Environmental variability in the wider Caribbean and ecological, social and economic consequences

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39TH

Scientific meeting of the Association of Marine Laboratories of the Caribbean

Reunión Científica de la Asociación de Laboratorios Marinos del Caribe

Hosted by the Grupo Puntacana Foundation,

Dominican Republic

This event intends to bring students, long time scientists, practitioners, government officials and all with an interest in marine science and policy together for a five-day meeting, focusing on presentations, productive interactions and field trips. The meeting is open to anybody that wishes to participate. The meeting will focus on all aspects of marine science and management, but focuses especially on the science and management of marine ecosystems within the greater Caribbean region. By bringing together participants from a broad collection of marine related fields, science and management, this meeting will provide a setting for even further consideration and synthesis of new ecological ideas. The meeting will consist of standard presentations, four keynote speakers (Dr. Nicolas Pascal, Dr. Charles Sheppard, Dr. Steve Monismith and Dr. Anastazia Banaszak), perspective talks during the Welcome Reception and Banquet by Jake Kheel, Frank Rainieri, and a guest speaker (respectively) and fieldtrips to see historical Dominican Republic and its marine ecosystems.

Este evento tiene la intención de traer a estudiantes, científicos de mucho tiempo, practicantes, oficiales gubernamentales, y todos con un interés en la ciencia y la política marina juntos durante una reunión de cinco días, centrándose en, las interacciones productivas y excursiones. La reunión está abierta a cualquier persona que desee participar. La reunión se centrará en todos los aspectos de la ciencia y la gestión del medio marino, pero se centrará especialmente en la ciencia y la gestión de los ecosistemas marinos del gran Caribe. Al reunir a los participantes de una amplia colección de campos relacionados con el mar, la ciencia y la gestión, esta reunión servirá de escenario para aún más consideración y síntesis de nuevas ideas ecológicas. La reunión consistirá en presentaciones estándar, cuatro presentaciones magistrales (Dr.

Nicolas Pascal, Dr. Charles Sheppard, Dr. Steve Monismith and Dr. Anastazia Banaszak), presentaciones de perspectiva durante la recepción de Bienvenida y el Banquete por Jake Kheel, Frank Rainieri y un invitado especial (respectivamente) y excursiones para ver la parte histórica de Republica Dominicana y sus ecosistemas marinos.

Welcome Message

Jake Kheel
Vicepresident
Grupo Puntacana Foundation

When Grupo Puntacana (GPC) began almost 50 years ago, the concept of "sustainable development" didn't exist. The company made decisions guided by commonsense, limited financial capital, and a deep respect for the Dominican people and the countries' rich natural resources. As it turns out, many of the decisions turned out to be examples of what is now known as sustainable development.

Today, the Punta Cana region has become one of the most important tourism destinations in Latin America. A significant part of the Dominican economy depends directly or indirectly on the tourism industry. Like much of the Caribbean, the Punta Cana destination relies largely on its coastal resources to attract international visitors. Our magnificent beaches, coral reefs, and coastlines are ecosystems that, in many ways, power the national economy.

Done right, tourisms' impact can be overwhelmingly positive. ***Sustainable tourism*** delivers employment, foreign investment, economic growth, and opportunities for cultural interchange, all while improving the local economy, ecosystems and communities. It's a delicate balance, but one that we are convinced is not only achievable, but also entirely indispensable.

Grupo Puntacana firmly believes that our long-term commitment to sustainable tourism has made us a stronger and more resilient company. Sustainability challenges us to constantly innovate and adapt to a rapidly changing planet in order to compete. Adaptation and innovation are skills that translate well to the business world.

What the environmental community needs now, more than ever, is to effectively engage more companies like ours and convince them the value of sustainability. As governments around the world increasingly abdicate their responsibility to

environmental protection, it is being left to concerned citizens, universities, local governments, foundations and more than ever, companies, to fill the void.

Grupo Puntacana is pleased to host the 39th Scientific Meeting of the Association of Marine Laboratory of the Caribbean (AMLC) as a means to bridge the gap between the tourism industry and the marine scientific community. We hope this meeting generates a meaningful dialogue, increases the role of businesses in protecting marine habitats, and achieves a lasting legacy on the region.

About the AMLC

The Association of Marine Laboratories of the Caribbean (AMLC) was founded in 1956 by marine researchers with interests in the marine science of the tropical Atlantic and the Caribbean. Founded primarily as a scientific organization, the strength of AMLC lies in the diversity of its member laboratories and the extensive expertise of its membership. Institutional, Individual Scientist, and Student memberships are available.

Goals of AMLC

- To advance common interests in the marine sciences
- To encourage the exchange of research results
- To foster cooperative research projects
- To expose students to established scientific methods
- To participate in decisions made by national and international organizations concerning the marine environment

The AMLC is currently a confederation of 36 marine research, education, and resource management institutions endeavoring to encourage the production and exchange of research and resource management information, advance the cause of marine and environmental education in the region, and facilitate cooperation and mutual assistance among its membership. The AMLC also has more than 300 Individual Members with professional research and management interests in the region. The AMLC is a 501(c)(3) corporation governed by an Executive Board consisting of one Institutional Representative from each Institutional Member plus a slate of officers elected by the Executive Board. A list of current officers can be found below.

AMLC meetings are hosted by member laboratories actively conducting marine research in the Caribbean. The host institution provides overall management of the meeting, arranging facilities for research presentations, receptions, and participant accommodations. The host also provides field trip opportunities during one designated “Field Trip Day” of the conference to provide occasions for participants to relax and network in informal environments. The AMLC has no designated official language so researchers are free to make their presentations in their native language. Scientific

Meetings are held every other year, for which peer-reviewed Proceedings are published in a respected peer-reviewed journal.

Current Officers (2018)

President: Victor Manuel Galvan, Grupo Puntacana Foundation, Dominican Republic

Executive Director: Dr. Rita Peachey, Bonaire

Deputy Executive Director: Dr. Clare Morrall, St George's University, Grenada

Treasurer: Dr. Franziska Elmer, School for Field Studies, Turks & Caicos

Secretary: Dr. Ligia Collado-Vides, Florida International University, USA

Membership Director: Dr. Michelle Dennis, Ross University, St. Kitts & Nevis

Member-at-Large: Dr. David G. Zawada, U.S. Geological Survey, USA

For more information on the AMLC visit:

www.amlc-carib.org

Conference Theme

Theme of the 39TH AMLC meeting on Punta Cana, Dominican Republic

Environmental Variability in the Wider Caribbean and the Ecological, Social and Economic Consequences

Variabilidad Ambiental en el Gran Caribe y las Consecuencias Ecológicas, Sociales y Económicas

The Caribbean is experiencing environmental changes that are having undeniable dire impacts on ecosystems and the services they provide. Increasing temperatures, accumulation of nutrients, wastes, plastics, habitat destruction and overfishing are reaching thresholds considered beyond ecosystem's functioning capacities. Ecosystem's deterioration, such as overfishing, bleaching and diseases, and algal blooms, are impacting local societies and their economies. Loss of fisheries and tourists are at a higher rate. However, the Caribbean is an interconnected region that need to respond and act regionally. Managers are responding locally, while common to the region, at different time and pace scales. A deeper understanding of the tropical marine ecosystems responses to global changes is urgent, therefore, during this meeting we will address the ***environmental variability in the wider Caribbean and the ecological, social, and economic consequences*** with the aim to help manage these ecosystems using scientific-sound strategies.

Plenary Speakers

Sunday Reception

Frank Rainieri Marranzini

Founder, President and Chief Executive Officer - Grupo Puntacana

Frank Rainieri Marranzini is the president and CEO of Grupo Puntacana, and a recognized leader and visionary of the Tourism industry in the Dominican Republic. Mr. Rainieri began his bachelor's degree in Business Administration at Saint Joseph College in Philadelphia, which he concluded at APEC University in Santo Domingo. Over the past 20 years, Mr. Rainieri and his family have provided the original inspiration, leadership and enthusiasm that has made Punta Cana one of the most successful and popular resort destinations in the world. Currently, Puntacana is the most highly visited Caribbean destination. Mr. Rainieri developed and owns the Punta Cana International Airport, a modern, convenient and architecturally exciting facility.

At the 15,000-acre Puntacana Resort & Club, Mr. Rainieri has created a resort community that sets the new standard for excellence in Caribbean vacations and residential living. Frank Rainieri has received numerous awards. These include the Presidential Citation award presented to him by Ronald Reagan in 1985, and the "Hotelier of the Year" award by the Caribbean Hotel Association in 1998. In 2003, he was lauded by the president of Counterpart International for his role in keeping sustainable tourism development issues at the forefront of Caribbean tourism thinking. More recently, Mr. Rainieri was honored by the United Nations World Tourism Organization (WTO) for his "innovation and [the] global impact of [his] contribution to the development of tourism in the Caribbean". In addition to being the President and CEO of Grupo Puntacana, he is the President of the Grupo Puntacana Foundation, a non-profit organization dedicated to the preservation of the environment in Puntacana.

Monday Morning

Dr. Nicolas Pascal

Project Director – UNDP Blue Finance

Shifting governance on ocean conservation and management: are we ready for market approaches?

Coral reefs provide exceptional biodiversity and ecosystem services for local economies. However, globally they are in decline and in the Caribbean, greater than 50% of the reefs have been reported to be lost in the last 50 years. Furthermore, as a result of climate change, the Caribbean region is facing rapid ocean warming, increased intensity of storms and hurricanes (among others) thus reducing the capacities of remaining Caribbean reefs to sustain themselves and recover from acute stress events. Imminent actions have been identified at local, regional and global scales. By controlling local impacts, such as land-based sources of marine pollution and unsustainable fishing practices, managers hope to ensure that coral reefs are more resilient to global impacts. Measures such as the development of Marine Spatial Plans, the designation of Marine Management Areas and the use of ecological engineering are among the most effective tools used in the protection of threatened reefs. To be successful though, marine conservation via these and other measures, requires financing and management resources that can exceed public budget priorities.

During the last five years, a community of investors seeking positive social and environmental in addition to financial returns have stepped in to fill the marine conservation financing gap. These Impact Investors have invested over US$8 billion since 2004 in food and agriculture, forestry, habitat protection, clean water initiatives, and other conservation projects. With respect to marine biodiversity, a small but positive track record of impact investments have demonstrated the feasibility of achieving environmental, social and financial returns.

Current reports have revealed at least US$3.1 billion in committed capital, sitting on the sidelines, awaiting attractive deals. To capture some of this capital, recent approaches seek to provide a diversified portfolio of investments in marine conservation, shifting governance models and management approaches. We will review a selection of these mechanisms which are still in proof-of-concept (such as parametric reef insurance, public-private partnerships, biodiversity offsets and payments for ecosystem services) and show how marine conservation models can be design to capture some of the investment capital to assist in filling the conservation gap.

Tuesday Morning

Dr. Charles Sheppard

Emeritus Professor - University of Warwick

Why are corals not like they were in the good old days?

Research on the exceptionally high diversity and productive coral reef system and its conservation has increased in the last 30 years as fast as in many other fast-growing scientific subjects. But, in stark contrast to the other subjects, for example medical research, the condition of reefs worldwide continues to decline. This is because the main impediment for reef conservation today is no longer one of scientific knowledge, but is political.

It has been shown repeatedly, in many different ways, what the value of reefs are for provision of food, for shoreline protection, and for the economies of many countries: it can no longer be claimed that we do not know the value of coral reefs to us, and by 'us' I mean not only those people living on top of them in the tropics but the value to the whole, integrated, global ecosystem. Economic estimates of coral reefs extend to a third of one million dollars per hectare per year. This excludes social costs, but it does show economists and governments that the living component of our planet should be considered more centrally.

The reasons for the decline of reefs are well understood, and it is known that these reasons are not the same as those that prevent reefs recovering after an impact. The latter are more varied according to location. Reasons for decline are now pre-eminently the extended warming episodes that are affecting our oceans, while the reasons for reefs not recovering afterwards are commonly local in origin: raised nutrients, overfishing, shoreline disturbance etc. In areas such as the Arabian Gulf over 80% of reefs have essentially disappeared but, this is commonly met with disbelief in government circles. Many other areas of the world are declining as quickly.

Management remains very inadequate, indeed in many places the term 'reef management' is an oxymoron filled with hubris. This is not a scientific failure but rather it is political failure. Prognoses are, sadly, for a further decline as the principal reason now for reefs being killed, i.e. warming episodes, are increasing both in intensity and frequency. For many regions of the tropics we are now at or possibly beyond that cusp of when frequency of recurrence of these reef-killing episodes is exceeding the ability of reefs to recover during cooler periods between them. Implications to biodiversity (because reefs support nearly a quarter of all marine species), to shoreline and property erosion, and to food security are enormous.

Thursday Morning

Dr. Stephen Monismith

Professor -Stanford University Civil and Environmental Engineering

His research in environmental and geophysical fluid dynamics involves the application of fluid mechanics principles to the analysis of flow processes operating in rivers, lakes, estuaries and the oceans, with a particular interest in the ecological impacts of those flows. His current research includes studies of estuarine hydrodynamics and mixing processes, flows over coral reefs and on the inner shelf, turbulence in density stratified fluids, and physical-biological interactions in phytoplankton and benthic systems. Current projects include field and computational work on wave-driven flows over coral reefs, stratified turbulence due to shoaling internal waves, benthic grazing on coral reefs and in kelp forests, dispersion in complex estuarine tidal flows, and lab and computational studies of flows through coral colonies. Professor Monismith is currently director of the Environmental Fluid Mechanics Laboratory and Chair of Stanford University's Department of Civil and Environmental Engineering.

Banquet Speakers

Thursday Evening

Jake Kheel

Vice President - Fundación Grupo Puntacana,

Jake Kheel is a sustainability innovator, thought-leader, and award-winning documentary filmmaker. For more than a decade he has confronted social and environmental challenges in the tourism industry as vice president of Grupo Puntacana Foundation in the Dominican Republic. He leads one of the Caribbean's most expansive coral reef conservation efforts; helped implement Zero Waste at Grupo Puntacana, the first and largest integrated solid waste program in the country; and directs the Center for Sustainability, a think tank for sustainable development. He has led numerous high impact sustainability programs in the Dominican Republic

that have been replicated in other destinations and companies. Under his leadership, Grupo Puntacana has received numerous international awards, including awards from World Tourism and Travel Council, Conde Nast Traveler, Travel & Leisure, and National Geographic Traveler. Jake regularly presents at international conferences; writes in Spanish and English publications; and serves as an expert on environmental issues on international news outlets. He is the President of the National Association of Businesses for Environmental Protection (ECORED) and serves on several not-for-profit board of directors.

Dr. Francisco Dominguez Brito

Former Attorney General of the Dominican Republic
Former Minister of the Environment and Natural Resources

Domínguez received a law degree at the Pontificia Universidad Catolica Madre y Maestra (PUCMM) and a master's of Civil Law at Panthéon-Assas University in Paris, France. In 2004 he became Attorney General for the Dominican Republic leading new initiatives for reforming procedural processes and improving citizen access to documents. By presidential Decree, Brito was name Minister of the Environment and Natural Resources in 2016, a role that he would serve with great success. Amongst his biggest successes were the intervention and rescue of the Valle Nuevo National Park, relocating small farmers outside the national park, ensuring a water source for approximately 6 million people. During his tenure, 90 million trees were planted in the mountain ranges in the south of the country. He also promoted social empowerment by reaching out to NGO's in the decision-making process related to the natural environment by establishing dozens of agreements for the Co-management of protected areas. Brito, supported the Grupo Puntacana Foundation's and other NGO's initiatives to protect important marine species and in 2017, thanks in part to Blue Finance, Grupo Puntacana Foundation, The Dominican Foundation for Marine Studies, and others, declared an indefinite off-season for rays, sharks, and sea urchins and a two-year band on the capturing, possession, consumption, and commercialization of parrot fish.

Friday Morning Plenary

Dr. Anastazia Banaszak

Research Professor National Autonomous University of Mexico, Puerto Morelos

Coral Reef Restoration: Advances and Challenges

Over the last 4 decades, the populations of *Acropora palmata* and *A. cervicornis* have suffered drastic losses due to disease and increased sea surface temperatures coupled with natural catastrophes. The result is a loss of reef structure and function throughout the Caribbean leading to phase shifts to algal-dominated reefs. Despite the implementation of management actions recovery is not compensating the losses.

The impacts of climate change and development associated with tourism cause continuous damage to the environment, making the natural processes of reef ecosystem recovery slow and difficult. Given the speed of this environmental deterioration, the persistence of coral reefs is questionable. Over the last two decades, active restoration programs have been incorporated as a response to try to stop or reverse the decline of reef ecosystems.

Initially, restoration practices were designed to remedy specific disturbances, such as ship groundings or hurricanes, using “fragments of opportunity”; more recently, active pruning of stock colonies is used to supply fragments for restoration projects. These fragments are not genetically diverse and potentially susceptible to diseases and thermal stress. New techniques based on sexual propagation aim to improve genetic diversity and gene flow and connectivity between populations. Advances in research on the use of sexual recruits in reef restoration, especially of *Acropora* in the Caribbean are presented as well as the development of techniques to upscale restoration techniques while reducing costs.

Host Institution

Grupo Puntacana Foundation

Grupo Puntacana Foundation is a not-for-profit foundation established in 1994 to protect and restore the natural resources of the Punta Cana region, while contributing to the sustainable development of the Dominican Republic. For over two decades, our areas of action have included working in a variety of both land and marine based environmental conservation and restoration programs.

