been involved with CCMI since 2004, I joined the board of directors in 2010. I am a marine scientist at heart and started my education in Biological Science in 1994 later working as a marine biologist (working in Belize, Bermuda and the Philippines) which provides me with the insight into CCMI's objectives and experience of how other marine stations operate.

Healthy reefs and vibrant oceans are what I hope we can achieve as an organisation and I invite everyone to join as Navigators or supporters of this important organisation.

Education and awareness are a focal part of preserving the marine environment and the Cayman Islands have one of the most spectacular reef systems in the world. Little Cayman is, at present, protected from the most devastating impacts of over-development. CCMI's location there allows for researchers to monitor and learn from the reef ecosystem while distinguishing environmental impacts, such as global warming, free of the influence of over-development we see on other islands throughout the Caribbean and worldwide.

As the new Chairman of the CCMI Board in 2016, I understood the enormous potential for CCMI to finally achieve a regional stature as the Caribbean's premier marine institute. As a group, the board was resolved to make several changes which included bringing Dr. Carrie Manfrino, President and Founder of CCMI to full employment. We are now positioned to take on the ambitious growth that we planned with our Vision 2020 which includes fully developing a research program to address the significant issues facing coral reefs today. I hope you will enjoy reading about our progress in 2016.

PRESIDENT'S REPORT

CARRIE MANFRINO, PHD
PRESIDENT

This was a record breaking year on all fronts. Research funding, publications and international presentations and collaborations reached an all-time high. The year also marked the beginning of a new era for CCMI's leadership. After 12 years as an advisor, board member, officer, and general council to CCMI, Mr. Chris Humphries of Stuarts Walkers Hersant and Humphries became the Chairman of the Board. We also welcomed Dr. Tom Frazer, who has been a long-time collaborator, to the board. Chris Humphries and the board helped navigate my final departure from the university post I held for 21 years in New Jersey. I was awarded the Fulbright Scholarship to explore the potential natural solutions to rising sea level in the Indian Ocean and continued building a global presence for CCMI.

Early in the year, we had a historic visit by the Earl and Countess of Wessex who participated in a variety of community activities during their stay. His Royal Highness Prince Edward presented Chris Humphries with the C.O.R.A.L award. This award is granted to individuals who have a Commitment to coral reef conservation, invested in Outreach, expressed Respect for the community and ecosystem, Advanced the protection of coral reefs, and provided Leadership. The Earl of Wessex also dived with us on Bloody Bay Wall for the first time.

The summer months were packed with programmes and students. In June we held our first symposium at St. James' Palace in London, Rethinking the Future of Coral Reefs. By the fall, The National Science Foundation awarded us with a major new Field Station and Marine Laboratory grant to expand the institute's facilities on Little Cayman. We renovated and expanded to make the buildings more resistant to storms and to provide room for research and educational programs to work synergistically.

Our research programme themes which are focused on protecting the ocean's biodiversity and improving coral reef resilience generated a number of grants and publication. We continue to work to understand how the ocean, coral reef ecosystems, and groups of organisms respond to anthropogenic impacts and climate change. This year, simulations of increasing acidification projected for 2100 shed light on the vulnerabilities of the common marine calcareous algae, Halimeda. These calcifying organisms provide the sand on our beaches and therefore buffer islands and coastal communities from rising sea levels. We have created a new time-depth series that indicates that the water column sampled at one site off of Little Cayman is relatively isothermal, temperature do not change with depth. If this is the case in other locations around the island, then deeper reefs may not provide the hypothesised refuge for coral in warming sea temperatures. Graduate students from the Florida Atlantic University, the University of Florida and the University of California, Santa Barbara conducted PhD and MS research on several topics. They measured the foraging by green turtles which turned out to be more extensive than previously thought in the lagoons around the research station. Work examining the impact of diving on parrotfish behaviour is currently being analysed but early results indicate that fish show a reduced flight response distance inside the marine protected area that are frequently dove.

From a financial perspective, operational expenses were held steady but capital improvement expenditures, driven by grant funding, rose. Our campaign to generate multi-year funding is proving successful, our Navigators Council is adding additional stability, and these funds allow us to plan projects for several years. We arrive into 2017 in a strong financial position thanks to multi-year pledges, new grants, and the best results ever from the Festival of Seas fundraiser. We are especially grateful to all of our supporters and to KPMG who have undertaken our annual audit (pro-bono) which will be available later in the year.