Among our most successful programs are:

i) The reintroduction of the endemic and critically endangered Ridgway's Hawk in the Punta Cana area
ii) The development of alternative income generation sources for several dozen fishermen and their families, helping to protect the local coral reef, fish populations and provide consistent livelihoods for fisher families.
iii) Community empowerment and environmental awareness programs helping to establish the first community-managed, constructed wetland to help treat sewerage for over 150 families in the community of Domingo Maiz
iv) The *Acropora* coral restoration program that has seen over 8km of coral tissue returned back onto natural coral reefs in the last 14 years, promoting natural recovery of the species. This work is done through the foundation's two pioneering Centers: The Center for Sustainability established in 1999 and the Center for Marine Innovation founded in 2018.

The Center for Sustainability was a result of a collaboration agreement between Grupo Puntacana, Cornell University and Grupo Puntacana Foundation and develops innovative research, education and conservation programs with national and international organizations, universities, and local partners. The Center is equipped with a dry lab, administrative offices, a library, class room space and a computer center. In the second floor of the center, there are 12 dorm style rooms that can sleep up to 28 visiting students and professors. The Center manages the largest private forest reserve in the country, the Indigenous Eyes Ecological Reserve, which consists of a 1,500 acer subtropical forests area with freshwater lagoons which visitors can enjoy. The Center realizes diverse sustainable agriculture, waste management, and conservation projects, while receiving thousands of monthly visitors for tours and excursions.

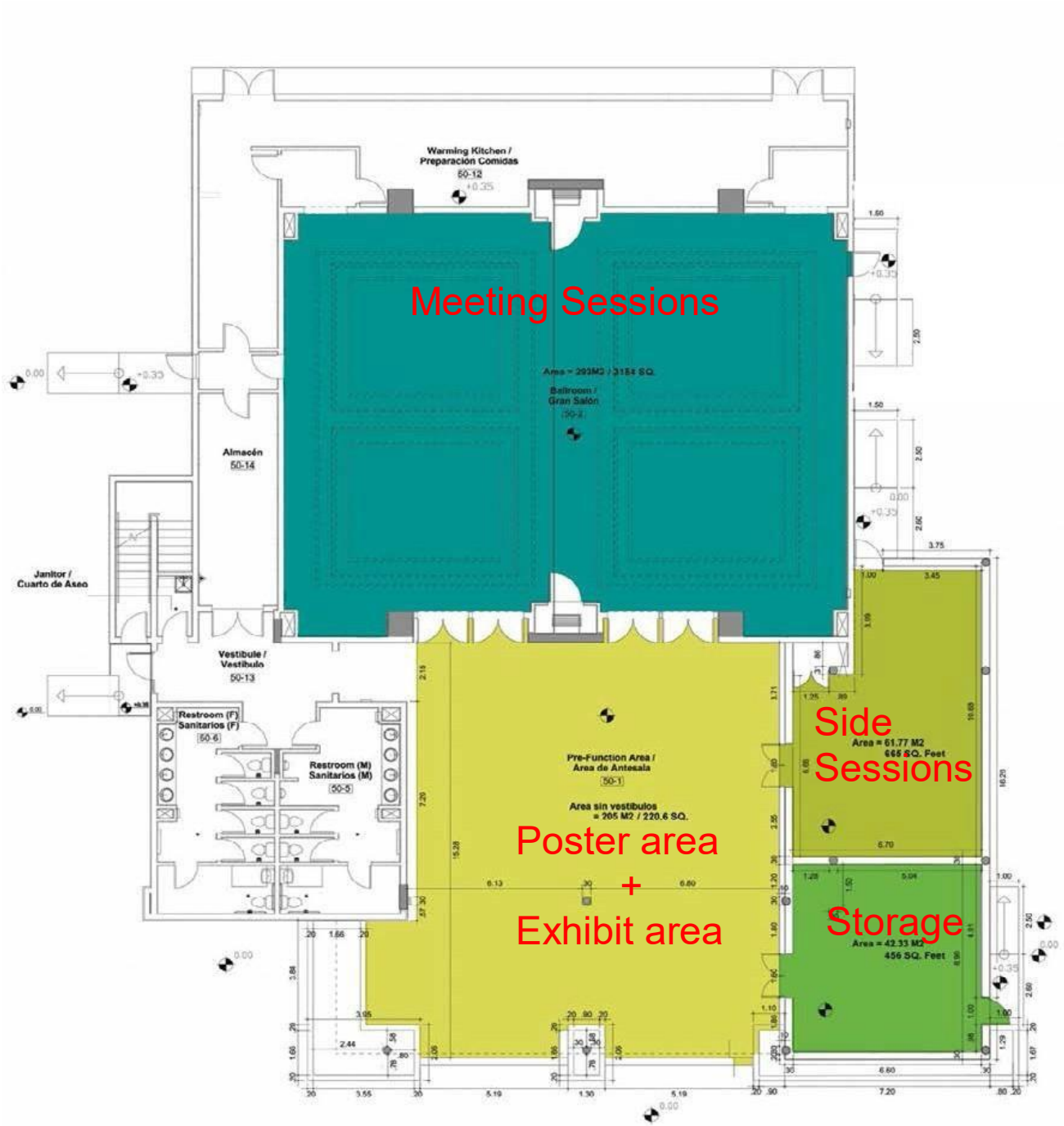
The Center for Marine Innovation (CIM) was created in 2018 as a Center for exploring marine and coastal management, conservation, and restoration. The CIM has evolved to manage some of the Foundation's most important projects in-situ *Acropora* coral nurseries, coral microfragmentation, and a pilot ornamental fish nursery.

The objectives of the CIM include: i) scientific research and project implementation to support the development of practical tools that help reduce environmental impacts, ii) to

serve as national and/or regional capacity building and environmental awareness training center for conservation and restoration, iii) to support the development of young science professionals through the foundation's internship program, iv) develop collaborative relationships to scale, replicate, and expand marine protection programs, and v) develop alternative income generation opportunities for local fishermen and their families.

The CIM is composed of an external microfragmentation area with 10 raceway fiberglass thanks, 2 external 7,000-gallon circular retention tanks, an interactive tank hosting local marine species, an internal wetlab with space for 25 aquaria and microfragmentation space, 8m^2 of work space, two work boats, dive equipment room, an ornamental fish nursery and an administrative area.

MEETING VENUE



Meeting sessions

Poster and booth area

The Westin Puntacana

MAP OF PUNTA CANA AND PUNTACANA RESORT & CLUB:

Registration

Participants can officially register during the first meeting day (08h00 to 16h00 on Monday May 20th) or before the start of the session on any of the conference dates except Wednesday. During registration you will receive your badge, purchased banquet tickets, conference shirt, etc. The registration table on May 20th will be directly outside the conference room. Registration covers the following: Welcome Reception, access to conference sessions, all coffee breaks, one-hour open bar at the poster sessions, special price at the venue hotels, conference shirt, tote bag, and access to the student mixer (students only). If you need assistance related to the conference, find one of the conference volunteers or anyone with the following logo on their shirts:

Participant	Early Registration (US$) Jan 15 - Mar 8, 2019	Regular Registration (US$) Mar 8- Apr 20, 2019	Late Registration (US$) Apr 20 -May 20, 2019
Student	100	140	180
Regular	200	240	280
One-day Pass	50% off regular registration	70 Students/120 regular members/90 Institutional reps	
Banquet Guest	50		

39th AMLC GENERAL CONFERENCE AGENDA May 19 - 24, 2019

Time	Sunday	Monday	Tuesday	Wednesday	Thursday	Friday
7:00-8:00	Arrivals and Board Meeting	Meeting Registration load presentations	Meeting Registration load presentations	AMLC Official Fieldtrips	Meeting Registration load presentations	Meeting Registration load presentations
8:00 - 8:15		MORNING ANNOUNCEMENTS	MORNING ANNOUNCEMENTS	1) Historical Tour of Santo Domingo Lunch Included 2) Tour of the Grupo Puntacana Foundation projects **9-2PM** Meals not Included 3) Diving trip with Blue Vision Adventures **Side** **Workshops:** i) Coral Microfragmentation with Dave Vaughan. **9AM-1PM**	MORNING ANNOUNCEMENTS	MORNING ANNOUNCEMENTS
8:15 - 9:00		**Plenary**	**Plenary**		**Plenary**	**Plenary**
9:00-10:00		Coral Reef Disease and Bleaching	Reef Restoration and Resilience		Human related issues including fisheries + Reef Monitoring-AGRRA: Science to Action	Historical Ecology, Mangrove & Seagrass Ecology
10:00-10:30		**COFFEE**	**COFFEE**		**COFFEE**	**COFFEE**
10:30-12:00		Coral Reef Disease and Bleaching	Reef Restoration and Resilience		Reef Monitoring-AGRRA: Science to Action	Marine Population Connectivity in the Caribbean + Climate Change & Other Stressors
12:00-1:30		**Lunch**	**Lunch**		**Lunch**	**Lunch**
1:30-3:15		Coral Reef Disease and Bleaching + Sargassum and Other Harmful Algae	MPA management & Reef Monitoring		Reef Monitoring-AGRRA: Science to Action	Climate Change & Other Stressors (1:30-2:45)
3:15 - 3:45		**COFFEE**	**COFFEE**		**COFFEE**	
3:45-4:45	Registration 4PM-8:00PM at the Westin Puntacana Resort & Club	Sargassum and Other Harmful Algae + Novel Techniques in Remote Sensing and	Human related issues including fisheries		Historical Ecology, Mangrove & Seagrass Ecology (3:45-5:30)	
4:45 - 5:00						

5:00 - 6:00		Reef Science (3:45-5:30pm)				
6:00 - 6:30		**Poster Session + Open Bar (1 Hour)**	**Poster Session + Open Bar (1hour) (6:00-8:00) + Lightning Talks (7:15- 8:00)**			
6:30 - 7:00						
7:00- 7:30	**Welcome Reception (Frank Rainieri Residence)**			**STUDENT MIXER (Cava Bar, Puntacana Village)**	**Banquet + Student Awards+ Plenary**	
7:30 - 8:00						
8:00 - 8:30						
9:30 - 10:00						

39th AMLC PLENARY AND ORAL PRESENTATIONS

Monday, May 20th

Time Slot	Session	Authors	Presentation Title
8:15-9:00	**Plenary Speaker**	**Dr. Nicolas Pascal, Executive Director, UNDP Blue Finance**	**Shifting governance on ocean conservation and management: are we ready for market approaches?**
9:00-9:15	Coral Reef Disease and Bleaching	Muller E*, Alcaraz N, Sartor C, van Woesik R	SPATIAL EPIDEMIOLOGY OF THE STONY CORAL TISSUE LOSS DISEASE OUTBREAK IN FLORIDA
9:15-9:30		Aeby G*, Ushijima B, Jones S, Meyer J, Häse C, Paul V	ECOLOGY OF A TISSUE LOSS DISEASE(S) AFFECTING MULTIPLE SPECIES OF CORALS ALONG THE FLORIDA REEF TRACT
9:30-9:45		Jones S*, Aeby G, Ushijima B, Meyer J, Häse C, Paul V	DIFFERENCES IN MORTALITY RATE AMONG CORAL SPECIES AFFECTED BY SCTLD IN TWO REGIONS ALONG THE FLORIDA REEF TRACT
9:45-10:00		Rosales S, Clark A, Huebner L, Ruzicka R, Muller E*	CHARACTERIZATION OF THE MICROBIOME OF CORALS WITH STONY CORAL TISSUE LOSS DISEASE
10:00-10:30	**COFFEE BREAK**		
10:30-10:45	Coral Reef Disease and Bleaching	Hayes NK*(**S**), Walton CJ, Gilliam DS	RECOVERY POTENTIAL FOLLOWING A REGIONAL STONY CORAL DISEASE OUTBREAK ALONG THE SOUTHEAST FLORIDA REEF TRACT
10:45-11:00		Neely KL*, Lewis C	TREATMENT OF CORAL DISEASES: HISTORICAL PERSPECTIVES, MODERN EFFORTS, AND FUTURE DIRECTIONS
11:00-11:15		Ruzicka R*, Schopmeyer SA, Moore J, Gregg L, O'Neil K, Bruckner A, Gilliam DS, Martinelli M, Johnson M, Goergen E, Kerrigan K	MULTIPLE SPECIES CORAL RESCUE IN RESPONSE TO THE STONY CORAL TISSUE LOSS DISEASE ON THE FLORIDA REEF TRACT
11:15-11:30		Hiley A*(**S**), Gilliam DS	LONG-TERM SPATIAL AND TEMPORAL TRENDS IN OCTOCORAL DENSITY ON THE SOUTHEAST FLORIDA REEF TRACT
11:30-11:45		Dennis MM*, Becker AAMJ, Freeman MA	PATHOLOGY OF OPPORTUNISTIC FUNGAL INFECTIONS IN CARIBBEAN SEA FANS (GORGONIA SPP.) RESEMBLING PRIMARY ASPERGILLOSIS
11:45-1:30	**LUNCH BREAK**		
1:30-1:45	Coral Reef Disease and Bleaching	Hendrick G*(**S**), Dolan M, McKay T, Sikkel P	HOST IDENTIFICATION BY SEQUENCING DNA WITHIN BLOOD MEALS OF THE CARIBBEAN GNATHIID ISOPOD, GNATHIA MARLEYI

1:45-2:00		Nicholson MD*(**S**), Sikkel PC	ENERGETIC CONTRIBUTIONS OF A COMMON FISH ECPARASITE TO CARIBBEAN CORAL REEFS
2:00-2:15	Sargassum and Other Harmful Algae	Amaral-Zettler, L	NEXT-GENERATION APPROACHES TO UNDERSTANDING THE HOLOPELAGIC SARGASSUM HOLOBIOME
2:15-2:30		García-Sánchez, M.*(**S**), Graham, M.C., Vera, E., Álvarez-Filip, L., van Tussenbroek, B.I.	CHANGES IN THE SPECIFIC COMPOSITION OF PELAGIC SARGASSUM IN THE MEXICAN CARIBBEAN
2:30-2:45		Luz Verónica, Monroy-Velázquez, Rosa Elisa Rodríguez-Martínez, Teresa Aguiar, Patricia Briones Fourzan, Vivianne Solis Weiss, Brigitta I. van Tussenbroek*	MOTILE FAUNA ASSOCIATED WITH PELAGIC SARGASSUM IN A MEXICAN REEF LAGOON
2:45-3:00		Franziska Elmer*, Caitlin Reisa, Elizabeth Walker, Delaney Koch, Gregory Hoffer	EFFECTS OF SARGASSUM SPP. BLOOMS ON SEAGRASS BEDS
3:00-3:15		Vera, E.*(**S**), García-Sánchez, M., van Tussenbroek, B.I.	CONSEQUENCES OF LOSS OF SEAGRASS MEADOWS DUE TO SARGASSUM BROWN TIDE IN THE MEXICAN CARIBBEAN
3:15-3:45	**COFFEE BREAK**		
3:45-4:00	Sargassum and Other Harmful Algae	Joseph Weekes*(**S**), Kimberly Baldwin, Hazel A. Oxenford	TESTING THE APPLICATION OF DRONE TECHNOLOGIES IN QUANTIFYING STRANDED SARGASSUM SEAWEED
4:00-4:15		Patrick McConney, Hazel A. Oxenford*, Kareem Sabir	CHALLENGES OF MANAGING SARGASSUM INFLUXES: A WAY FORWARD
4:15-4:30		Karli Hollister*(**S**), Heather Spalding, Rosmin Ennis, Tyler Smith	CORAL-ALGAL COMPETITION AND OVERGROWTH DYNAMICS OF A RAPIDLY EMERGING RED ALGA (RAMICRUSTA SP.) IN ST. THOMAS, US VIRGIN ISLANDS
4:30-4:45	Novel Techniques in Remote Sensing and Reef Science	Ximena Escovar-Fadul*, Joseph Pollock, Steve Schill, Joseph Mascaro, Jiwei Li, Greg Asner	REVOLUTIONARY AERIAL MAPPING TECHNOLOGIES TO ADVANCE COASTAL CONSERVATION AND RESTORATION
4:45-5:00		David G. Zawada*, Kimberly K. Yates	RECENT INCREASES IN SEAFLOOR ELEVATION: FALSE HOPE FOR THE FLORIDA REEF TRACT
5:00-5:15		Marc Todd*(**S**), Rayanne Vega-Perkins, Kyra Jean Cipolla, Abby Dias, Nick Peoples. Franziska Elmer	UTILIZING 3-D MODELING TO DETERMINE CORAL REEF CALCIUM CARBONATE PRODUCTION AT THE ARCH REEF SITE IN SOUTH CAICOS, TCI
5:15-5:30		Andreina Rivera*(**S**), Jose Agudo-Adriani Cappelletto, Alfredo Esteban Ascanio, Aldo Croquer	EXPLAINING SPATIAL VARIATION OF FISH ASSEMBLAGES WITH STRUCTURAL COMPLEXITY: THE VALUE OF 3D RECONSTRUCTIONS

Tuesday, May 23rd

Time Slot	Session	Authors	Presentation Title
8:15-9:00	**Plenary Speaker**	**Dr. Charles Sheppard, Emeritus Professor, University of Warwick**	**Why are corals not like they were in the good old days?**