ROYAL VISIT

ROYAL VISIT

The Earl, Patron of CCMI, and The Countess of Wessex paid a visit to the Little Cayman Research Centre (LCRC) March 6 - 7 of 2016. This was The Earl's fifth visit to the research centre. During this visit, The Earl commented on the rapid growth of CCMI and praised the research and education programmes. Their Royal Highnesses met school children from Little Cayman Primary School as The Earl launched CCMI's Ocean Literacy programme in 2007. During this visit, he said "It's the education programme which I think is so exciting. Being able to educate and try and teach every young Caymanian about what is around them and to value what's below the ocean and the reef system they have here... I think that's really important." Their Royal Highnesses also spoke with university students in residence at CCMI from Dartmouth University in the United States. These students had the opportunity to discuss with the HRH Earl of Wessex some of the skills and insights which they gained while participating in research projects at CCMI. The Earl also spoke on the importance of protecting our marine environment, saying, "Declining coral reefs pose urgent threats to society and indeed, to the economy of entire island nations. The Central Caribbean Marine Institute is one of the premier research institutes that is working to reduce this disastrous decline and to save coral reefs around the globe."

"Declining coral reefs pose urgent threats to society and indeed, to the economy of entire island nations. The Central Caribbean Marine Institute is one of the premier research institutes that is working to reduce this disastrous decline and to save coral reefs around the globe."

His Royal Highness, The Earl of Wessex

LONDON SYMPOSIUM

Rethinking the future of our coral reefs

'Rethinking the Future of Coral Reefs' was the theme our symposium at St. James's Palace to discuss solutions to serious losses on coral reefs over the last 40 years. The global nature of the problem of coral reef decline requires that we reframe our thinking.

Coral reefs are second only to the rainforests as the most biologically diverse environment on earth. They provide a home for 25% of marine life in the ocean while occupying only 1% of the earth's surface and only 2% of the ocean floor. They also play a vital role in protecting coastlines from storm and hurricane damage.

The group declared that coral reefs are threatened everywhere due to three main causes – climate change, over-fishing, and pollution - though there are many other reasons why they have declined.

Group members also agree that marine protected areas are not sufficiently protecting coral reefs. Warming seas and the resultant sea surface temperature increase led to coral bleaching in the Caribbean, across the Great Barrier Reef and Indian Ocean, including in Sri Lanka, where CCMI's Director of Research and President was working on her Fulbright.

Corals turn white (bleaches) in response to prolonged increases in sea surface temperature. They are white because the tiny symbiotic algae that provide their colour are released as a stress response mechanism that scientists are still trying to understand. When they bleach, corals are still alive and can recover when temperatures return to normal. But if temperatures don't return to normal within a number of weeks, coral mortality can have a devastating impact on the reef ecosystem.

"The reality is that while marine protected areas can boost the entire system's resilience, mass mortality from coral bleaching occurs across the boundaries of protection. What is clear is that reducing direct human impacts on stressed coral reefs is required for recovery. In the Cayman Islands, at several locations on the Great Barrier Reef and in the Indian Ocean, it took between 9-12 years for corals to recover from the 1998 massive coral bleaching event", said Manfrino.

What this implies is that human impacts need to be reduced to allow time for corals to recover but it may become more difficult for recovery if El Nino events occur more frequently as temperatures continue to rise.

Seven presentations were made at the Symposium, including by some of the world's leading scientists: Professor Terry Hughes, Professor Nick Graham, Dr. Gareth Williams, Professor Joshua Cinner, Dr. Rachel Turner and Jerker Tamelander, who covered topics including "International Policy & Reef Management" and "Drivers of Natural Variation in Coral Reef Ecosystem State".