9:00-9:15	Reef Restoration and Resilience	Edwin A. Hernández-Delgado*, Samuel E. Suleimán-Ramos	THE CHALLENGE OF UPSCALING CORAL FARMING AND REEF REHABILITATION FOR ENHANCING COASTAL RESILIENCE
9:15-9:30		Johanna Calle Triviño*(**S**), Aarón Israel Muñiz Castillo, Camilo Cortés Useche, Rita Inés Sellares Blanco, Jesus Ernesto Arias González	ASSESSMENT OF NURSERIES AND OUTPLANTING SITES IN THE SOUTHEASTERN OF DOMINICAN REPUBLIC AFTER HURRICANES MATTHEW (20016), IRMA AND MARIA (2017))
9:30-9:45		Ellen D. Goldenberg*(**S**), Elizabeth A. Goergen, David S. Gilliam	OUTPLANTING *ACROPORA CERVICORNIS* LOCALLY INCREASES ABUNDANCE OF MACROALGAE CONSUMERS
9:45-10:00		Villalpando-Garza María*, Sellares-Blasco Rita Inés, Luis-Báez Alido & Calle-Triviño Johanna	PREDICTED SPAWNING TIMES OF LOCAL CORALS AS A TOOL FOR LARVAL PROPAGATION IMPLEMENTATION IN SOUTHEASTERN DOMINICAN REPUBLIC
10:00-10:30	**COFFEE BREAK**		
10:30-10:45	Reef Restoration and Resilience	Catalina Morales-Ruiz*(**S**), Juan J. Cruz-Motta, Ernesto Weil	RECOLONIZATION OF *ORBICELLA FAVEOLATA* COLONIES KILLED DURING THE THERMAL ANOMALY OF 2005: STATUS OF THE NEW ASSOCIATED ASSEMBLAGES AND JUVENILE DYNAMICS
10:45-11:00		Zlatka Rebolledo*(**S**), Aldo Cróquer	PARTITIONING SPATIAL VARIATION OF JUVENILE CORALS; FROM CENTIMETERS TO KILOMETERS: A CASE STUDY FROM MOCHIMA NATIONAL PARK, VENEZUELA.
11:00-11:15		Hamlyn SB.*(**S**), Mandara JA,Craig ZW., Bartels E, Muller EM	FATE TRACKING MASSIVE CORAL OUTPLANTS BY SPECIES AND GENOTYPE WITHIN THE STONY CORAL TISSUE LOSS DISEASE OUTBREAK
11:15-11:30		Lisa Carne*, Arthur Gleason, Les Kaufman, Karina Scavo	RESTORATION UPDATES AND INNOVATIONS FROM BELIZE: FIVE YEARS OF PHOTO-MOSAIC RESULTS PLUS MICRO-FRAGGING IN SITU-WITHOUT LAND-BASED NURSERIES
11:30-1:30	**LUNCH BREAK**		
1:30-1:45	MPA management & Reef Monitoring	Camilo Cortés-Useche*(**S**), Aarón Israel Muñiz-Castillo, Johanna Calle-Triviño, Rita Sellares-Blasco, Jesús Ernesto Arias-González	REEF CONDITION IN MARINE PROTECTED AREAS OF SOUTHEASTERN DOMINICAN REPUBLIC: USE OF INDICATORS BASED ON SCLERACTINIAN CORALS AND BENTHIC FUNCTIONAL GROUPS
1:45-2:00		Michael Martínez-Colón*, Silvia Spezzaferri, Guillem Mateu Vicens	USE, APPLICABILITY, AND IMPORTANCE OF BENTHIC FORAMINIFERA AS ENVIRONMENTAL BIOINDICATORS
2:00-2:15		Verde Alejandra*(**S**), Lopez-Hernandez Maria A., Sanchez Daniela, Agudo-Adriani Esteban, Miyazawa Emy, Croquer Aldo	ARE MPAS IN VENEZUELA MAKING A DIFFERENCE PROTECTING BENTHIC AND FISH COMMUNITIES?
2:15-2:30		Ninon Martinez*, Leandra Cho-Ricketts	THE EARLY EFFECTS OF MARINE RESERVE DESIGNATION AND FISHERIES MANAGEMENT REFORM ON FISH BIOMASS, DIVERSITY, AND ABUNDANCE WITHIN THE TURNEFFE ATOLL, BELIZE

2:30-2:45		Angela Karina Ortiz-Cajica*(**S**), Rodolfo Rioja-Nieto	SEASCAPE ECOLOGY, VARIATION, AND INTENSITY OF USE, FOR THE SPATIAL CONSERVATION PRIORITIZATION OF A MARINE PROTECTED AREA IN THE MEXICAN CARIBBEAN
2:45-3:00		Jeniece Germain*(**S**), Henri Vallès, Renata Mazzei, Redouan Bshary	SPATIO-TEMPORAL PATTERNS OF MICROHABITAT USE BY THE CLEANER GOBIES *ELACATINUS EVELYNAE* AND *E. PROCHILOS* IN BARBADOS
3:00-3:45	**COFFEE BREAK**		
3:45-4:00	Human related issues including fisheries	Kimberly K. Yates*, David G. Zawada, Soupy Dalyander, Legna Torres-Garcia.	IMPACTS OF SEAFLOOR EROSION ON THE FLORIDA REEF TRACT: PAST, PRESENT AND FUTURE
4:00-4:15		Gilliam, David S., Waldman, Alanna D*(**S**)	THE IMPACT OF HURRICANE IRMA ON THE DENSITY AND VOLUME OF THE GIANT BARREL SPONGE POPULATION ON THE SOUTHEAST FLORIDA REEF TRACT
4:15-4:30		Simonin, Paul W.*, Baier-Lockhart, Kathy., Jadot, Catherine., Bruno, Olivia., Hoang, Karen., Parise, Katherine., Pfister, Connor	QUEEN CONCH REGIONAL POPULATION TRENDS AND HURRICANE EFFECTS AROUND SOUTH CAICOS, TURKS AND CAICOS ISLANDS
4:30-4:45		Mcloughlin, Jané Isabel Salazar*, Cho-Ricketts, Leandra	QUEEN CONCH: CHALLENGES WITH A JUVENILE FISHERY
4:45-5:00		Clark, Abigail S.*, Behringer, Donald C.	RELATIONSHIP BETWEEN VIRAL LOAD AND INFECTION IN CARIBBEAN SPINY LOBSTERS EXPOSED TO PANULIRUS ARGUS VIRUS 1

Thursday, May 22nd

Time Slot	Session	Authors	Presentation Title
8:15-9:00	**Plenary Speaker**	**Dr. Stephen Monismith, Professor, Department of Civil and Environmental Engineering, Stanford University**	**Current projects include field and computational work on wave-driven flows over coral reefs, and lab and computational studies of flows through coral colonies.**
9:00-9:15	Human related issues including fisheries	Ascanio, Alfredo*(**S**), Cróquer, Aldo	SPATIAL VARIATION AND TROPHIC STRUCTURE OF DEMERSAL FISH COMMUNITIES: A CASE STUDY FROM THE DELTA OF THE ORINOCO'S RIVER
9:15-9:30		Grimes, Kristin Wilson*, Bucklin, Carrie Jo, Habtes, Sennai, Forbes, Jr. Howard, Taylor, Marcia, Goodwin, Cait, Guannel, Michele, Nick, Sydney	REDUCING LAND-BASED SOURCES OF MARINE DEBRIS THROUGH COMMUNITY ENGAGEMENT ACTIVITIES IN THE U.S. VIRGIN ISLANDS
9:30-9:45	Reef Monitoring-AGRRA: Science to Action	Steneck RS*, Arnold S, Boenish R, de Leon R, Mumby PJ, Rasher DB, Wilson M	COMPLETE RESILIENCE IN A CARIBBEAN CORAL REEF ECOSYSTEM: LESSONS FROM A 15 YEAR CASE STUDY FROM BONAIRE
9:45-10:00		Camacho R*, Steele S, Challenger S	STATUS AND TRENDS OF CORAL REEFS IN ANTIGUA, BARBUDA AND REDONDA
10:00-10:30	**COFFEE BREAK**		
10:30-10:45	Reef Monitoring-	Palmer SE*, Campbel D, Hay B, Lee S, Lang JC	ECOLOGICAL AND SOCIO-ECONOMIC INDICATORS OF FISHING PRESSURE ON

	AGRRA: Science to Action		CORAL REEFS IN THE PORTLAND BIGHT PROTECTED AREA, JAMAICA
10:45-11:00		Henderson A, Oxenford HA, Vallès H*	SWITCHING BETWEEN STANDARD CORAL REEF BENTHIC MONITORING PROTOCOLS IS PROBLEMATIC
11:00-11:15		Coore K*, Palmer S	REEF HEALTH AND WATER QUALITY OF THE PORT ROYAL CAYS, JAMAICA: TOOLS FOR INFORMING EFFECTIVE CORAL REEF MANAGEMENT STRATEGIES
11:15-11:30		Dahlgren C*, Knowles L, Sherman K, Lang J, Kramer P, Marks K, Kramer P	REVERSING THE DECLINE OF BAHAMIAN CORAL REEFS: ASSESSING REEF HEALTH FOR EFFECTIVE MANAGEMENT AND RESTORATION
11:30-11:45		Irazabal I*, Torres R, Steneck R	LONG-TERM CORAL REEF MONITORING AS A MANAGEMENT TOOL: TWENTY YEARS OF DATA FROM THE DOMINICAN REPUBLIC
11:45-12:00		Drysdale I*, Myton J, Borcsok A, McField M, Lang J	STORY OF AN MPA: TELA BAY, FROM UNKNOWN REEFS TO MARINE WILDLIFE REFUGE IN HONDURAS
12:00-1:30	**LUNCH BREAK**		
1:30-1:45	Reef Monitoring-AGRRA: Science to Action	Alvarez-Filip L*, Perez-Cervantes E, Estrada-Saldivar NA, Gonzalez-Barrios FJ, Navarro-Espinoza E, Espinosa-Andrade N, Molina Hernandez A, Medellin-Maldonado F	A RAPID SPREAD OF AN EXTREMELY LETHAL CORAL DISEASE IN THE MEXICAN CARIBBEAN
1:45-2:00		Miller J*, Feeley M, Richter L, Waara R	QUANTIFYING CHANGE FROM HURRICANES AND CORAL DISEASES ON TWO REEF SYSTEMS
2:00-2:15		Yranzo A*, Herrera-Reveles A, Villamizar E, Perez J, Boadas H, Narciso S, el Souki M	BENTHOS ASSESSMENT IN REEFS FROM MORROCOY NATIONAL PARK AND CURARE WILDLIFE REFUGE VENEZUELA, AFTER MORE THAN TWO DECADES OF THE MASSIVE DIE-OFF
2:15-2:30		Cortés J, Oxenford HA, van Tussenbroek BI, Jordán-Dahlgren E, Cróquer A*, Bastidas C, Ogden JC	THE CARICOMP NETWORK OF CARIBBEAN MARINE LABORATORIES (1985-2007): HISTORY, KEY FINDINGS AND LESSONS LEARNED
2:30-2:45		Gleason ACR	DEVELOPMENT OF UNDERWATER LANDSCAPE MOSAICS FROM NOVELTY TO MANAGEMENT TOOL
2:45-3:00		Charpentier B*, Gayle P, Charpentier F	USING PHOTOGRAMMETRY AND THREE-DIMENSIONAL (3D) MODELLING FOR MAPPING AND MONITORING JAMAICA'S CARICOMP SITE
3:00-3:15		McField M, Kramer P, Drysdale I, Giro A, Craig N, Rueda M, Soto M*	HEALTHY REEF INITIATIVE'S COLLABORATIVE NETWORK RESPONDING TO THREATS TO THE MESOAMERICAN REEF
3:15-3:45	**COFFEE BREAK**		
3:45-4:00	Historical Ecology,	Loren McClenahan	Keynote: HARNESSING HISTORICAL DATA FOR CONSERVATION

4:00-4:15	Mangrove & Seagrass Ecology		Keynote: HARNESSING HISTORICAL DATA FOR CONSERVATION
4:15-4:30		Peter D. Roopnarine*, Ashley Dineen, Courtney Chin	CORAL REEF COMMUNITY STRUCTURE AND THE FIDELITY OF FOSSIL RECONSTRUCTION
4:30-4:45		Erin M. Dillon*(**S**), Richard D. Norris, Douglas J. McCauley, Aaron O'Dea	SHIFTS IN SHARK ASSEMBLAGES OVER THE LAST 7000 YEARS IN BOCAS DEL TORO, PANAMA
4:45-5:00		Michal Kowalewski*, Sahale Casebolt, A. Challen Hyman, Charles A. Jacoby, Thomas K. Frazer	MULTI-MILLENNIAL STABILITY OF SEAGRASS MEADOWS RECORDED IN SURFICIAL MOLLUSK SHELL ACCUMULATIONS
5:00-5:15		Blanca Figuerola*, Ethan L. Grossman, Nicole D. Leonard, Noelle Lucey, Aaron O'Dea	UNRAVELING PAST ENVIRONMENTAL CONDITIONS OF CARIBBEAN CORAL REEFS USING TEMPORAL CHANGES IN MICROGASTROPODS AND THEIR SHELL STABLE ISOTOPE SIGNAL
5:15-5:30		Aaron O'Dea*, Mauro Lepore, Andrew Altieri, Melisa Chan, Nicte-ha Muñoz, John M. Pandolfi, Marguerite A. Toscano, Jian-xin Zhao, Erin M. Dillon	HOW VARIABLE WERE CARIBBEAN REEFS BEFORE HUMANS? AN EXAMPLE FROM BOCAS DEL TORO, PANAMA

Friday, May 23rd

Time Slot	Session	Authors	Presentation Title
8:15-9:00	**Plenary Speaker**	**Dr. Anastazia Teresa Banaszak, Research Professor, Universidad Nacional Autonoma de México**	***Coral Reef Restoration: Advances and Challenges***
9:00-9:15	Historical Ecology, Mangrove & Seagrass Ecology	Miguel Figuerola*(**S**), Juan Cruz Motta, Ernesto Weil	STATUS OF CORAL REEF BENTHIC COMMUNITIES IN LA PARGUERA TEN YEARS AFTER THE 2005-07 MASS MORTALITIES
9:15-9:30		Abigail Libbin Cannon*(**S**), Mackenzie Brandt, Christian Wold, Aaron O'Dea, Jennifer E Smith	THE EFFECT OF SIMULATED GREEN TURTLE GRAZING ON THALASSIA TESTUDINUM PRODUCTIVITY, BENTHIC COMMUNITY COMPOSITION, AND STINGRAY FORAGING BEHAVIOR
9:30-9:45		Edwin Hernandez Delgado	LONG-TERM PERSISTENCE OF PROPELLER AND ANCHOR DAMAGE ON SEAGRASS CANOPY, BENTHIC FAUNAL, AND FISH ASSEMBLAGES IN PUERTO RICO
9:45-10:00		Allie Durdall*, Sydney Nick, Caroline Pott, Richard Nemeth, Kristin Wilson Grimes	CHANGES TO A CRITICAL MARINE FISH NURSERY HABITAT IN ST. CROIX, USVI: REASSESSMENT AFTER TWO DECADES OF MANGROVE HABITAT GAIN AND LOSS, INVASIVE SPECIES, HURRICANES, AND DROUGHT IMPACTS

10:00-10:30	**COFFEE BREAK**		
10:30-10:45	Marine Population Connectivity in the Caribbean	Atherley N*(**S**), Dennis M, Freeman M	GENETIC AND DISEASE CONNECTIVITY OF *PANULIRUS ARGUS*
10:45-11:00	Climate Change & Other Stressors	Alain Duran*, Andrew A. Shantz, Deron E. Burkepile, Ligia Collado-Vides, Victor M. Ferrer, Laura Palma, Amanda Ramos, Silvia Patricia Gonzalez-Diaz	FISHING, POLLUTION, CLIMATE CHANGE, AND THE LONG-TERM DECLINE OF CORAL REEFS OFF HAVANA, CUBA
11:00-11:15		Patricia González-Díaz*, Gaspar González-Sansón, Consuelo Aguilar Betancourt, Sergio Álvarez Fernández, Orlando Perera Pérez, Leslie Hernández Fernández, Víctor Manuel Ferrer Rodríguez, Yenisey Cabrales Caballero, Elena de la Guardia Llanso	STATUS OF CUBAN CORAL REEFS
11:15-11:30		Katie Eaton*, Ray Banister, Emily Hall, Erinn Muller	QUANTIFYING RESILIENT GENOTYPES OF ORBICELLA FAVEOLATA EXPOSED TO INCREASED TEMPERATURE, OCEAN ACIDIFICATION, AND THE STONY CORAL TISSUE LOSS DISEASE
11:30-11:45		John E. Skutnik, Sango Otieno, Sok Kean Khoo, Kevin B. Strychar*	MULTI-STRESSOR IMPACTS TO THE MESOPHOTIC CORAL MONTASTRAEA CAVERNOSA
11:45-12:00		Mendoza-Quiroz Sandra*, Ramírez-Tapia Gandhi G., Tecalco-Rentería Raúl, Escalante-Mancera Edgar, Petersen Dirk, Banaszak Anastazia T.	THE IMPACT OF SHORT-TERM, LOCAL STRESSORS ON SEXUAL RECRUITS OF REEF-BUILDING CORALS.
12:00-1:30	**LUNCH BREAK**		
1:30-1:45	Climate Change & Other Stressors	Emily R. Hall*, Alexandra Fine, Lindsay Arick, Erinn Muller	COASTS – CLIMATE AND OCEAN ACIDIFICATION SIMULATION TANK SYSTEM IN THE FLORIDA KEYS
1:45-2:00		Emily R. Hall*, Lindsay Arick	CAN SEAGRASS AMELIORATE CORAL PHYSIOLOGICAL PERFORMANCE UNDER OA CONDITIONS?
2:00-2:15		Suarez-Ulloa, Victoria, Rivera-Casas, Ciro, Michel, Michelot, Erin-Lopez, Jose*	SEASONAL DNA METHYLATION VARIATION IN THE FLAT TREE OYSTER ISOGNOMON ALATUS FROM A MANGROVE ECOSYSTEM IN NORTH BISCAYNE BAY, FLORIDA
2:15-2:30		Holly Trew*(**S**), Henri Vallès	ABUNDANCE, DISTRIBUTION, AND GROWTH OF THE EXCAVATING SPONGE CLIONA DELITRIX ON BARBADOS' SOUTH AND WEST COASTS
2:30-2:45		Agudo-Adriani, Esteban*, Ascanio Alfredo, Croquer, Aldo	GEOGRAPHIC DISTRIBUTION PATTERNS OF REEF FISH ASSEMBLAGES HIGHLIGHT THE IMPORTANCE OF CONSIDERING BROAD-SCALE SPATIAL PROCESSES