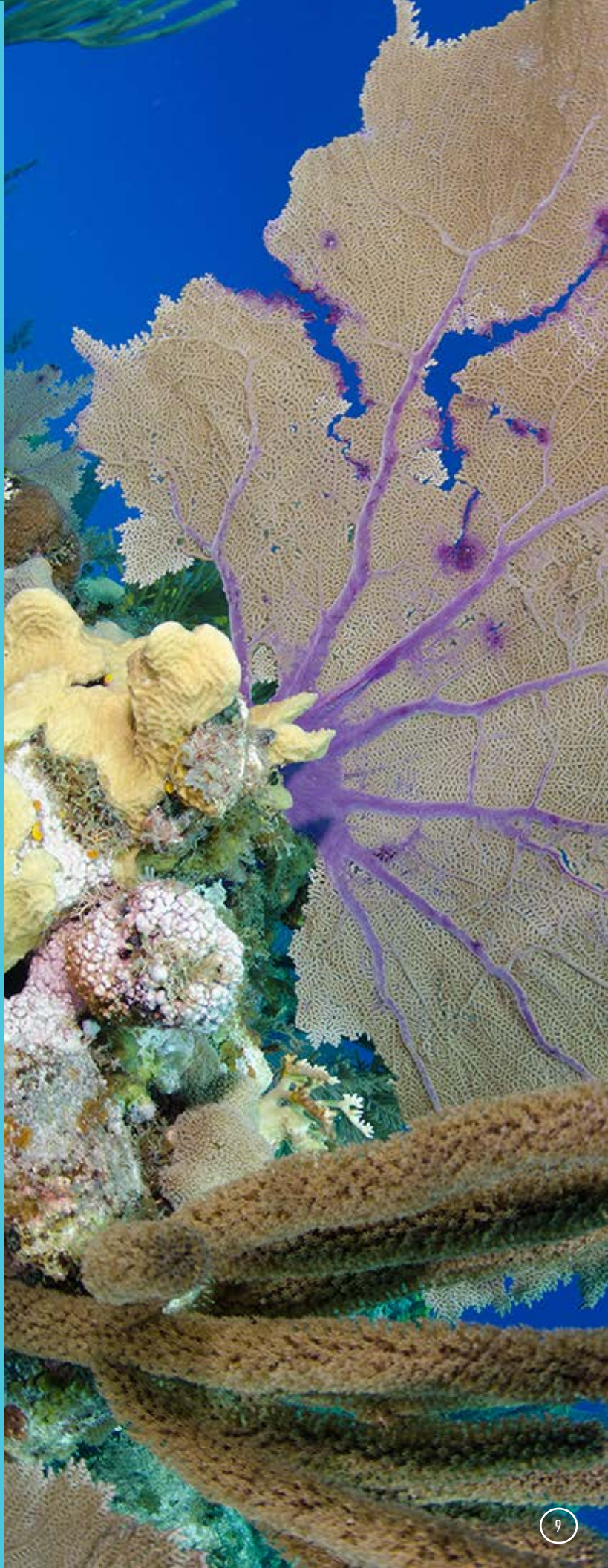
LONDON SYMPOSIUM cont

Dr. Gareth Williams proposed several new solutions: "We must take a two-pronged approach to managing the world's coral reefs. We need to urgently cut greenhouse gas emissions to slow the frequency of severe coral bleaching events, while simultaneously manage reefs at a local scale to promote resilience. Local-scale action alone will not be enough; we cannot climate-proof coral reefs. However, the good news is local reef fates are likely different from regional projected fates which are determined by global climate models. This smaller scale variation in reef vulnerability means we can prioritise local-scale action. By comparing local vulnerability to current management, we can identify key conservation opportunities, for example areas where supporting human adaptive capacity is essential or areas where managers can have the greatest influence on long-term reef condition and ecosystem service provision".

Jerker Tamelander, Head of the Coral Reef Unit of the United National Protection Programme (UNEP) in his presentation, reported, "2015 saw the adoption of the Paris Agreement on climate change and the 2030 development agenda.

The future of coral reefs is determined by how these agreements are implemented." Looking ahead at the dangers posed, he went on to say, "We stand to lose a significant portion of the world's coral reefs in the coming decades. It is critical that we protect reefs, to improve chances that coral reefs will adapt and continue to deliver ecosystem services in the future."

CARRIE MANFRINO AND TERRY HUGHS, CO-COVENERS
TIM ECOTT, DEPUTY DIRECTOR



PROGRAMME SERVICES

Understanding resilience to climate change

OCEAN OBSERVATORIES

The Coral Reef Early Warning System (CREWS) is a collaboration with NOAA that provides near real time advisory information for scientists, for shipping and for recreation. Data from the CREWS Buoy has also been integral to our long term monitoring efforts at Little Cayman In 2016, CCMI began a significant maintenance programme and investment into the CREWS buoy, updating the instrumentation and the communications.

Jim Hendee, one of CCMI's original NOAA partners reported at the 13th International Coral Reef Symposium 2016 that the status of the CREW project is one of heightened activity. The Network began over 15 years ago with NOAA funding as a station in the Bahamas, and grew to include stations in Puerto Rico, St. Croix, Saipan with other sources of funding, Jamaica and Little Cayman. However, storms and other realities resulted in the destruction or removal of all of those stations, excepting the Little Cayman station, which continues operating today as a new buoy design. A new collaboration between NOAA and the Caribbean Community Climate Change Centre has resulted in the expansion of the network to include two stations each in Belize, Tobago, and the Dominican Republic, plus one in Barbados.

OCEAN ACIDIFICATION

Over the past few years, Dr. Marguerite Koch and graduate students, Dr. Kate Peach, Regina Zweng, and Elizabeth Dutra have conducted simulations to test whether ocean acidification will lower the calcification rates in marine plants and whether differences in light levels might mitigate the effects. Halimeda, the most abundant genus of marine calcifying green algae, also produces enormous quantities of sediment. The group was able to demonstrate that elevated pCO2, associated with ocean acidification, at levels simulating the year 2100, did not result in reduced calcification in any of six different Halimeda species. These results have far reaching implications about which organisms will be winners under future climate predictions.