LIGHTNING TALKS -TUESDAY NIGHT

PM Hours	Tuesday		
	Authors	**Institution**	**Talk Title**
7:15-7:20	Tali Vardi*	NOAA / Coral Restoration Consortium	Coral Restoration Consortium
7:20-7:25	David Vaughan*	Plant a Million Corals	Micro-Fragmentation, Its not just for land-based nurseries anymore.
7:25-7:30	Ximena Escovar*	The Nature Conservancy	Building Resilient Reefs of the Future: Innovative Coral Restoration and Monitoring in the U.S. Virgin Islands.
7:30-7:40	Sarah Hamlyn*, Zachary Craig, Joey Mandara, Erich Bartels, Erinn Muller	Mote Marine Laboratory	Restoration within the stony coral tissue loss disease zone
7:40-7:45	Victor Galvan*, Rita Sellares, Camilo Cortez, Samantha Mercado, Susana Pernas	Grupo Puntacana Foundation	Evaluating Nursery and Transplantation Performance of the Network of Coral Nurseries within the Dominican Coastal Restoration Consortium (CDRC)
7:45-7:50	Samantha Mercado* y Victor Galvan	Grupo Puntacana Foundation	5 años de restauración a gran escala de arrecifes de coral en Punta Cana, R.D: alcances y retos.
7:50-7:55	Melina Soto*, Melanie McField, Nicole Craig, Ian Drsydale, Lisa Carne, Claudia Padilla	Healthy Reefs for Healthy People Initiative	Herbivory restoration in the Mesoamerican Reef
7:55-8:00	Kelly Latijnhouwers* and Valerie Chamberland	SECORE	Successful recruitment of A. palmata offspring mass-reared in in situ larval rearing pools.
8:00-8:05	Valérie Chamberland*, Kelly Latijnhouwers, Kristen Marhaver, Robbert-Jan Geertsma, Mark Vermeij	SECORE	Species Fact Sheets on the reproductive biology, early life history and larval propagation of Caribbean corals.
8:05-8:10	Pedro Chevalier*, Hansel Caballero, Raúl Corrada, Dorka Cobián, Juliet Gonzáles, Alexis Fernández, Miguel Pino.	Acuario Nacional de Cuba	Cultivo y propagación de corales pétreos para la restauración de arrecifes en Cuba
8:10-8:15	Samuel Suleiman*	Sociedad Ambiente Marino	Hope for the Reef: Rebuilding Coral Reef and Base Community Resilience in the Hurricane Highway
8:15-8:20	Claudia Padilla*, Eloy Ramírez, Andrés Morales, David González	INAPESCA CRIAP PUERTO MORELOS	Coral Reef Restoration Program in Mexico: Scaling up the efforts and the concepts

Poster Agenda

Monday, May 20th				
Day	**Poster Slot**	**Session**	**Authors**	**Presentation Title**
DAY 1	1	Coral reef disease and bleaching	Reia Guppy*, Christopher Ackbarali, Damien Ibrahim	ASSESSMENT OF PALYTOXIN ISOLATED FROM THE ZOANTHID PALYTHOA CARIBAEORUM
	2		Gina Hendrick*, Maureen Dolan, Tanja McKay, Paul Sikkel	ESTABLISHING DNA INTEGRITY WITHIN BLOOD MEALS OF FREE-LIVING STAGES OF FISH-PARASITIC GNATHIID ISOPODS (CRUSTACEA, ISOPODA, GNATHIIDAE) (**Student**)
	3		Abigail Knipp*, Justin Cory Pettijohn, Hiedi Hertler	INTERANNUAL AND INTERSPECIFIC VARIABILITY IN CORAL RESILIENCE TO THERMAL STRESS IN THE TURKS AND CAICOS ISLANDS DURING THE 2014-2017 GLOBAL CORAL BLEACHING EVENT (**Student**)
	4		Lima, L.F.O*, Alker, A., Bhavya, N.P., Morris, M., Edwards. R., de Putron, S., Dinsdale, E.A.	THE CORAL MICROBIOME OF PSEUDODIPLORIA STRIGOSA IS SPECIFIC TO EACH REEF ZONE AND ENRICHED WITH HEAT SHOCK GENES IN FLUCTUATING ENVIRONMENTS IN BERMUDA (**Student**)
	5		David C. Papanu*, Michelle M. Dennis, Mark A. Freeman, Anne A.M.J. Becker	WHEN ASPERGILLUS IS MISSING IN SEA FAN ASPERGILLOSIS (**Student**)
	6		Anna L. Pleto*, Michelle M. Dennis, Alexandra Gutierrez, Kelsey Johnson, Mark A. Freeman, Anne A.M.J. Becker	INSIDE THE PURPLE SPOT: MICROSCOPIC AND MOLECULAR APPROACH TO MULTIFOCAL PURPLE SPOTS IN SEA FANS (**Student**)
	7		Raquel Xavier, Ana Pereira, Andres Pagan, Gina Hendrick*, Matthew Nicholson, Daniela Rosado1, Marta Soares, Marcos Perez-Losada, Paul Sikkel	ENVIRONMENT AND ONTOGENY ARE THE MAIN DRIVERS FOR SKIN MICROBIOME OF DAMSELFISHES OF STEGASTES ADUSTUS AND STEGASTES LEUCOSTICTUS (**Student**)
	8	Marine Population Connectivity in the Caribbean	Kourtney Barber*, Michael Middlebrooks, Susan Bell, Sidney Pierce	CHLOROPLAST IDENTIFICATION AND FEEDING SPECIFICITY OF THE SACOGLOSSAN SEA SLUG ELYSIA PAPILLOSA (**Student**)
	9		Sara Casareto*, Michael Middlebrooks	GROWTH RATE AND SURVIVAL RATES OF JUVENILE ELYSIA SUBORNATA SEA SLUGS VARY DEPENDING ON ALGAL DIET (**Student**)
	10		Ron I. Eytan	ISLAND HOPPING: CORAL REEF FISH PHYLOGEOGRAPHY ACROSS THE CARIBBEAN
	11		Edwin A. Hernández-Delgado*, Carlos Toledo-Hernández, Claudia P. Ruíz-Díaz, Nicolás X. Gómez Andújar, Kristian Ortiz, Juan S. Requena, Juan L. Sánchez, Samuel E. Suleimán-Ramos	THE ROLE OF DISTURBANCE IN THE DISPERSION OF THE INVASIVE SEA VINE, HALOPHILA STIPULACEA

	12		Lowell Andrew R. Iporac*, Samantha Olszak, Lauren Saqui, Phillip Cifuentes, Ligia Collado-Vides	PILOTING A CITIZEN SCIENCE APPROACH TO MONITOR PELAGIC SARGASSUM LANDINGS IN SOUTH FLORIDA (**Student)**
	13		Nathan K. Truelove, Stephen J. Box, Karl Aiken, Azra Blythe-Mallett, Erik Boman, Catherine J. Booker, Tamsen T. Byfield, Martha H. Davis, Gabriel Delgado, Bob A. Glazer, Sarah Griffiths, Kimani A. Kitson-Walters*, Andy S. Kough, Adam S. Candy, Ricardo Pérez Enríquez, Marcia E. Roye, Iris Segura-García, Mona K. Webber, Allan W. Stoner	SPATIAL GENETIC STRUCTURE OF THE OVERHARVESTED QUEEN CONCH FISHERY IN THE CARIBBEAN WITH A FOCUS ON THE JAMAICAN FISHERY
	14	**Marine Population Connectivity in the Caribbean**	Michael Middlebrooks*, Nicholas Curtis, Sidney Pierce	THE ALGAL FOOD SOURCE AND SYMBIOTIC CHLOROPLAST DONOR OF THE SACOGLOSSAN SEA SLUG ELYSIA CRISPATA VARIES THROUGHOUT THE CARIBBEAN
	15		Daniela Sánchez*, Esteban Agudo-Adriani, Alfredo Ascanio, Aldo Croquer	STATUS OF LIONFISH (PTEROIS VOLITANS) ALONG THE VENEZUELAN COAST: 10 YEARS AFTER THE FIRST REPORT OF INVASION (**Student**)
	16		Lauren Twele*, Rachel Moline, Michael Middlebrooks	A COMPARISON OF PHOTOTAXIC BEHAVIOR IN PHOTOSYNTHETIC AND NON-PHOTOSYNTHETIC SACOGLOSSAN SEA SLUGS (**Student**)
	17		Omar M. Zayas Cruz*, Nikolaos V. Schizas	POPULATION CONNECTIVITY OF THE COMMON OCTOPUS (OCTOPUS VULGARIS) IN PUERTO RICO AND MANAGEMENT IMPLICATIONS (**Student**)
	18		Marcio Aronne*, Víctor Galván	RESTAURANDO *ACROPORA CERVICORNIS* USANDO VARIAS ESTRUCTURAS DE JARDINES DE CORAL EN EL MONUMENTO NATURAL MARINO ARCHIPIÉLAGO CAYOS COCHINOS
	19		Pedro P. Chevalier,* Hansel Caballero, Raúl I. Corrada, Alexis Fernandez	CULTURE AND PROPAGATION OF STONY CORALS FOR REEF RESTORATION IN CUBA
	20	**Reef restoration and resilience**	Raúl Igor Corrada Wong*, Pedro Pablo Chevalier Monteagudo, Dorka Cobián Rojas, Hansel Caballero Aragón	"LIONFISH PTEROIS VOLITANS / MILES (TELEOSTEI: SCORPAENIDAE) TOURNAMENTS IN CUBA, AN OPTION FOR THE CONTROL AND HANDLING OF THIS SPECIES"
	21		Joseph Pollock, Ximena Escovar-Fadul*	THE NATURE CONSERVANCY'S CORAL STRATEGY IN THE CARIBBEAN
	22		Jaime S. Fonseca-Miranda,* Alex E. Mercado-Molina, Claudia P. Ruiz-Diaz, Alberto Sabat	SPATIOTEMPORAL PATTERNS OF PARTIAL MORTALITY IN THE THREATENED CORAL ACROPORA CERVICORNIS
	23		Peter M. H. Gayle*, D-L. Smith, G-M Maddix, A. Cox, R. McKenzie, B. Marsally, M.K. Webber	EX-SITU PROPAGATION OF CORAL MICRO-FRAGMENTS IN JAMAICA – (PRELIMINARY) LESSONS LEARNED
	24		Cassidy Gilmore*, Dr. Kevin Strychar	ON THE BRINK OF EXTINCTION: STAGHORN CORAL

	25	**Reef restoration and resilience**	Edwin A. Hernandez-Delgado, Yanina M. Rodriguez-Gonzalez*, Frances Candelas Sanchez, Samuel E. Suleiman-Ramos	THE RACE BETWEEN DESPAIR AND HOPE: A SUCCESSFUL STORY OF CORAL REEF RESTORATION AND NATURAL RECOVERY FOLLOWING TWO MAJOR HURRICANES IN PUERTO RICO
	26		Catalina Morales-Ruiz*, Francisco González Casañas, Manuel Nieves, Ernesto Weil	SCLERACTINIAN CORALS, OCTOCORALS AND HYDROCORALS ASSOCIATED WITH MANGROVE ROOTS IN LA PARGUERA NATURE RESERVE, PUERTO RICO (**Student**)
	27		Neely, Karen L*, Lewis, Cindy, Chan, Andie, Baums, Iliana	BREEDING BABY UNICORNS: ASSISTED REPRODUCTION OF PILLAR CORAL IN FLORIDA
	28		Manuel F. Olmeda-Saldana*, Stacey M. Williams, Juan J. Cruz-Motta	DIADEMA ANTILLARUM GRAZING EFFECTS ON ALGAL/BENTHIC COVER AND DIVERSITY IN LA PARGUERA, SOUTHWESTERN PUERTO RICO
	29		Rempel, Hannah S.*, Bodwin, Kelly N., Ruttenberg, Benjamin I.	RECOVERY OF THREATENED ORBICELLA ANNULARIS CORALS FROM PARROTFISH PREDATION WITHIN AND OUTSIDE OF A CARIBBEAN MARINE RESERVE (**Student**)
	30		Javier Rodriguez-Casariego*, Alex Mercado-Molina, Alberto Sabat, Jose Eirin-Lopez	ROLE OF EPIGENETIC MODIFICATIONS MEDIATING CORAL ACCLIMATORY RESPONSES DURING POST-HURRICANE MARIA RESTORATION EFFORTS IN CULEBRA, PUERTO RICO (**Student**)
	31		Ernesto Weil*, Nicholas M. Hammerman, Rebecca L. Becicka, Juan J. Cruz Motta	GROWTH AND MORTALITY DYNAMICS OF ACROPORA CERVICORNIS AND A. PROLIFERA IN SOUTHWEST PUERTO RICO
	32		Samantha Mercado y Victor Galvan	IMPACTO DE LA VEDA TEMPORAL DEL PEZ LORO EN TRES LOCALIDADES CON DISTINTO REGIMEN DE PROTECCION EN REPUBLICA DOMINICANA.
Tuesday May 21st				
DAY 2	1	**Human related issues including fisheries**	Laura Abreu Nicolas	USING ENVIRONMENTAL DNA TO STUDY SHARK DIVERSITY IN THE LA PARGUERA NATURAL RESERVE, PUERTO RICO (**Student**)
	2		Natalie Baez Rodriguez	IDENTIFICATION OF SPOTTED EAGLE MANTA RAYS IN PUERTO RICO USING ENVIRONMENTAL DNA (**Student**)
	3		Frances Candelas*, Pedro Alejandro, Jaime Fonseca, Samuel Suleiman, Edwin Hernandez	EL CASO DE LA RESERVA NATURAL CANAL DE LUIS PEÑA: UN EJEMPLO DE LA IMPORTANCIA DEL TERCER SECTOR EN LOS ESFUERZOS DE CONSERVACION
	4		Chauntelle Green*, Hugh Small, Suzanne E. Palmer	USAGE AND DISPOSAL PATTERNS OF VISITORS TO THE UWI PORT ROYAL MARINE LABORATORY, JAMAICA
	5		Noel Heinsohn	FROM START TO SETTLEMENT, STARTING A MARINE ORNAMENTAL HATCHERY IN THE

	6		Noel Heinsohn*, Jose David Munoz	FROM COLLECTION TO REPRODUCTION, WORKING WITH *ELACATINUS* SP. IN THE
	7		Ana Carolina Hernández-Oquet*, Andreina Valdez-Trinidad	PRELIMINARY EVALUATION OF THE CORAL REEFS OF LAS TERRENAS (SAMANÁ PROVINCE), EL MORRO NATIONAL PARK AND BUEN HOMBRE (MONTECRISTI PROVINCE), DOMINICAN REPUBLIC (**Student**)
	8		Martínez-Fuentes Alexandra*, Gutiérrez-Lince Ma. Jimena, Dorantes Michelle, Restrepo Jaime, Valverde Roldán	SEA TURTLE RESEARCH AND CONSERVATION STRATEGIES: 60 YEARS OF THE SEA TURTLE CONSERVANCY PROGRAM AT TORTUGUERO, COSTA RICA
	9		Fernando Melendez*, Manuel Olmeda, Juan Cruz, Dahiana Arcila, Ricardo Betancur	EFFECTS OF THE HURRICANE MARIA IN HAMLET COMMUNITIES (HYPOPLECTRUS SPP., SERRANIDAE) IN PUERTO RICO (**Student**)
	10		Steffanie Munguia	WISER USE: CONSERVING BIODIVERSITY WITH COASTAL BLUE CARBON IN THE CARIBBEAN (**Student**)
	11	**Human related issues including fisheries**	Alexander Navarro*, Leandra Cho-Ricketts	USING UNDERWATER LASER AND VIDEO TECHNIQUES TO MONITOR NASSAU GROUPER SPAWNING AGGREGATIONS (SPAGS) IN BELIZE
	12		Melinda Paduani*, Michael Ross	PLASTIC SINKS OR SOURCES: CHARACTERIZING CYCLING OF PLASTIC ON MANGROVE SHORELINES IN BISCAYNE BAY, FL (**Student**)
	13		Karen Pannocchia, Benjamin Schapiro, Ronald Savage*	USAID'S HISTORICAL SUPPORT FOR MARINE PROTECTED AREAS IN THE REGION AND COMMON CHALLENGES
	14		Serrano Jerez, María de los Ángeles	CIENCIA, EDUCACIÓN Y DIVULGACIÓN PARA EL DESARROLLO SOSTENIBLE…55 AÑOS DE EXPERIENCIA EN EL ACUARIO NACIONAL DE CUBA
	15		Mauricio Solano	FINANCIAL MECHANISM FOR THE CONSERVATION OF CORAL REEFS IN THE DOMINICAN REPUBLIC
	16		Samuel E. Suleiman Ramos*, Frances Candelas Sanchez, Alex E Mercado Molina, Edwin A. Hernandez Delgado, Jaime S Fonseca Miranda	ALLIANCES OF CITIZEN SCIENCE BASED ON THE COMMUNITY: AN EFFICIENT STRATEGY FOR THE MANAGEMENT AND CONSERVATION OF COASTAL RESOURCES.
	17		Kristie Alleyne, Henri Vallès*	THE BEHAVIOR OF TWO SYMPATRIC CARIBBEAN CLEANER GOBIES (ELACATINUS PROCHILOS AND ELACATINUS EVELYNAE) ON CORAL AND SPONGE SUBSTRATES
	18		Cory Walter	"EYES ON AND UNDER THE WATER." THE IMPORTANCE OF CITIZEN SCIENCE FOR MARINE RESEARCHERS IN THE FLORIDA KEYS
	19		Someira Jeniree Zambrano Romero	DOMINICAN REEF NETWORK (RAD), A CORAL REEF CONSERVATION ALLIANCE

	20	**Reef monitoring – AGRRA: Science to Action**	Alejandro José Bravo-Jiménez*, Aldo Cróquer	PREDICTING THE SPATIAL DISTRIBUTION OF BENTHIC CORAL COMMUNITIES IN VENEZUELA: A VALUABLE TOOL FOR MANAGEMENT (Student)
	21		Ana Herrera-Reveles*, Anaurora Yranzo, Hazael Boadas, Jeannette Perez, Samuel Narciso and Estrella Villamizar	CORAL REEF FISH COMMUNITIES ASSESSMENT AT MORROCOY NATIONAL PARK AND CUARE WILDLIFE REFUGE, VENEZUELA
	22		Judith C. Lang*, Giselle Hall, Kenneth W Marks, Lynnette X. Roth, John Knowles, Patricia R. Kramer, Philip A. Kramer	THE CARIBBEAN MARINE BIODIVERSITY PROGRAM
	23		Miyazawa, E.*, Agudo-Adriani, E., Mariño-Briceño, G., Ascanio, A., Montilla, L.M., Cróquer, A.	ON THE IMPORTANCE OF SPATIAL SCALES ON CORAL ALPHA AND BETA DIVERSITY: A CASE STUDY FROM VENEZUELAN CORAL REEFS (Student)
	24		Montilla, L.M.*, Miyazawa, E., Agudo-Adriani, E., Ascanio, A., López-Hernández, M., Rebolledo, Z., Rivera, A., Sánchez, D., Verde, A., Croquer, A.	TRANSECTS, QUADRATS OR POINTS: WHAT IS THE BEST COMBINATION TO GET A MORE PRECISE DESCRIPTION OF A CORAL COMMUNITY?
	25	**Historical Ecology & Mangrove and Seagrass Ecosystems**	Miguel Figuerola*, Matthew Lucas, Michael Moul, Ernesto Weil	DIFFERENTIAL IMPACTS OF HURRICANE MARIA IN ACROPORA CERVICORNIS THICKETS OFF LA PARGUERA NATURAL RESERVE ACROSS SMALL SPATIAL SCALES (< 3 KM) (**Student**)
	26		Lowell Andrew R. Iporac*, Manny Vera, Ligia Collado-Vides	ASSESSING INVERTEBRATE HABITAT PREFERENCE IN A SHALLOW TROPICAL COASTAL BAY (**Student**)
	27		Jimena Samper-Villarreal, Margarita Loría-Naranjo, Brigit van Tussenbroek*, Jorge Cortés	SYRINGODIUM FILIFORME SEAGRASS REPRODUCTIVE SEASONALITY IN A TROPICAL CARIBBEAN REEF LAGOON
	28		Andreina Valdez-Trinidad*, Ana Carolina Hernandez-Oquet	PRELIMINARY EVALUATION OF THE SEAGRASS BEDS OF LAS TERRENAS (SAMANÁ PROVINCE) AND EL MORRO NATIONAL PARK (MONTECRISTI PROVINCE), DOMINICAN REPUBLIC (**Student**)
	29		Evan Tuohy, Christina Wade, Ernesto Weil*	POPULATION STATUS OF THE LONG-SPINED SEA URCHIN DIADEMA ANTILLARUM PHILIPPI IN LA PARGUERA, PUERTO RICO, 30 YEARS AFTER THE MASS MORTALITY
	30	**Novel Techniques in Remote Sensing and Reef Science**	Laura Angélica Niño-Torres*, Rodolfo Rioja-Nieto, Roberto Carlos Hernández-Land	HYPERSPECTRAL CHARACTERIZATION OF CORAL REEF-FORMING SPECIES OF COZUMEL ISLAND, MEXICO
	31	**Climate Change and Other Stressors**	López-Hernández, María A.*, Ramos, Ruth, Montilla, Luís M., García, Elia, Cróquer, Aldo	DETOXIFICATION IN HEALTHY CORALS, DISEASE AND ZOOXANTHELLAE DURING AND AFTER STRESS BY TO XENOBIOTICS

	32		López-Hernández, María A.*, Montilla, Luís M., Verde, Alejandra, Agudo-Adriani, Esteban, Rivera, Andreína, Miyazawa, Emy, Mariño, Gloria, Ascanio, Alfredo, Cróquer, Aldo	VENEZUELAN CORAL REEFS: A HEALTH ASSESSMENT USING THE REEF HEALTH INDEX WITH COMPLEMENTARY VARIABLES
	33		Cróquer, A., Cappelletto, J., Agudo-Adriani, E., Mariño-Briceño, G.*	LACK OF RECOVERY OF LIFE CORAL COVER IN MORROCOY (VENEZUELA): AN APPLICATION OF 3D BENTHIC MODELS TO UNDERSTAND KEY PROCESSES
	34		Michael Martinez-Colon*, Angelique Rosa-Marin, Charles Jagoe, Cherryl Woodley	FORAM INDEX AND ITS APPLICABILITY IN CORAL REEF MONITORING IN PUERTO RICO
	35		Martínez-Fuentes Alexandra*, Restrepo Jaime, Valverde Roldán	INCIDENCE OF CONGENITAL MALFORMATIONS IN EMBRYOS OF GREEN SEA TURTLE (CHELONIA MYDAS) DURING 19 YEARS AT TORTUGUERO, COSTA RICA
	36		Holly Trew*, Henri Vallès	EXPERIMENTAL ESTIMATION OF GROWTH RATES OF THE EXCAVATING SPONGE CLIONA DELITRIX IN BARBADOS (**Student**)

ORAL ABSTRACT

Session: *Coral Reef Disease and Bleaching*

SPATIAL EPIDEMIOLOGY OF THE STONY CORAL TISSUE LOSS DISEASE OUTBREAK IN FLORIDA

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Florida's coral reefs are currently experiencing a multi-year disease-related mortality event that has resulted in the massive die-off of colonies from multiple coral species. First observed near Virginia Key in late 2014, Stony-Coral-Tissue-Loss Disease (SCTLD) has since spread to the northernmost extent of the Florida reef tract and south into the lower Florida Keys. The present study investigated the epizootiology of the disease throughout the Florida reef tract. Data sources were compiled by Florida Fish & Wildlife Research Institute's Center for Spatial Analysis and focused on disease surveys from 2015 to 2017. The analyses were conducted over a large (10s of km) spatial area on annual timeframes to assess the broad-scale patterns of the disease. A dispersion model applied to the data showed the same rate of spread for both the northern and southern disease fronts. A Bayesian general linear model was used to determine which ecological variables may have influenced disease presence. Sites with SCTLD often had higher coral diversity and greater depth than sites without the disease. We also tested whether the disease outbreak followed a predictable contagion model using a modified Ripley's K analysis. Significant clusters were evident up to 40 km in radius during the outbreak, suggesting that the disease cluster was approximately 80 km in diameter. Our results also suggest that more diverse and deeper reefs were more susceptible to SCTLD, that the disease dispersed north and south from the initial outbreak at an equal rate, and followed the dynamics of a contagious disease, with an epicenter spanning over an 80 km diameter within a single year.

Keywords: stony coral tissue loss disease, Florida reef tract, spatial epidemiology, Bayesian model, Ripley's K, coral disease

ECOLOGY OF A TISSUE LOSS DISEASE(S) AFFECTING MULTIPLE SPECIES OF CORALS ALONG THE FLORIDA REEF TRACT

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An ongoing outbreak of tissue loss disease(s), collectively termed stony coral tissue loss disease (SCTLD), affecting multiple species of corals has resulted in significant mortality along the Florida Reef tract. SCTLD is unique, in that, disease signs vary among affected coral species with differences in rates of tissue loss and lesion occurrence. This suggests that there may be multiple etiologies and/or differential host response and susceptibility. However, little was known about the ecology of the disease. We examined coral species exhibiting different manifestations of tissue loss lesions (subacute and acute) from two regions in Florida (Ft. Lauderdale and Marathon in the Florida Keys). Using manipulative studies, the transmission rates for each lesion type and differences in susceptibility among multiple coral species were determined. When healthy Montastrea cavernosa, Orbicella faveolata and Porites astreoides were tested with diseased M. cavernosa (subacute lesions), O. faveolata had a 100% rate of disease transmission upon physical contact and a 40% transmission rate (waterborne) in non-touching fragments. M. cavernosa, exposed to the same lesions, had a 30% transmission rate with contact but only 10% of non-touching fragments developed lesions. In contrast, P. astreoides appeared to be more disease resistant with no apparent disease transmission during the 11-day experiment. Diseased Colpophyllia natans (acute lesions) from the Florida Keys transmitted comparatively faster to M. cavernosa and Meandrina meandrites with each having a 100% transmission rate after 3-4 days of contact. Waterborne transmission also occurred, with a 60% and 100% transmission rate, to M. cavernosa and M. meandrites, respectively. A therapeutic diagnosis approach using antibiotics was implemented to determine whether bacteria were involved in the disease. Diseased fragments of all species tested, whether with subacute or acute lesions, responded to antibiotic treatment with a cessation or slowing of lesion progression suggesting that bacteria are involved with SCTLD.

Un brote continuo de enfermedad (s) de pérdida de tejido, denominada colectivamente enfermedad de pérdida de tejido de coral pedregoso (SCTLD, por sus siglas en inglés), que afecta a múltiples especies de corales, ha resultado en una mortalidad significativa a lo largo del tracto del arrecife de Florida. El SCTLD es único, ya que los signos de la enfermedad varían entre las especies de coral afectadas con diferencias en las tasas de pérdida de tejido y la aparición de lesiones. Esto sugiere que puede haber múltiples etiologías y / o respuestas y susceptibilidad diferenciales del huésped. Sin embargo, poco se sabía sobre la ecología de la enfermedad. Examinamos las especies de coral que muestran diferentes manifestaciones de lesiones de pérdida de tejido (subagudas y agudas) de dos regiones en Florida (Ft. Lauderdale y Marathon en los Cayos de Florida). Usando estudios de manipulación, se determinaron las tasas de transmisión para cada tipo de lesión y las diferencias en la susceptibilidad entre múltiples especies de coral. Cuando se probó la sana Montastrea cavernosa, Orbicella faveolata y Porites astreoides con M. cavernosa enferma (lesiones subagudas), O. faveolata tuvo una tasa del 100% de transmisión de la enfermedad al contacto físico y una tasa de transmisión del 40% (a base de agua) en fragmentos no tocantes. M. cavernosa, expuesta a las mismas lesiones, tuvo una tasa de transmisión del 30% con el contacto, pero solo el 10% de los fragmentos sin contacto desarrollaron lesiones. A diferencia de. P. astreoides pareció ser más resistente a la enfermedad sin transmisión aparente de la enfermedad durante el experimento de 11 días. Colpophyllia natans enfermas (lesiones agudas) de los

Cayos de Florida se transmitieron comparativamente más rápido a los meandritos de M. cavernosa y Meandrina, y cada uno tiene una tasa de transmisión del 100% después de 3-4 días de contacto. También se produjo transmisión por agua, con una tasa de transmisión del 60% y 100%, a M. cavernosa y M. meandrites, respectivamente. Se implementó un enfoque de diagnóstico terapéutico con antibióticos para determinar si las bacterias estaban involucradas en la enfermedad. Fragmentos enfermos de todas las especies analizadas, ya sea con lesiones subagudas o agudas, respondieron al tratamiento con antibióticos con un cese o ralentización de la progresión de la lesión, lo que sugiere que las bacterias están involucradas con el SCTLD.

Keywords: Florida, stony coral tissue loss disease, disease ecology, disease transmission, antibiotics, diagnosis

DIFFERENCES IN MORTALITY RATE AMONG CORAL SPECIES AFFECTED BY SCTLD IN TWO REGIONS ALONG THE FLORIDA REEF TRACT

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Florida's coral reefs are experiencing an ongoing multi-year outbreak of stony coral tissue loss disease (SCTLD). Unique in its large geographic range, extended duration, high rates of mortality, and the number of species affected, this outbreak has resulted in significant mortality along the Florida Reef tract. Additionally, rates of tissue loss vary among affected coral species, suggesting that there may be multiple etiologies and/or differential host response and susceptibility. To determine rate of tissue loss in-situ, we tagged and tracked individual colonies. One set focused on corals in the Ft. Lauderdale region, mostly Montastraea cavernosa, displaying subacute tissue loss lesions, and the other set was monitored in the Middle Florida Keys where corals displayed acute tissue loss lesions. We determined the rate of tissue loss by visually estimating a percent overall loss for each colony by month. Colony mortality and disease prevalence were followed through time. In Ft. Lauderdale, tagged M. cavernosa colonies with subacute lesions lost an average of 2.8% of their tissue per month and had a case fatality rate of 15% after 12 months. All 20 tagged colonies had active disease lesions at the start of the study (July 2017) and the disease remained active on 19 colonies through November 2017. Disease prevalence started to decline in December 2017 and by March 2018, only 4 colonies had active lesions. Rate of tissue loss followed a similar pattern with a higher rate until December 2017 (2.3% tissue per month) and then declined (0.26% tissue per month). We found a much different pattern of disease progression on the tagged colonies with acute tissue loss in the middle Florida Keys- Tagged colonies in this region had a higher rate of mortality with 42% of 21 colonies dead within one month and 90.5% of the colonies dead after seven months.

CHARACTERIZATION OF THE MICROBIOME OF CORALS WITH STONY CORAL TISSUE LOSS DISEASE

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In 2014, a coral disease outbreak emerged off the coast of Miami, Florida, USA, which is now canonically referred to as Stony Coral Tissue Loss Disease (SCTLD). Along the Florida Reef Tract (FRT), coral reefs have succumbed to numerous disease outbreaks. However, SCTLD has shown an alarming prevalence and has spread quickly north and south throughout the FRT. Over 20 species of coral have displayed SCTLD lesions, which often corresponds with the subsequent death of the coral. As a means to characterize potential pathogens that may cause SCTLD, we collected tissue samples from four affected coral species (Dichocoenia stokesii, Diploria labyrinthiformis, Stephanocoenia intersepta, Meandrina meandrites). Tissue samples were from apparently healthy corals, diseased coral lesions, and unaffected tissue of diseased corals. Samples were collected from 3 regions: (1) The Upper Florida Keys (SCTLD was previously present “Post-invasion zone”), (2) the Middle Florida Keys (SCTLD was active a nd prevalent, “Invasion zone”), and (3) the Lower Florida Keys (SCTLD was not reported, “Pre-invasion zone”). In addition, from each site, sediment and water samples were taken to try to identify a source of disease spread. We used high-throughput sequencing methods to sequence the 16S rRNA gene and bioinformatics analysis to characterize the microbiome of these corals, water, and sediment samples. Across all coral species, we identified a relatively higher abundance of the bacteria orders Rhodobacterales and Rhizobiales in diseased tissue compared to healthy colonies and unaffected tissue on diseased colonies. Also, our results showed relatively higher abundances of Rhodobacterales in water from sites with active disease (the Middle Keys). Our data indicate that Rhodobacterales and Rhizobiales may play a role in SCTLD and that disease may be disseminated through the water column.

Keywords: tissue-loss, disease, Rhodobacterales, Rhizobiales, high-throughput sequencing

RECOVERY POTENTIAL FOLLOWING A REGIONAL STONY CORAL DISEASE OUTBREAK ALONG THE SOUTHEAST FLORIDA REEF TRACT (**Student**)

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Coral reefs have declined globally due to anthropogenic stressors and the increased frequency and severity of bleaching and disease events. In 2014, a stony coral tissue loss disease (SCTLD) outbreak

was reported off the coast of southeast Florida and subsequently spread throughout the region. Stony coral demographic data from the Southeast Florida Reef Evaluation and Monitoring Project (SECREMP) were used to examine the regional impacts of the disease event on the southeast Florida stony coral population. SECREMP is a long-term monitoring project consisting of 22 sites from Miami-Dade County north to Martin County. Regional SCTLD prevalence increased significantly and significant, region-wide declines in stony coral diversity, and density were observed with up to 64% of live tissue area lost as a result of the disease event. Multiple species were severely impacted with 11 of 29 total species in the sample sites recorded with SCTLD including reef building, complexity-contributing species *Montastraea cavernosa* and *Meandrina meandrites*. With the disease predominantly affecting larger adult colonies, recovery from this event may be dependent on the current juvenile population. Preliminary results show juvenile diversity similar to the adult diversity found before the disease event, indicating that the juvenile population will be vital for recovery.

TREATMENT OF CORAL DISEASES: HISTORICAL PERSPECTIVES, MODERN EFFORTS, AND FUTURE DIRECTIONS

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As stony coral tissue loss disease (SCTLD) leaves extensive mortality in its wake across the Florida Reef Tract, a slew of intervention techniques have been trialed in efforts to protect infected colonies. Laboratory and field tests have explored traditional treatment options (smothering and chlorinated firebreaks) as well as more innovative techniques (amputation and relocation, antibiotic delivery mechanisms, removal for treatment and safe housing in aquaria). Large scale efforts in partnership with former military divers have tested the most promising options on a large number of colonies. Success of treatments has varied with environmental conditions, size of lesions, and species. Though some treatments show short-term success, all intervention actions are currently being conducted at the level of individual lesions. Ideas for scaling up to colony or potentially reef-level treatments are considered in a cost-benefit and risk management scenario, balancing the known outcome of doing nothing with the unknown outcomes of novel treatment effects.