REEF RESTORATION

A big question in the scientific community is, will corals adapt to warmer temperatures predicted by climate models. By gradually staging 84 coral fragments from three genotypes into shallower environments it was possible to increase survival rates of nursery reared corals once outplanted onto shallow reef sites. Corals were moved from the coral nursery (6 m water depth) directly to the reef crest (< 1 m) where light intensity, temperature and wave action was high. A second 'graduated' treatment moved the corals first to 3 m water depth and then to the shallow reef crest. Corals in the 'graduated' treatment resulted in less breakage or loss despite periodic heavy storm surge than corals out planted directly from the nursery. More than half of the fragments planted in the spring experience bleaching stress during the summer however all have recovered. By year end, only two fragments suffered mortality in part due to rough storms immediately after outplanting. Successful fragmentation, due to wave action, is occurring at the site and new fragments have become established independently. Overall, growth of the coral fragments is slower at the outplant sites than at the nursery.

GRADUATE STUDENTS MAKING NEW DISCOVERIES

Each year, we welcome PhD and MSc students to work on their own research. April Ridlon, PhD candidate from University of California Santa Barbara, surveyed Little Cayman's unique gradient of diving pressure to observe behavioural differences in parrotfish flight responses which could result in different herbivory rates inside and outside marine parks. Robert Johnson and Alexandra Gulick, PhD candidates from the University of Florida simulated turtle grazing on seagrass beds to understand their impact and Paul Maneval, MSc student is investigating staghorn coral growth rates at our deep and shallow nursery sites.

Kathryn Lohr, a member of our research team until 2015 who helped set up CCMI's coral nursery, used her knowledge earned at CCMI to pursue a PhD at the University of Florida. Kathryn has been applying trait-based selection techniques to corals to increase the ability of restored coral populations survival.

ENHANCING EARLY CAREER SCIENTISTS

Our research priority includes offering experiences that build a community of highly skilled early career scientists. We anticipate that they will address the greatest scientific and engineering challenges facing society.

From 2014 – 2016, the National Science Foundation funded a Research Experience for 24 undergraduate students to pair up with international scientists working at CCMI exploring drivers of coral reef biodiversity and resilience. Collaborators from University of Kiel, University of Tokyo, Louisiana State University, Smithsonian Institution, Florida Atlantic University, and the National Oceanic and Atmospheric Administration led their own research while interns worked on independent projects. The results were over 20 publications and presentations at international conferences in excellent journals.

The Art and Phyllis Grindle Foundation supported our research internship program and three recent college graduates gained experience and training.

Protecting the biodiversity of coral reefs

EFFECTIVELY MANAGING THE INVASIVE LIONFISH

It is well known that the Indo-Pacific lionfish, *Pterois spp.*, are damaging the marine ecosystem balance in the western Atlantic Ocean, Gulf of Mexico, and Caribbean Sea by reducing native fish populations. They consume enormous numbers of prey and compete for resources. CCMI's Dr. Alli Candelmo's research is finding ways to increase the success of culling.

Lionfish arrived to Little Cayman in 2009 and numerous studies have led to publications and advanced degrees. CCMI staff, dive operators, and local volunteers conduct weekly lionfish culls and have removed 18,000 fish. Our scientists have dissected 8000 fish to understand their impact to native fish populations and capacity to reproduce.

CCMI has maintained six experimental lionfish sites on the north side of Little Cayman since 2011. Control sites are left un-culled and experimental sites are culled quarterly. The catch per unit effort (CPUE) has decreased in the Bloody Bay Marine Park where efforts were most concentrated. These results are encouraging as they indicate that targeted lionfish removals are able to help control local lionfish populations inside the Marine Park.

An extensive study of 28 sites around Little Cayman that examined concerns that increased culling pressure selects for more cryptic, wary individuals, making spearing more difficult was published. The study revealed that regular culls on Little Cayman have not increased cryptic behaviour of lionfish at dusk, but more evasive behaviour was observed during the day.

BEST GRANT AWARDED TO DR. CANDELMO

In 2015/16, 96 lionfish were tagged in-situ via SCUBA and released at sites on the north wall of Little Cayman. While tagged fish were spotted initially during surveys, over the year a relatively low percentage of tagged fish have been spotted on the tagging site. This indicates that lionfish may be much more mobile than originally believed and potentially moving vertically to deep waters. A BEST 2.0 Grant from the European Union will allow us to continue research on the movement patterns of lionfish using acoustic telemetry and to refine Little Cayman's lionfish culling management strategy.

SURVIVAL OF LARVAL STAGE TIGER GROUPER AND NASSAU GROUPER

During a 2016 grouper spawning event in Little Cayman, Dr. Alli Candelmo, CCMI Research Associate, established a collaboration with scientists from the Grouper Moon Project, a collaboration with Reef Environmental Education Foundation (REEF), Scripps Institution of Oceanography and the Cayman Islands Department of Environment (DOE). Nassau and tiger grouper embryos were collected in situ and reared in CCMI's laboratory where the team found fertilisation rates to be high for both species. Hatch success was consistently high for tiger grouper, but varied between females of Nassau grouper. Despite their smaller initial size tiger grouper larvae appear to be more robust to starvation. The variability in the survival rates of both embryos and larvae was lower in tiger grouper spawning bursts compared to Nassau grouper. Parental effects on embryo and larval condition and size may influence hatch success and larval survival, particularly in Nassau grouper.

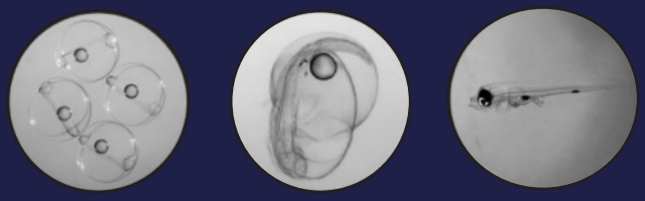


Figure 1. Tiger grouper embryos 17 hours post fertilization (left). Nassau grouper embryo hatching 27 hours post fertilization (middle). Nassau grouper larvae 4 days post hatch (right).

SPONGE FUNCTION ON LITTLE CAYMAN'S REEFS

The distribution and patterns of abundance of sponges on the reefs and reef walls of Little Cayman were the subject of a study by Dr. Steve Whalan, CCMI Research Associate. In the process, he discovered that the often overlooked sponges, and in particular, bioeroding sponges were highly competitive with live coral across several habitats. During the summer of 2016, several species of sponges were bleaching or diseased with loss of tissue. The obvious concern is that this group of organisms plays a significant role in filtering seawater and in eroding dead substrates so that they can be available for future settlement by corals and calcifying organisms. More work needs to be done on sponges and they need to be considered when managing coral reefs for increased resilience.

Science and Society

OCEAN LITERACY UPDATES

The Marine Ecology Course for local Caymanian students continued to expand with 10 programs and 157 students between the ages of 9 and 11 participating in our ocean literacy curriculum. All grade 5 and 6 students were given the CCMI special edition "A Parrotfishes Tale" to take home to reinforce the lessons learnt about the reef.

"I'm always impressed with the level of engagement of students at all learning levels and the way the presenters improve the content and activities each year."

Karlene Buckle, Cayman Prep Grade 6 Teacher, Cayman Islands.

"Bringing real world experiences to my classroom has motivated and inspired students in their learning journey."

Skye Salveson, Grade 5 teacher Colegio Roosevelt, The American School, Lima, Peru.

The challenge of achieving ocean literacy has increased because of rising costs and limited space at the research institute. A new, innovative approach called 'Reefs Go Live' is going into full swing once funding is secured. The program will allow our scientists to beam live broadcasts from underwater to students in their classrooms. The interactive nature of the program is being tested for full implementation by Fall 2017.

EDUCATION PROGRAMMES AND OUTCOMES

The education calendar in 2016 was the fullest in CCMI's history with 26 separate groups, 220 occupied days, a 59% increase since 2014. Citizen scientists (EDGE, Dive with Heroes and Earthwatch) increased by 170% since 2015. The increase in programs doubled our education capacity in the summer. The successful growth of education and the need for innovative solutions to meet this growth became transparent.

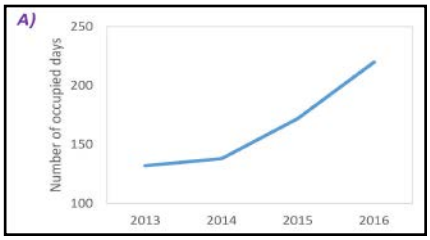


Figure 1: CCMI has shown positive growth across numerous indicators A) Number of occupied days at the Little Cayman Research Centre

EDMUND F. AND VIRGINIA B. BALL

In 2016, CCMI delivered two sessions of the Edmund F. and Virginia B. Ball Caribbean Marine Ecology Camps for the first time. A total of 23 students attended, including 11 Caymanian students who were awarded full scholarships. Students were split into teams with daily challenges using state of the art technologies. Seven SeaPerch underwater Remotely Operated Vehicles (ROVs) were funded by Rotary Central and students assembled the submersibles, designed the frame, and wired the motors. The ROVs were used to remotely collect ecological data on conch and sea cucumber populations and students performed search and recovery missions.