Keywords: disease, treatment, Florida, management

MULTIPLE SPECIES CORAL RESCUE IN RESPONSE TO THE STONY CORAL TISSUE LOSS DISEASE ON THE FLORIDA REEF TRACT

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The Florida Reef Tract (FRT) is experiencing an unprecedented disease outbreak described as Stony Coral Tissue Loss Disease (SCTLD). First reported near Miami in 2014, SCTLD has since spread to the northernmost extent of the FRT in Martin County and southwestward through the lower Florida Keys resulting in the mortality of thousands of colonies from >20 coral species, including primary reef builders and species listed under the Endangered Species Act. Efforts to identify the pathogen(s) of SCTLD, determine the mode(s) of transmission, and develop potential intervention techniques are currently underway, but our limited understanding of SCTLD greatly impedes management efforts to control the spread of this virulent disease. A multi-agency, multi-disciplinary Coral Rescue Team (CRT) was developed to: 1) design and implement a reef-tract wide coral collection plan for SCTLD-susceptible species, 2) preserve representative portions of the remaining genetic diversity of FRT corals in captivity, and 3) plan for future propagation, restoration and reintroduction of such corals to the wild. The CRT has determined priority target species for rescue, initiated pilot coral collections, developed coral care plans, and started delivery of rescued corals to Florida-based non-governmental organizations and universities as well as long-term housing facilities from the Association of Zoos and Aquariums outside Florida.

Keywords: Stony Coral Tissue Loss Disease

LONG-TERM SPATIAL AND TEMPORAL TRENDS IN OCTOCORAL DENSITY ON THE SOUTHEAST FLORIDA REEF TRACT (**Student**)

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In the Caribbean, global and local stressors have driven significant declines in primary reef-building corals. Following these declines, phase shifts towards macroalgal dominance has widely been observed; however, shifts towards corallimorph, sponge and octocoral dominance have also been reported. With stony coral cover rapidly declining along the southeast Florida Reef Tract (SEFRT), it is imperative to understand how stony coral loss and the drivers have affected other dominant reef constituents. This

study investigates long-term spatial and temporal trends in octocoral density, utilizing a long-term monitoring project in Broward County, Florida, USA. Analyses indicate spatial, temporal and short-term interactive effects on octocoral density. However, these effects do not appear to consistently associate with the decline in stony corals, suggesting that local drivers of stony coral decline may not be affecting the octocoral community to the same degree. Evidence suggests that this high-latitude reef system is a favorable habitat for octocorals, but a larger scale analysis is needed to determine if a phase shift is occurring on the SEFRT. The contribution of the octocorals community to overall reef health is in need of greater study. This study highlights the importance of understanding reef community dynamics with increasing global and local stressors.

Keywords: Coral Reef, Florida, Octocoral, Long-term

PATHOLOGY OF OPPORTUNISTIC FUNGAL INFECTIONS IN CARIBBEAN SEA FANS (GORGONIA SPP.) RESEMBLING PRIMARY ASPERGILLOSIS

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Aspergillosis of sea fans is a Caribbean-wide disease caused by Aspergillus sydowii infection. It is typically diagnosed from the observation of focal annular purple pigmentation surrounding an area of tissue loss. We hypothesized that such lesions are not unique to aspergillosis and represent a nonspecific host response to other injuries. Biopsies were collected from 20 Gorgonia spp. sea fans showing lesions grossly consistent with aspergillosis in shallow fringing reefs of St. Kitts. Histologically, the tissue loss margin was heavily befouled and often bordered by amoebocyte infiltrate. The purple pigmented area consistently showed intra-axial fungal hyphae of varying severity, but morphologically uniform and consistent with Aspergillus and many other genera of fungi. Co-infection was almost always present in the purple pigmented areas, including algae, cyanobacteria, and labyrinthulomycetes. Algae infection was most predominant, extending from the peri-axial region into the tissue and often bordered by amoebocyte infiltrate. In contrast, fungal infection was typically confined to the axis with little host response. At the lesion interface with apparently-healthy tissue, there was polyp necrosis and loss, and sometimes ciliate protists were present while algae, cyanobacteria, labyrinthulids, and fungal hyphae were diminished and often absent. Penicillium spp. were isolated from cultures on glucose peptone yeast agar, indicating that other species of fungi may infect sea fans and cause similar gross and microscopic lesions. The presence of mixed microorganisms, and polyp necrosis and loss of uncertain etiology away from the site of infection, suggest that the fungal infections are opportunistic. This study emphasizes the importance of using a standardized biomedical approach to disease diagnosis in corals, and the possibility of misclassification when relying on macroscopic field diagnoses. Further research is needed to better understand the role of fungal pathogens and coinfection dynamics in sea fan diseases.

Keywords: pathology, octocorals, soft corals, mycology, protists

HOST IDENTIFICATION BY SEQUENCING DNA WITHIN BLOOD MEALS OF THE CARIBBEAN GNATHIID ISOPOD, GNATHIA MARLEYI (**Student**)

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Among parasitic arthropods infecting coral reef fishes, members of the family Gnathiidae are the most common. Parasitic gnathiid isopods have three juvenile stages, during which they briefly attach to a host to obtain a blood meal, directly impacting their hosts by removal of vital fluids. Like terrestrial blood-feeding arthropods, gnathiids have the potential to indirectly impact hosts through the transmission of blood-parasites or facilitating infection. Because gnathiids spend most of their time living in the substrate, it is difficult to determine patterns of host exploitation. While gnathiids are considered host generalists, some host species may be more susceptible or heavily exploited than others. All known hosts of the gnathiid isopod, Gnathia marleyi, have previously been identified using wild-caught or caged fish. Thus, our knowledge of host-parasite interactions is limited to those species that are abundant and easy to capture. Previously, hosts of G. marleyi had been confirmed from 9 families, including 19 species. During their free-living stages, including fed (praniza) stages, gnathiids can be easily collected using lighted plankton traps. In this study, we collected gnathiid isopods using lighted plankton traps at multiple field sites in the Caribbean. This included gnathiids that had fed on wild hosts. Using DNA extracted from the blood meals of fed gnathiids, the mitochondrial target gene cytochrome c oxidase subunit 1 (COI) was sequenced to identify the blood meal source. In this study, 27 host species from 10 families were identified by sequencing of host DNA within gnathiid blood meals, bringing the total number of identified hosts of G. marleyi to 37 species from 14 families.

Keywords: Marine parasite, DNA degradation, Blood meal analysis, COI barcoding

ENERGETIC CONTRIBUTIONS OF A COMMON FISH ECPARASITE TO CARIBBEAN CORAL REEFS (**Student**)

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Historically, parasites have rarely been included in food web studies, despite their ubiquity in many ecosystems. Focus has instead generally been on pathways of “direct consumption”, such as predation. However, recent studies suggest that parasites are indeed a critical component of many systems. In ocean systems, gnathiid isopods are the most common ectoparasites of marine reef fishes, infecting multiple host species across three developmental instar stages. Yet, their contributions to consumptive pathways remains unquantified for most communities and ecosystems. The aim of this study was to

compare nutrient/energy flow from consumption of damselfish biomass by predators with that consumed by gnathiid isopods. To address this, adult damselfish were tagged and monitored in their territories over a 1-2 month period to estimate predation rates. To complement this, daily gnathiid infestation rates were estimated by placing caged damselfish on the reef for 45-minute intervals during each of eight time segments equally spaced throughout the diel cycle. While parasite infestation varied among sites (ranging from 17.64 parasites/24h to 108.2 parasites/24h), the estimated biomass transfer exceeded that of predation (88% survival, n=131) by a factor of 6. Further, though there was variation among sites with regard to parasite infestation, all sites showed a substantially higher biomass transfer by gnathiids relative to predators. We view these results as further evidence that fish-parasitic gnathiid isopods contribute significantly to coral reef trophic dynamics.

Session: Sargassum and Other Harmful Algae

NEXT-GENERATION APPROACHES TO UNDERSTANDING THE HOLOPELAGIC SARGASSUM HOLOBIOME

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The genus Sargassum includes over 350 primarily benthic species with only two recognized holopelagic representatives. Massive accumulations and strandings of holopelagic species of Sargassum on Caribbean, western African and Brazilian shores have reawakened interest in this important yet understudied brown macroalga that has been dubbed "the golden floating rainforest of the Atlantic Ocean". A rare form of *S. natans* referred to as *S. natans* VIII by Parr in the 1930's has been identified as a form accumulating in unprecedented quantities, but until only recently, no genomic data were available for any holopelagic Sargassum species. Our laboratory has been applying comparative genomics on known forms of the Sargassum holopelagic species: *S. fluitans* III and *S. natans* I, alongside the formerly rare, *S. natans* VIII to elucidate the relationships between the different forms, with the goal of producing population genomics markers to delineate different populations and sources of the strandings. As seen with species of benthic Sargassum from Asia, comparative organellar genomics is useful in differentiating between Atlantic Sargassum species, however the holopelagic forms are very closely related compared to their benthic cousins. Despite gene synteny and high sequence conservation, the holopelagic Sargassum species differ in their ecology and distribution patterns, warranting a more in-depth examination of the holopelagic Sargassum holobiome overall.

El género Sargassum incluye más de 350 especies principalmente bentónicas con solo dos representantes holopelágicos reconocidos. Las acumulaciones masivas y las varadas de las especies holopelágicas de Sargassum en las costas del Caribe, África occidental y Brasil han reavivado el interés en esta macroalga marrón importante pero poco estudiada que ha sido apodada "la selva dorada flotante

del Océano Atlántico". Una forma rara de *S. natans* referida como *S. natans* VIII por Parr en la década de 1930 ha sido identificada como una forma que se acumula en cantidades sin precedentes, pero hasta hace poco no había datos genómicos disponibles para ninguna especie de Sargassum holopelágica. Nuestro laboratorio ha estado aplicando la genómica comparativa en formas conocidas de la especie holopelagic Sargassum: *S. fluitans* III y *S. natans* I, junto con la anteriormente rara, *S. natans* VIII para dilucidar las relaciones entre las diferentes formas, con el objetivo de producir población. Marcadores genómicos para delimitar diferentes poblaciones y fuentes de los varamientos. Como se observa con las especies de Sargassum bentónico de Asia, la genómica de orgánulos comparativos es útil para diferenciar entre las especies de Sargassum del Atlántico, sin embargo, las formas holopelágicas están muy estrechamente relacionadas en comparación con sus primos bénticos. A pesar de la sintenia de genes y la alta conservación de secuencias, las especies de Sargassum holopelágicas difieren en su ecología y patrones de distribución, lo que justifica un examen más profundo del holobioma de Sargassum holopelágico en general.

Keywords: Genomics, populations

CHANGES IN THE SPECIFIC COMPOSITION OF PELAGIC SARGASSUM IN THE MEXICAN CARIBBEAN (**Student**)

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Since 2011, unusually quantities of pelagic Sargassum began washing-up along the Gulf of Mexico, Caribbean and Brazilian coast, impacting ecosystems and local economy. In contrast to what was previously thought, the origin of this new massive influx of pelagic Sargassum was not the Sargasso Sea, but an area off the coast of Brazil identified as the North Equatorial Recirculation Region. In this study we conduct a weekly systematic monitoring to estimate the biomass and species composition of massive arrivals of Sargassum on the Mexican coast. Field surveys (2016-2018) identified three morphological forms of pelagic Sargassum: *S. fluitans* III, *S.natans* I and *S.natans* VIII. In 2015, *S. natans* VIII (a formerly rare form) has been identified as the predominant form of Sargassum however, by the end of 2016 the ratio between *S. fluitans* III (56%) and *S.natans* VIII (44%) had changed and from 2017 onwards S.fluitans III became clearly dominant (86%). The third morphological form *S.natans* I, registered in 2015, was not recorded again until 2018 with an abundance of 21%. Overall biomass was highest in 2018 with the peak of 144 kg of fresh weight per m^2 in August. This study is the first record on the specific composition of pelagic Sargassum in the Western Caribbean and serves as a starting point to understand the origin of these massive influx into the Caribbean and discern temporal patterns in abundance.

Keywords: Sargassum, morphotype

MOTILE FAUNA ASSOCIATED WITH PELAGIC SARGASSUM IN A MEXICAN REEF LAGOON

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Buildup of decaying pelagic Sargassum on the beaches of the Mexican Caribbean during the massive influxes of 2015 and 2018 had detrimental impacts on the environment and tourist industry. To avoid ecological and economic impacts from massive beaching of Sargassum, it is preferable to remove the pelagic algal masses before they reach the shore. However, in the sea, the pelagic masses constitute an ecosystem with diverse associated fauna; thus, removal of *Sargassum* ssp. at sea should consider its potential impact on the fauna. This study conducted a survey on the motile macrofauna associated to pelagic Sargassum rafts in the Puerto Morelos reef lagoon, Mexican Caribbean. Pelagic Sargassum was sampled with nets at 2m, 50m and 500 m from the shore, at four sites during the months of September, October and November of 2018. The 108 samples contained 10,296 individuals belonging to 32 taxa distributed over eight Phyla. The main phyla were Arthropoda (48% of all individuals), Annelida (41%) and Mollusca (15%). The abundance of fish was very low (10 individuals) with 5 species of which 3 are typically associated with the Sargassum rafts, and two are common in seagrass meadows and reefs. Species composition and abundance of motile macrofauna varied between months and zones; the nearshore stations had lowest abundance; and there was no difference in the abundance of the fauna associated with rafts 50 or 500m off-shore. Three of the four most abundant species (together accounting for 89% of the individuals) were species typically associated with pelagic Sargassum, and the fourth was an amphipod that was only registered once near shore. Although more studies over larger time and spatial scales are required, these results suggest that removal in the of pelagic Sargassum within the reef lagoon may not have a significant effect of local population of small motile macrofauna.

Keywords: Sargassum, pelagic macrofauna

EFFECTS OF SARGASSUM SPP. BLOOMS ON SEAGRASS BEDS

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Sargassum spp. blooms washing up on shores have become a major economic and ecological issue in the Caribbean. Beached *Sargassum* spp. can be meters thick, emitting foul smells and turbid water which

affects ecosystems and the tourist industry. When floating in the water, *Sargassum* spp. also shades the benthos below it and possibly adds nutrients to the water. Until now, only one study assessed the effects of *Sargassum* spp. blooms on seagrass beds and found a large amount of seagrass mortality. On South Caicos (including its Cays), seagrass beds dominated by *Thalassia testudinum* (Turtle grass) have shown mortality due to beached Sargassum spp. A strip of all dead *T. testudinum* is found closest to shore while the seagrass bed further out (24-100m from shore) is completely healthy and dense. This study is monitoring the extent of beached Sargassum spp. and the development of mortality and regrowth of the adjacent seagrass beds at several locations around South Caicos, including one with daily removal of *Sargassum* spp. To better understand what causes this mortality, two experiments were performed in a bay with minimal beached *Sargassum* spp.: one tested the effect of shading by floating *Sargassum* spp. on seagrass beds while the other tests the effect of sunken *Sargassum* spp. debris that is often found logged in still intact seagrass beds. The first months of beached Sargassum spp. and seagrass monitoring showed that removal of beached *Sargassum* spp. leads to less loss of seagrass. Beached *Sargassum* spp. loads decreased from November to February and so did the extent of dead *T. testudinum*, indicating that healthy seagrass recolonizes the area with mortality. The shading experiement found that *Thalassia testudinum* growth was not affected by shading of *Sargassum* spp. The experiment with sunken Sargassum spp. is ongoing and results will be presented at the conference.

Keywords: Sargassum, Seagrass, Mortality, In water experiment,

CONSEQUENCES OF LOSS OF SEAGRASS MEADOWS DUE TO SARGASSUM BROWN TIDE IN THE MEXICAN CARIBBEAN (**Student**)

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Nearshore seagrass meadows in the Mexican Caribbean were severely impacted by Sargassum brown tide (Sbt) in 2015. Seagrasses create a more benign hydrodynamic environment by wave-baffling, and sediments are trapped in an extensive below-ground root rhizome mat. Accompanying calcareous algae produce annually tons of calcareous sand per hectare. We studied the consequences on sediment dynamics of the total loss of a nearshore seagrass meadow after Sbt. Collapse of the seagrass meadow resulted in beach erosion, and sediment was moved offshore as shown by increased sedimentation rates reflected in growth of vertical rhizomes of offshore surviving *Thalassia testudinum*. Further nearshore, the seagrasses were replaced by calcareous algae (mainly *Halimeda* spp.). In this study, we compare ecosystem functions of the lost seagrass meadows vs. the newly formed areas colonized by rhizophytic calcareous algae.