YELC UPDATE

CCMI's Young Environmentalist Leadership Course (YELC) was a huge success for its fourth year running. Ten Caymanian students were awarded full scholarships after an intensive recruitment process in March 2016 and began their dive training with Go Pro Diving in April 2016. All ten students became certified Rescue Divers, a vital first step to beginning a career in the local marine industry. When the students turn 18 they have the offer to return and complete professional Divemaster and Open Water SCUBA Instructor certifications with Go Pro Diving. Our Education Programme Manager then spent a week in July 2016 networking the ten students with local partners. Students learnt about the complexity of the proposed cruise ship berthing port from the Department of Environment and then were treated to a turtle nest excavation from their turtle team. The importance of mangroves was stressed by Cayman Kayaks on an ecology tour where students learnt about their value for storm protection and providing nursery habitats for juvenile fish and invertebrates. Students discussed how to get into the dive industry with the DiveTech team and how engineering and customer service skills are also vital from ProYacht.

In October, the ten students were hosted at CCMI's Little Cayman Research Centre for a week of in the field workshops including a coral nursery workshop where students got to experience outplanting staghorn coral to the reef. Throughout the week, students collected trash from the beaches to build two trash rafts that they sailed half a mile across the sound to Owen island. One team triumphed whilst the other team learnt that they needed to find more washed up rope.

Many of the YELC 2016 year's students have continued their final studies in school and are now considering options in the marine industry or further environmental education studies.

Thanks to Fosters Food Fair, Cayman National Bank and Go Pro Diving for their continued support of the programme.

YELC Alumni: Where are they now?

TYLER WATLER

A Young Environmentalist Leadership Course (YELC) Graduate of our 2015 programme is now employed at Cabana Dive Shop as a dive guide and taking tourists on SeaTrek tours (underwater helmets). After graduating from our YELC, Tyler was initially successful with gaining an internship at Red Sail Sports for 9 months and 1-week internship at the Department of Environment, before his current permanent position. CCMI's programme was invaluable in demonstrating the marine career opportunities for young Caymanians, "I would say the programme actually put me on a career path, learning all about the corals and lionfish you guys taught us, it really opened my eyes to what I wanted to do in the future." Tyler intends to continue to work in the dive industry and begin his own business "In the future I can see myself opening a dive shop, progressing to become as big as Red Sail Sports one day."

TYLER

KEANU

DANIEL DIXON

One of our early YELC graduates (2013) recently became one of only a handful of Caymanian dive instructors and has since secured a job at GoProDiving. He said "The YELC program helped me with my career in diving by first off giving me a connection in to diving, the YELC programme also helped by introducing me to diving and showing me the many different aspects that I could do, for example marine biology or I could teach diving".

KEANU MCLEAN

A 2014 YELC graduate, was successful in completing a two-year internship at the Department of Environment as a result of the YELC and Cayman Islands Further Education Centre (CIFEC) collaboration. He has since gone on to continue his education at University College of the Cayman Islands (UCCI) in an associates in science and intends to pursue a career in marine biology. The YELC programme was "very educational and life changing" and Keanu would strongly encourage the course to continue "We are surrounded by water and giving a helping hand can protect the reefs of the Cayman Islands in the future". Keanu was invited back in 2015 as a teaching assistant on the YELC providing support in the water and teaching identification skills. This also acted as a fantastic bridge between new students and CCMI instructors and gave Keanu further experience in this field and with CCMI.

DANIEL

Publications & Meetings

2015-2016 JOURNAL ARTICLES

1. Banks, S. and Foster, K. (2016) "Baseline levels of *Siderastrea siderea* bleaching under normal environmental conditions in Little Cayman." Open Journal of Marine Science.

2. Bedwell-Ivers HE, Koch MS, Peach KE, Joles L, Dutra E, Manfrino C (2016) The role of *in hospite* zooxanthellae photophysiology and reef chemistry on elevated pCO2 effects in two branching Caribbean corals: *Acropora cervicornis* and *Porites divaricata*. *ICES Journal of Marine Science*; doi:10.1093/icesjms/fsw026.

3. Bejarano S, Lohr K, Hamilton S, Manfrino C (2015) Relationships of invasive lionfish with topographic complexity, groupers, and native prey fishes in Little Cayman. *Marine Biology* 162: 253-266.

4. Camp, E., Suggett, D.J., Genderon, G., Jompa, J., Manfrino, C., Smith, D.J. (2016) Mangrove and seagrass beds provide different biogeochemical services for corals threatened by climate change, *Frontiers in Marine Science*, doi:10.3389/fmars.2016.00052.

5. Camp EF, Smith DJ, Evenhuis C, Enochs I, Manzello D, Woodcock S, Suggett DJ. 2016 Acclimatization to high-variance habitats does not enhance physiological tolerance of two key Caribbean corals to future temperature and pH. Proc. R. Soc. B 283: 20160442. http://dx.doi.org/10.1098/rspb.2016.0442.

6. Crandall J, Teece MA, Estes BA, Manfrino C, Ciesla JH (2016) Nutrient acquisition strategies in mesophotic hard corals using compound specific stable isotope analysis of sterols. *Journal of Experimental Marine Biology and Ecology*, 474: 133-141.

7. Dutra E, Koch M, Peach K, Manfrino C (2015) Tropical crustose coralline algal individual and community responses to elevated pCO2 and low irradiance. *ICES Journal of Marine Science*: doi:10.1093/icesjms/fsv213.

8. Lohr KE, Bejarano S, Lirman D, Schopmeyer S, Manfrino C (2015) Optimizing the productivity of a coral nursery focused on staghorn coral *Acropora cervicornis*. *Endangered Species Research*, 27: 243-250.

9. Lohr, K. E., McNab, A. A. C., Manfrino, C., & Patterson, J. T. (2017). Assessment of wild and restored staghorn coral *Acropora cervicornis* across three reef zones in the Cayman Islands. *Regional Studies in Marine Science*, 9c, 1-8. DOI information: 10.1016/j.rsma.2016.11.003

10. Peach, K. E., Koch, M.S., Blackwelder, P.L. , Manfrino, C. , 2017, Calcification and photophysiology responses to elevated pCO2 in six *Halimeda* species from contrasting irradiance environments on Little Cayman Island reefs, *Journal of Experimental Marine Biology and Ecology* 486:114-126. 55 DOI: 10.1016/j.jembe.2016.09.008.

11. Von Reumont J, Hetzinger S, Garbe-Schonberg D, Manfrino C, Dullo W –Chr (2016) Impact of warming events on reef-scale temperature variability as captured in two Little Cayman coral Sr/Ca records. Geochemistry, Geophysics, Geosystems.

VISITING SCIENTISTS PUBLICATIONS

12. Allen JJ, Akkaynak D, Sugden AU, Hanlon RT (2015) Adaptive body patterning, three-dimensional skin morphology and camoflauge measures of the slender filefish *Monacanthus tuckeri* on a Caribbean coral reef. *Biological Journal of the Linnean Society* 116(2) 377-396.

13. Gardner PG, Frazer TK, Jacoby CA, Yanong RPE (2015) Reproductive biology of invasive lionfish (*Pterois spp.*). *Frontiers in Marine Science*, 2 (Article 7): 1-10.

14. Loh T-L et al. (2015) Indirect effects of overfishing on Caribbean reefs: sponges overgrow reef-building coral. PeerJ 3x901: DOI 10.7717/peerj.901.

MEETINGS AND PRESENTATIONS

1. Butkowski D, Sparke T, Candelmo A. Volunteers make a difference: Lionfish distribution and successful removal efforts in Little Cayman. 69th Gulf and Caribbean Fisheries Institute Conference; 2016 Nov 7-11; Grand Cayman, Cayman Islands.

2. Camp M, Shein K, Abbott JA, Foster K, Manfrino C (2016) Can anyone be a scientist? Exploring the role of citizen science in coral reef research. International Coral Reef Symposium, June 2016, Honolulu, HI.

3. Camp M, Shein K, Foster K, Hendee J (2016) Does body type really matter? Relating climate change, coral morphology and resilience. Ocean Sciences Meeting, February 2016, New Orleans, LA.

4. Candelmo AC, Pattengil-Semmens CV, McCoy CR, Semmens BX, Waterhouse L, Stock B, Sparke T. (2016) Survival of Nassau and tiger grouper early life stages from a Little Cayman, Cayman Islands spawning aggregation. 69th Gulf and Caribbean Fisheries Institute Conference; 2016 Nov 7-11; Grand Cayman, Cayman Islands.

5. Cook A, Lohr K, Sparke T (2016) Predation, disease, and implications for management of the endangered staghorn coral *Acropora cervicornis* in varying reef zones. National Council on Undergraduate Research, April 2016, Asheville, North Carolina.

6. Cook A, Lohr K, Sparke T (2016) Predation, disease, and implications for management of the endangered coral *Acropora cervicornis* in varying reef systems. Benthic Ecology Meeting, March 2016, Portland, ME.

7. DeBuysser J, Butkowski D, Candelmo A. (2016) Catch Them If You Can: Assessment of invasive lionfish (*Pterois volitans*) behaviour on Little Cayman, Cayman Islands to aid culling efficiency. 69th Gulf and Caribbean Fisheries Institute Conference; 2016 Nov 7-11; Grand Cayman, Cayman Islands.

8. Foster K, Foster G (2016) Using population demographics to project recovery from the 2015 coral bleaching event in Little Cayman. International Coral Reef Symposium, June 2016, Honolulu, HI.

9. 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.

10. Hsia S, Ouellette G, Manfrino C. 2016. Caves, Carbonates and Climate: Karst Landscape Development through Environmental Forcing, Little Cayman Island. American Geophysical Union 47th Fall Meeting Conference, San Francisco, United States, Dec 12-16, 2016. Poster.