Keywords: sargassum, seagrass loss, ecosystem functions

TESTING THE APPLICATION OF DRONE TECHNOLOGIES IN QUANTIFYING STRANDED SARGASSUM SEAWEED (**Student**)

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Unprecedented mass influxes of pelagic sargassum into the Caribbean have caught coastal and marine resource managers off guard as thousands of tons of the seaweed have inundated nearshore waters and piled up along beaches causing enormous difficulties for coastal communities, and the tourism and fisheries sectors. It has also attracted the interest of entrepreneurs looking to design and market new equipment and products. However, developing appropriate responses and management plans to cope with sargassum, understanding the ecological impacts, and assessing the viability of entrepreneurial ideas require knowledge of the location and quantity of sargassum strandings. To date there are no standard monitoring protocols in place for quantifying stranded sargassum in the region. In this study we test the application of using a low cost drone to obtain high resolution aerial imagery and photogrammetry mapping software to map and quantify the volume of sargassum along an east coast beach in Barbados. We also employ a more conventional ecological approach using replicate transects and sample quadrats to compare and contrast results, and to add value to the information obtained by the drone through providing volume to wet and dry weight conversions and sargassum species composition. Through these tests, under different conditions experienced between June and September 2018, we hope to develop a low-cost and effective drone-based protocol for monitoring sargassum strandings over large areas.

La afluencia masiva sin precedentes de sargazo pelágico en el Caribe ha sorprendido a los administradores de recursos costeros y marinos desprevenidos, ya que miles de toneladas de algas marinas han inundado las aguas costeras y se han acumulado a lo largo de las playas, causando enormes dificultades para las comunidades costeras y los sectores del turismo y la pesca. También ha atraído el interés de los empresarios que buscan diseñar y comercializar nuevos equipos y productos. Sin embargo, el desarrollo de respuestas y planes de manejo apropiados para hacer frente al sargazo, la comprensión de los impactos ecológicos y la evaluación de la viabilidad de las ideas empresariales requiere un conocimiento de la ubicación y la cantidad de varamientos de sargazo. Hasta la fecha, no existen protocolos de monitoreo estándar para cuantificar el sargazo varado en la región. En este estudio, probamos la aplicación del uso de un avión no tripulado de bajo costo para obtener imágene s aéreas de alta resolución y el software de cartografía por fotogrametría para mapear y cuantificar el volumen de sargazo en una playa de la costa este de Barbados. También empleamos un enfoque ecológico más convencional que utiliza transectos repetidos y cuadrantes de muestra para comparar y contrastar los resultados, y para agregar valor a la información obtenida por el avión no tripulado proporcionando volumen a las conversiones de peso seco y húmedo y la composición de especies de sargazo. A través de estas pruebas, bajo diferentes condiciones experimentadas entre junio y septiembre de 2018, esperamos desarrollar un protocolo basado en drones de bajo costo y efectivo para monitorear los varamientos de sargazo en grandes áreas.

Keywords: Sargassum, drone technologies, monitoring, quantifying, mapping

CHALLENGES OF MANAGING SARGASSUM INFLUXES: A WAY FORWARD

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Repeated mass strandings of pelagic sargassum along Brazilian, Caribbean and West African shorelines are causing multi-sectoral impacts and presenting immense challenges to coastal managers. The first occurrences of mass sargassum influxes back in 2011 were completely unexpected and as a result there was no guiding policy, financing, best practice knowledge or management plans in place to deal with the problem. Now eight years on, with the recognition that mass sargassum influxes likely represent a new 'norm' for this broad region, there is a real need to mainstream management of sargassum influxes into adaptive planning and risk aversion strategies to ensure resilience of coastal communities and even national economies, as is the case for many small island states in the Caribbean, that rely heavily on coastal tourism. Here we examine the context for management planning, recognizing that it should be multi-level, that inter-sectoral coordination is essential and that the planned response should treat sargassum both as an opportunity as well as a threat. We propose a way forward and suggest key elements to be included in a management plan. Priority areas to be included would be: (1) cross cutting actions such as communication, knowledge sharing, research and monitoring, forecasting and early warning, financing and investment; (2) actions towards response and resilience such as a register of damages, clean up procedures and scenario-based strategic operating procedures; and (3) actions towards sustainable use and benefits such as managed access, and support for micro, small and medium enterprises using sargassum.

Los repetidos varamientos de sargazo pelágico a lo largo de las costas brasileñas, caribeñas y del oeste de África están causando impactos multisectoriales y presentan enormes desafíos para los gestores costeros. Las primeras ocurrencias de afluencias masivas de sargazo en 2011 fueron completamente inesperadas y, como resultado, no hubo una política, un financiamiento, un conocimiento de las mejores prácticas o planes de gestión establecidos para enfrentar el problema. Ahora, ocho años después, con el reconocimiento de que las afluencias masivas de sargazo probablemente representan una nueva "norma" para esta amplia región, existe una necesidad real de integrar la gestión de las afluencias de sargazo en la planificación adaptativa y las estrategias de aversión al riesgo para garantizar la resiliencia de las comunidades costeras e incluso Las economías nacionales, como es el caso de muchos pequeños estados insulares en el Caribe, que dependen en gran medida del turismo costero. Aquí examinamos el contexto para la planificación de la gestión, reconociendo que debe ser multinivel, que la coordinación intersectorial es esencial y que la respuesta planificada debe tratar al sargazo como una oportunidad y como una amenaza. Proponemos un camino a seguir y sugerimos elementos clave para ser incluidos en un plan de gestión. Las áreas prioritarias que se incluirán serían: (1) acciones transversales tales como comunicación, intercambio de conocimientos, investigación y monitoreo, previsión y alerta temprana, financiamiento e inversión; (2) acciones de respuesta y resiliencia, como un registro de daños, procedimientos de limpieza y procedimientos operativos estratégicos basados en escenarios; y (3) acciones hacia el uso sostenible y beneficios como el acceso gestionado y el apoyo a micro, pequeñas y medianas empresas que utilizan sargazo.

Keywords: sargassum, management planning, mainstreaming,

CORAL-ALGAL COMPETITION AND OVERGROWTH DYNAMICS OF A RAPIDLY EMERGING RED ALGA (RAMICRUSTA SP.) IN ST. THOMAS, US VIRGIN ISLANDS (**Student**)

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Caribbean coral cover has decreased by about 80% in the last three decades, with much of the live coral being replaced by macroalgae. A rapidly emerging red alga, *Ramicrusta* sp. (hereinafter *Ramicrusta*), has recently overtaken several coral reefs in the Caribbean region. Multiple species of *Ramicrusta* are characterized by rapid growth and the ability to overgrow living corals, which causes damage and mortality to a variety of coral species. In the Caribbean, *Ramicrusta* spreads rapidly throughout reefs and often dominates the substrate as the most abundant benthic species. The US Virgin Islands (USVI) is no exception. *Ramicrusta* has already established in multiple locations around the USVI and has demonstrated widespread harm to corals by overgrowing living tissue, causing bleaching and colony mortality, and impairing coral recruitment. The alga commonly outcompetes other benthic organisms and prevents coral recovery, posing a severe threat to reefs in the USVI. A lack of information about *Ramicrusta* in the Caribbean emphasizes the need for research concerning the ecology of the alga and its potential impacts on coral reef ecosystems. This study uses high-resolution 3D modeling to measure *Ramicrusta* growth on corals in the USVI to quantify and characterize the overgrowth rates of *Ramicrusta*, determine if certain coral taxa experience faster overgrowth by the alga, and investigate trends in environmental parameters that may influence *Ramicrusta* growth and abundance.

Keywords: coral, algae, competition, *Ramicrusta*, photogrammetry, ecology

Marine Population Connectivity in the Caribbean

GENETIC AND DISEASE CONNECTIVITY OF PANULIRUS ARGUS (**Student**)

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The marine environment, with currents and gyres, allows for the free movement of many marine species, especially those with a planktonic distribution stage. One such organism is the Caribbean spiny lobster, *Panulirus argus*. Phyllosoma larvae are carried passively for 6 to 9 months and undergo metamorphosis into the puerulus stage. This planktonic stage allows *P. argus* to cover long distances before settling in coastal areas within its geographical range. Post-larvae settle in sea grass beds and develop through the juvenile and adult stages. This study seeks to further explore genetic connectivity of *P. argus* and determine the population dynamics and genetic structure in Saint Kitts relative to neighbouring Caribbean islands. In addition to the dispersal of ecologically and economically important species, there may also

be dispersal of pathogens. Resulting diseases may affect fecundity and overall population health. *Panulirus argus* virus 1 (PaV1) was discovered in Florida in 1999 and has spread throughout the Caribbean. In 2013, PaV1 was detected in lobsters in Puerto Rico, 257 miles away from Saint Kitts. In this study, 248 lobsters were screened grossly and histologically for signs of disease, and PaV1 has not been found. The population was screened for other pathogens and parasites such as microsporidians and nemertean worms. Microsporidian infections in *P. argus* are rare and documented events have been restricted to Florida. However, using histological and molecular techniques, one infected lobster was found in Saint Kitts, which is indicative of geographical expansion. A nemertean worm, *Carcinonemertes conanobrieni*, is an egg-predator found in lobsters from Florida. It is the only nemertean worm known to parasitize this lobster species. Using the NCBI sequence database, we have concluded that egg masses found on adult lobster gills in Saint Kitts are nemerteans. Our sample, however, is not *C. conanobrieni* and remains unidentified.

El ambiente marino, con corrientes y giros, permite la libre circulación de muchas especies marinas, especialmente aquellas con una etapa de distribución planctónica. Uno de esos organismos es la langosta espinosa del Caribe, *Panulirus argus*. Las larvas de phyllosoma se transportan de forma pasiva durante 6 a 9 meses y se someten a metamorfosis en la etapa de puerulus. Esta etapa planctónica permite que *P. argus* cubra largas distancias antes de establecerse en áreas costeras dentro de su rango geográfico. Las post-larvas se asientan en lechos de pastos marinos y se desarrollan a través de las etapas juvenil y adulta. Este estudio busca explorar más a fondo la conectividad genética de *P. argus* y determinar la dinámica de la población y la estructura genética en Saint Kitts en relación con las islas vecinas del Caribe. Además de la dispersión de especies de importancia ecológica y económica, también puede haber dispersión de patógenos. Las enfermedades resultantes pueden afectar la fecundidad y la salud general de la población. El virus 1 de Panulirus argus (PaV1) fue descubierto en Florida en 1999 y se ha extendido por todo el Caribe. En 2013, se detectó PaV1 en langostas en Puerto Rico, a 257 millas de Saint Kitts. En este estudio, 248 langostas se examinaron de forma general e histológica para detectar signos de enfermedad, y no se ha encontrado PaV1. La población se examinó para detectar otros patógenos y parásitos, como los microsporidianos y los gusanos nemertinos. Las infecciones microsporídicas en *P. argus* son raras y los eventos documentados se han restringido a Florida. Sin embargo, utilizando técnicas histológicas y moleculares, se encontró una langosta infectada en Saint Kitts, lo que es indicativo de la expansión geográfica. Un gusano nemertino, *Carcinonemertes conanobrieni*, es un depredador de huevos que se encuentra en langostas de Florida. Es el único gusano nemertino conocido para parasitar esta especie de langosta. Usando la base de datos de secuencias NCBI, hemos llegado a la conclusión de que las masas de huevos que se encuentran en las branquias de las langostas adultas en Saint Kitts son nemertinos. Nuestra muestra, sin embargo, no es *C. conanobrieni* y permanece sin identificar.

Keywords: *Panulirus argus*, Disease, Microsporidian, Nemertean

Reef restoration and resilience

THE CHALLENGE OF UPSCALING CORAL FARMING AND REEF REHABILITATION FOR ENHANCING COASTAL RESILIENCE

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Multiple coral farming and reef restoration efforts are being implemented across the Wider Caribbean. They are aimed at fostering the recovery of depleted coral populations, with special attention on Acroporid corals. However, achieving the recovery and sustainability of the overall coastal resilience remained a challenging task. Failing to achieve coral population persistence may imply long-term failure to rehabilitate fundamental processes such as reef accretion, failing to recover reef's CaCO3 budget, sustained herbivory, wave energy attenuation, the rehabilitation of benthic spatial heterogeneity, net coastal resilience, and community-based livelihoods. The most complicated challenge has been achieving appropriate spatial scales of interventions. This will require the integration of multiple modeling tools to address success of future interventions, including: coral demographics, wave numerical models, and CaCO3 budget dynamics. This will allow understanding the role of reef rehabilitation under future climate and environmental scenarios. The impact of climate-related and environmental-related disturbances in *Acropora cervicornis* demographic dynamics was addressed in restored coral populations in Culebra Island, Puerto Rico, during a 4 to 10-year time span. Factors such as recurrent coral disease outbreaks, with variable prevalence (7-78%) led A. cervicornis populations to extinction in less than a decade. Similarly, chronic turbid runoff pulses and sediment loads resulted in losing *A. cervicornis* assemblages. Catastrophic impacts by category five Hurricanes Irma and María in 2017 resulted in the total extirpation of restored coral populations. All models suggest that population's λ remain <1.0, which implies the need to increase the magnitude and the spatial scale of coral farming and reef rehabilitation interventions to sustain future populations. Losing coral assemblages will also result in a significant loss of local reef's CaCO3 budget, in benthic habitat spatial heterogeneity, in losing reef's role as essential fish habitat, and as buffer of wave energy. The need for improved scales of intervention will be discussed.

A través del Gran Caribe se están implementando múltiples esfuerzos de cultivo de coral y restauración de arrecifes. Su objetivo es fomentar la recuperación de las poblaciones de coral diezmadas, con especial atención en los corales Acropóridos. Sin embargo, lograr la recuperación y la sostenibilidad de la resiliencia costera en general sigue siendo una tarea difícil. El no lograr alcanzar la persistencia de las poblaciones de corales puede implicar un fracaso a largo plazo para rehabilitar procesos fundamentales como el crecimiento neto del arrecife, el fracaso en recuperar el presupuesto de CaCO3, una herbivoría sostenida, la atenuación de la energía de las olas, la rehabilitación de la heterogeneidad espacial béntica, la resiliencia costera neta y los medios de vida de las comunidades costeras. El desafío más complicado ha sido lograr escalas espaciales apropiadas de intervenciones. Esto requerirá la integración de múltiples herramientas de modelado para abordar el éxito de futuras intervenciones, que incluyan: la dinámica demográfica de los corales, modelos numéricos de olas y las dinámicas presupuestarias de CaCO3. Esto permitirá comprender el papel de la rehabilitación de los arrecifes bajo diversos escenarios climáticos y ambientales futuros. El impacto de las alteraciones relacionadas con el clima y el medio ambiente en la dinámica demográfica de *Acropora cervicornis* se estudió en las poblaciones de coral restauradas en la Isla Culebra, Puerto Rico, durante un período de 4 a 10 años.

Factores como los brotes recurrentes de enfermedades de coral, con prevalencia variable (7-78%) llevaron a la extinción de las poblaciones de *A. cervicornis* en menos de una década. De manera similar, los impulsos crónicos de escorrentías turbias y las cargas de sedimentos dieron como resultado la pérdida de *A. cervicornis*. Los impactos catastróficos por los huracanes categoría cinco Irma y María en 2017 resultaron en la extirpación total de las poblaciones de coral restauradas. Todos los modelos sugieren que el λ de la población sigue siendo <1.0, lo que implica la necesidad de aumentar la magnitud y la escala espacial de las intervenciones de cultivo de corales para la rehabilitación de los arrecifes de coral y para sostener a las poblaciones futuras. La pérdida de corales también resultará en una pérdida significativa del presupuesto de CaCO3 del arrecife local, en la heterogeneidad espacial del hábitat bentónico, en la pérdida del rol del arrecife como hábitat esencial para los peces y como amortiguador de la energía de las olas. Se discutirá la necesidad de mejores escalas de intervención. .

Keywords: *Acropora cervicornis*, Carbonate Budget, Coral reef rehabilitation, Restoration, Demography, Wave numerical model.

ASSESSMENT OF NURSERIES AND OUTPLANTING SITES IN THE SOUTHEASTERN OF DOMINICAN REPUBLIC AFTER HURRICANES MATTHEW (2016), IRMA AND MARIA (2017) (**Student)**

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Acropora cervicornis is a key Caribbean species, both in structural and functional terms. It has declined dramatically since the early 80`s, and are classified as Critically Endangered Species. To promote their recovery, restoration programs by introducing fragmented specimens have intensified. In 2011 Dominican Marine Studies Foundation, FUNDEMAR started the A. cervicornis restoration program at Bayahibe in the southeastern part of the island. In this study we present the analysis after the strong cyclonic seasons in 2016 and 2017 in the greater Caribbean. Hurricane Matthew caused the loss of most of the structures, with a total of 35 structures. Mean survival of the fragments after cyclonic seasons 2016 and 2017 for all nurseries was 35.06± 11.30%, within a range of 16.96 - 52.07%. Mean survival of transplanted colonies after the strike of Hurricane Matthew (2016) for the four outplanting sites operating to that moment was 28.68 ± 20.0%, within a range of 5.49-51.78% and colonies after Hurricanes Irma and Maria (2017) for four outplanting sites was 61.57 ± 16.86%, within a range of 46.66 - 83.17%. Coral coverage losses of >24% were also evidenced, resulting in a decrease of 0.103 Reef Functional Index. However, the ecological cost of hurricanes did not have a significant effect on the reduction of fish biomass.

Acropora cervicornis es una especie caribeña clave tanto en términos estructurales como funcionales. Ha disminuido dramáticamente desde principios de los años 80, y está clasificado como especie en peligro crítico de extinción. Para promover su recuperación, se han intensificado los programas de restauración mediante la introducción de especímenes fragmentados. En 2011 la Fundación Dominicana de Estudios Marinos, FUNDEMAR inició el programa de restauración de A. cervicornis en Bayahibe, en el sureste de la isla. En este estudio presentamos el análisis después de las fuertes temporadas ciclónicas de 2016 y 2017 en el Gran Caribe. El huracán Matthew causó la pérdida de la mayoría de las estructuras, con un total de 35 estructuras. La supervivencia media de los fragmentos después de las temporadas ciclónicas 2016 y 2017 para todos los viveros fue de 35.06± 11.30%, dentro de un rango de 16.96 - 52.07%. La supervivencia media de las colonias trasplantadas después del impacto del huracán Matthew (2016) para los cuatro sitios de trasplante que operaban hasta ese momento fue de 28.68 ± 20.0%, dentro de un rango de 5.49-51.78% y las colonias después de los huracanes Irma y María (2017) para cuatro sitios de trasplante fue de 61.57 ± 16.86%, dentro de un rango de 46.66 - 83.17%. De igual forma se evidenciaron pérdidas de cobertura >24%, traducidas en una disminución del 0.103 Índice Funcional del Arrecife. Sin embargo, el costo ecológico de los huracanes no tuvo un efecto considerable en la disminución de la biomasa de peces.