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FIELD STATION REPORT

FACILITIES UPGRADES AND EXPANSIONS

With the award of a $266,000 grant from the National Science Foundations, PI Dr. Carrie Manfrino was able to enhance the capacity for research and education by expanding the CCMI facilities to accommodate the growing number of visiting U.S. scientists and students.

Project outcomes included:

1. Creating new on-site private accommodations for scientists and graduate students by renovating the main building to create a third floor with two private bedrooms/work areas.

2. Expanding common areas including the dining/kitchen pavilion to increase food service by installing a new fridge freezer system and doubling the seating capacity in the dining area to match the residential capacity.

3. Making safety upgrades to reduce the chances of weather adversely affecting the research projects and education programs with (39) new hurricane rated windows and doors.

4. Achieving a threefold increase in passive solar systems for heating water at the off-the-grid bath house for the increased number of daily showers, and remodelling the bath house to improve efficiencies.

The renovations improve the overall logistics for scientists to be on site to monitor experiments and mentor students. Common area improvements add back time to field, lab, and class daily schedules by streamlining meal service and increasing the living areas. The project is also demonstrating that sustainable alternatives including passive and PV solar systems included in the off-the-grid bath house can comfortably replace conventional, resource-inefficient facilities.

The success of the improvements includes an increase in the capabilities of the facility with a full integration of science and education with a broad range of student groups, research interns, graduate students, and scientists. The facility is better equipped to offer a growing number of scientists with field support, accommodations, and access to laboratories and workspace.

The broader impacts include creating the space so that research can go uninterrupted while university groups are also conducting laboratory and field scientific experiments. The improvements make room for early career scientists, K-12 students, community members, and island visitors to learn about coral reef ecosystems, sustainability, and foster the pursuit of scientific discovery.

CCMI FINANCIAL REPORT

FINANCIAL REPORT

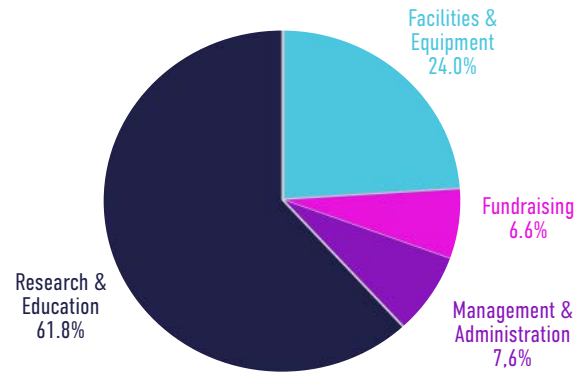
This financial report expresses pre-audit numbers. Audited financials will be released once completed.

A total of 86% of expenses were spent on programmes and improvements to the Little Cayman facility in 2016. Management and fundraising costs were maintained at 14%, including the expenses from the annual Festival of Seas special event, which provides significant unrestricted funding for non-programmatic costs.

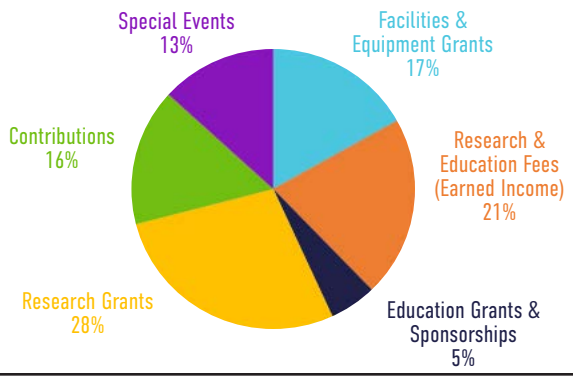
The expansion of the Little Cayman facility was possible by a major grant from the US National Science Foundation ($264, 693). A three year improvement grant was also received for research equipment and refitting our research vessel with a new outboard engine from the Dart Foundation ($178,000).

Earned income is largely from university bookings, K-12 courses, visiting scientists, retail sales and interest income.

TOTAL EXPENSES - $1,434,200



2016 TOTAL REVENUE* $1,583,410



Contributions grew as a result of increasing members in our Navigators council who make three-year commitments to support the core costs of operation.

In-kind support was from contributions of services from KPMG for the annual audit, Fountainhead Strategic Marketing for communications and fundraising, and Stuarts Walkers Hersant and Humphries for legal services.

Grants and sponsorships supported Biodiversity and Resilience research themes, education programme scholarships and internships for local students, and facilities and equipment improvements. Grants funding rose to 50%, which shows excellent progress.

Looking forward, funding for the research programme is strong as a result of multi-year grants and support. Earned income remains stable and education programme revenue will be higher in 2018 due to additional interest by major universities.

The total revenue includes the release of restricted funds to the appropriate projects.

OUR SPONSORS

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