Keywords: *Acropora cervicornis*, Coral Reef Restoration, Cyclonic seasons

OUTPLANTING ACROPORA CERVICORNIS LOCALLY INCREASES ABUNDANCE OF MACROALGAE CONSUMERS **(Student)**

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Acropora cervicornis is a major contributor to coral reef structural complexity, providing habitat for fishes and invertebrates throughout Florida and the Caribbean. Unfortunately, disease, bleaching, and anthropogenic stressors have caused drastic population declines over the past several decades that have had negative impacts on the native fishes. To preserve genetic diversity, many organizations have cultivated *Acropora cervicornis* fragments in coral nurseries and outplanted them back onto reefs. This practice has proven effective at increasing coral abundance, but the ecosystem benefits have not been thoroughly assessed. This is addressed by comparing fish assemblages on natural reefs to outplant reefs in Southeast Florida. Fish count surveys were conducted to record fish species and size at four locations in Broward County, Florida, USA from 2012 to 2017. All four sites contained control and outplanted coral plots. These data were used to examine community composition, demographic and functional trends over time, and with the increasing structural complexity of the outplanted corals. Results show a significant increasing trend of herbivore, omnivore, and total fish abundance over time that was positively associated with the structural complexity of the growing outplanted corals. These findings provide information on the ecosystem benefits of *A. cervicornis* restoration efforts. .

Keywords: Outplanting, *Acropora cervicornis*, Fish, Restoration

PREDICTED SPAWNING TIMES OF LOCAL CORALS AS A TOOL FOR LARVAL PROPAGATION IMPLEMENTATION IN SOUTHEASTERN DOMINICAN REPUBLIC

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Larval propagation is a highly promising technique using coral sexual reproduction to scale up reef restoration efforts by increasing wild coral genetic diversity and resilience. Coral spawning day and time ranges vary by species and region. In order to effectively expand the implementation of larval propagation techniques in different Caribbean regions with more coral species, it is essential to document and register spawning days and times for vulnerable coral species locally, through time. In 2015 and 2016, Calle-Triviño et al. (2018) tested and implemented assisted fertilization and larval propagation techniques for the first time in the Dominican Republic using Acropora cervicornis colonies in the main coral nursery of Fundemar. Since 2017, Fundemar has pioneered and spearheaded spawning documentation and registration of six coral species (*Colpophyllia natans*, *Dendrogyra cylindrus*, *Diploria labyrinthiformis*, *Montastraea cavernosa*, *Orbicella annularis* and *Orbicella faveolata*) in southeastern Dominican Republic to accurately predict spawning times. Reporting and sharing this data is necessary to increase coral spawning knowledge and expand larval propagation restoration efforts in the Caribbean. With four consecutive years of data for *Acropora cervicornis* and two years of data for six other coral species we now have locally adapted spawning prediction times, making Fundemar's larval propagation program more accurate and effective.

Keywords: Larval propagation, Spawning, Documentation, Prediction, Sexual reproduction

RECOLONIZATION OF ORBICELLA FAVEOLATA COLONIES KILLED DURING THE THERMAL ANOMALY OF 2005: STATUS OF THE NEW ASSOCIATED ASSEMBLAGES AND JUVENILE DYNAMICS **(Student)**

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The combination of diseases and intensive bleaching resulting from the 2005 thermal anomaly caused a 53% loss of live coral cover in reefs off La Parguera Natural Reserve (LPNR). With the disappearance of tissue, colony surfaces were available for algae and sessile invertebrate recolonization, including scleractinian corals. Recruitment and initial survival of juveniles are crucial processes for the maintenance of populations of founding species and the natural recuperation of coral reef communities. To evaluate the status of current invertebrate assemblages and juvenile dynamics of scleractinians on the dead colonies, 12 large colonies of the massive coral *Orbicella faveolata* (killed in 2005-07) were

tagged in each of two depths in two reefs in the LPNR. Each colony was entirely photographed for the community characterization, and two representative areas were marked (quadrats) in each colony, and photographed every three months to assess recruitment, growth and mortality rates of juvenile s. One quadrant was cleared of excess algae initially, and then cleaned of sediment every month to assess effect of sedimentation. Three sediment traps were deployed among surveyed colonies at each depth and one HOBO temp logger was deployed in each reef to assess sedimentation and temperature variability across depths and reefs. All juveniles and recruits in permanents quadrants were identified and measured from the photographs. Structure and composition of benthic assemblages associated with *O. faveolata* differed significantly and independently between sites and between depths. Very interestingly, magnitudes of differences were similar for both factors (33.33 for Depth and 33.02 for site) however; the direction of that difference was not the same. Ongoing analysis will allow quantitative comparisons of community structures, the characterization of juvenile dynamics, and to assess their correlation with sedimentation and temperature. The study will provide valuable information about post-mass mortality succession and recuperation of coral reef areas in Puerto Rico.

La combinación de enfermedades y el blanqueamiento intensivo durante la anomalía térmica del 2005, causaron la pérdida del 53% de la cobertura viva de coral en la Reserva Natural La Parguera (RNLP). Al desaparecer el tejido, las superficies de las colonias quedan disponibles para la colonización por algas e invertebrados sésiles, incluyendo corales escleractínidos. El reclutamiento y la sobrevivencia inicial es un proceso crucial para el mantenimiento de las poblaciones de especies fundadoras y el proceso de recuperación natural del arrecife coralino. Para evaluar el estado actual de los ensamblajes de invertebrados sésiles y la dinámica de juveniles de corales escleractínidos, 12 colonias del coral masivo O. faveolata (muertas entre el 2005-07) en cada una de dos profundidades de dos arrecifes de la RNLP, fueron marcadas, mapeadas y fotografiadas en su totalidad para la caracterización de la comunidad. Se marcaron dos áreas representativas (cuadrantes) en cada colonia, y se fotografiaron cada tres meses para evaluar el reclutamiento, el crecimiento y las tasas de mortalidad de los juveniles. A un cuadrante de cada colonia, inicialmente se le eliminó el exceso de algas y luego una vez al mes se elimina el sedimento para determinar el impacto de sedimentación. Tres trampas de sedimentos fueron puestas entre las colonias en cada profundidad y muestreadas una vez al mes, además se pusieron HOBO loggers de temperatura en cada arrecife para explorar la variabilidad de la sedimentación y temperatura a través de las profundidades y los dos arrecifes. Todos los juveniles y reclutas en los cuadrantes permanentes fueron identificados y medidos a partir de fotografías. Resultados preliminares indican que la estructura y composición de los ensamblajes bénticos asociados a O. faveolata difieren significativa e independientemente entre sitios y entre profundidades. Interesante anotar que las magnitudes de las diferencias fueron similares para ambos factores (33.33 para profundidad y 33.02 para sitio) sin embargo, la dirección de esta diferencia no es la misma. La continuación de los análisis permitirá comparar cuantitativamente la estructura de las comunidades, la caracterización de la dinámica de los juveniles y evaluar su relación con la sedimentación y temperatura. Este estudio proporcionará información valiosa sobre la sucesión y recuperación después de una mortalidad masiva de las áreas de arrecifes de coral en Puerto Rico y el Caribe. .

Keywords: Coral reef, Sedimentation, Succession, Ecology

PARTITIONING SPATIAL VARIATION OF JUVENILE CORALS; FROM CENTIMETERS TO KILOMETERS: A CASE STUDY FROM MOCHIMA NATIONAL PARK, VENEZUELA **(Student)**

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In Venezuela, most studies have focused on describing the structure of adult coral communities, while corals in their early stages have received less attention. Successful recruitment and survivorship of juveniles is important for shaping the community structure and population dynamics of corals. This study aimed to determine spatial variability of juvenile corals abundance at different spatial scales in Venezuela, in Mochima National Park, Venezuela. We also tested whether brooders were more abundant than spawnners. For this, we used a fully-nested design encompassing four scales: (1) six sites (distanced by tens of kilometers), (2) four transects within sites (distanced by 5-10 m), (3) fifteen 80x90 cm2 photoquadrats within each transect (distanced by 2 m) and finally, four 25x25 cm sub-quadrats within each quadrat separated to each other by 10-20 cm as replicates. The variance component was estimated for each source of variation with an analysis of variance based on permutation (PERMANOVA). The juvenile coral community was highly variable among all spatial scales; however, largest variability (CV = 69%) was found in the residual (i.e., variation among replicates) followed by sites (pseudo-F 3.3, df= 5, CV = 11%, p= 0.001) and about 20% of variance explained by transects (pseudo-F 2.2, df= 18, p= 0.001) and quadrats (pseudo-F 1.08, df= 332, p=0.036). *Porites astreoides* (52%), *Pseudodiploria strigosa* (21%) and *Siderastrea siderea* (16%) dominated the juvenile coral community. Brooders exceeded the abundance of spawnners at San Agustín (2:1) and Gabarra (5:1) only. Our study is the first to investigate and measure spatial variation of juvenile corals in Venezuela; and suggests that small-scale processes might play a key role for shaping these communities.

En Venezuela, la mayoría de los estudios realizados se han centrado en la estructura de la comunidad coralina adulta, mientras que los estadios tempranos han recibido menor atención. Este estudio tuvo como objetivo determinar los patrones de variabilidad en la abundancia de juveniles a diferentes escalas espaciales en Venezuela, en el Parque Nacional Mochima. También probamos si los planuradores eran más abundantes que los liberadores de gametos. Para esto usamos un diseño totalmente anidado que abarca 4 escalas: (1) seis sitios (distanciados por decenas de kilómetros), (2) cuatro transectas dentro de los sitios (distanciadas por 5-10 m), (3) quince foto cuadratas de 80x90 cm2 dentro de cada transecta (distanciadas por 2 m) y, finalmente, cada sub cuadrata de 25x25 cm2 dentro de cada foto cuadrata separadas entre sí por 10-20 cm como réplicas. El componente de varianza se estimó para cada fuente de variación con un análisis de varianzas basado en permutaciones (PERMANOVA). La comunidad coralina juvenil es altamente variable entre todas las escalas espaciales; sin embargo, la mayor variabilidad (CV= 69%) se encontró en el residual (en la variación entre réplicas) seguido por los sitios (pseudo-F=3.3, gl=5, CV=11%, p=0.001) y aproximadamente el 20% de la varianza fue explicado por las transectas (pseudo-f=2.2, gl=18, p=0.001) y cuadratas (pseudo-F=1.08, gl=332, p=0.036). Los juveniles más abundantes fueron *Porites astreoides* (52%), *Pseudodiploria strigosa* (21%) y *Siderastrea siderea* (16%). Los planuladores fueron más abundantes que los liberadores de gametos solamente en San Agustín (2:1) y Gabarra (5:1). Nuestro estudio es el primero en investigar y medir la variabilidad espacial de corales juveniles en Venezuela; y sugiere que los procesos a pequeña escala podrían jugar un papel clave para dar forma a estas comunidades.

Keywords: Corals, Early stages, Coral reef, Venezuela, Spatial variation

FATE TRACKING MASSIVE CORAL OUTPLANTS BY SPECIES AND GENOTYPE WITHIN THE STONY CORAL TISSUE LOSS DISEASE OUTBREAK (**Student**)

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Coral reef restoration practitioners have traditionally focused on growing branching corals known for rapid expansion within offshore nurseries. While these corals have many advantages, they also lack the ability to build permanent reefs and are highly susceptible to natural perturbations such as storm damage. However, Mote Marine Laboratory has developed techniques to propagate reef building (massive) corals to restore reefs using a polyculture rather than a monoculture approach. The large scale epizootic affecting almost the entire Florida Reef Tract, termed the Stony Coral Tissue Loss Disease (SCTLD), however, poses a threat to many massive corals used for restoration. To determine the level of susceptibility of different coral species and different genotypes, corals of three species (*Montastraea cavernosa*, *Orbicella faveolata*, and *Pseudodiploria clivosa*) were outplanted within nearshore, mid-channel and offshore sites (N=6) within the Lower Florida Keys region. Additionally, sites were paired within the SCTLD disease front and the pre-invasion zone. High frequency monitoring occurred for six months post outplant to quantify mortality to SCTLD and to conduct rapid assessments of the surrounding reef areas. Preliminary data indicate that overall coral survival is high, but that survival and growth may be lower on offshore reefs because of higher levels of fish predation and coral dislodgement. SCTLD was not a significant cause of mortality, at least within the first several months post outplanting. Furthermore, outplanted corals within the disease zone showed a lower probability of disease than wild colonies, an effect which appeared to vary among genotypes. This study suggests that continued outplanting of massive coral species is a viable and important addition to coral reef restoration efforts in the wider Caribbean, particularly in the face of increasing disturbances such as SCTLD.

Keywords: Florida; Coral restoration; SCTLD, Reef building coral; Outplanting

RESTORATION UPDATES AND INNOVATIONS FROM BELIZE: FIVE YEARS' OF PHOTO-MOSAIC RESULTS PLUS MICRO-FRAGGING IN SITU-WITHOUT LAND-BASED NURSERIES

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Reef replenishment efforts with acroporids began in Belize in 2006 and scaled up in 2010 at Laughing Bird Caye National Park (LBCNP) where there are now over 80,000 nursery-grown outplanted acroporids. Expansion has continued since 2015; there are now over ten replenished reef sites in four

different Marine Protected Areas (MPAs) and two control sites, outside of MPA's. Quantifying and sharing results in a standardized way has been a limitation in the restoration field; here we present data from five years of photo-mosaics on six sub-sites at LBCNP, a no-take zone, and four years of photo-mosaics from three sub-sites at nearby Moho Caye, an unprotected reef. In ideal conditions, acroporids naturally fragment and disperse with storm events over time, increasing the original outplanted coral numbers exponentially. Conversely, since outplanting micro fragments of Acropora palmata began in Belize in 2017, those original outplanted coral numbers decrease, as counted micro-fragments (of the same genet) fuse and grow into colonies, as intended, for re-skinning or re-sheeting shallow reef sites. We propose that using photo-mosaics to calculate change in coral cover over time is currently the best available standardized monitoring tool for assessing reef restoration results. Additionally, it provides data on other benthic community changes that may be correlated with adding acroporids to shallow reef sites. Most importantly, these results allow us to begin to answer the question: what is the minimum amount and density of replenishment or re-seeding needed on reefs with the right conditions? At sub-site 9 in LBCNP, as one example, just 209 A. cervicornis outplants in 2010 grew to 36% of 39% total live coral cover in a 110m2 plot by 2018. As another example, results from the analyzed photo-mosaics show an increase in coral cover at LBCNP of over 30% in just four-five years.

Los esfuerzos de reabastecimiento de arrecifes con acropóridos comenzaron en Belice en 2006 y se ampliaron en 2010 en el Parque Nacional Laughing Bird Caye (LBCNP), donde ahora hay más de 80,000 acropóridos cultivados en viveros. La expansión ha continuado desde 2015; ahora hay más de diez sitios de arrecifes repuestos en cuatro Áreas Marinas Protegidas (AMP) diferentes y dos sitios de control, fuera de las AMP. Cuantificar y compartir resultados de manera estandarizada ha sido una limitación en el campo de la restauración; Aquí presentamos datos de cinco años de fotomosaicos en seis subsitios en LBCNP, una zona de no captura, y cuatro años de fotomosaicos de tres subsitios en el cercano Moho Caye, un arrecife sin protección. En condiciones ideales, los acropóridos se fragmentan y dispersan de forma natural con los eventos de tormentas a lo largo del tiempo, lo que aumenta exponencialmente el número de coral original extraído. Por el contrario, desde que comenzaron los micro fragmentos de Acropora palmata en Belice en 2017, los números de coral original extraídos disminuyen a medida que los microfragmentos contados (del mismo geneto) se fusionan y crecen en colonias, según lo previsto, para repintar o repintar sitios de arrecifes poco profundos. Proponemos que el uso de mosaicos fotográficos para calcular el cambio en la cobertura de coral a lo largo del tiempo es actualmente la mejor herramienta de monitoreo estandarizado disponible para evaluar los resultados de la restauración de arrecifes. Además, proporciona datos sobre otros cambios en la comunidad béntica que pueden estar relacionados con la adición de acroporids a sitios de arrecifes poco profundos. Lo más importante es que estos resultados nos permiten comenzar a responder la pregunta: ¿cuál es la cantidad y la densidad mínimas de reabastecimiento o resiembra necesarias en arrecifes con las condiciones adecuadas? En el subsitio 9 en LBCNP, como ejemplo, solo 209 plantas externas de A. cervicornis en 2010 aumentaron a 36% del 39% de la cobertura total de coral vivo en una parcela de 110 m2 para 2018. Como otro ejemplo, los resultados de los fotomosaicos analizados muestran un aumento en la cobertura de coral en LBCNP de más del 30% en solo cuatro a cinco años.

Keywords: Acroporids, Restoration, Photo-mosiacs, Micro-fragmenting, Belize

Session: Marine Protected Areas Management and Monitoring

REEF CONDITION IN MARINE PROTECTED AREAS OF SOUTHEASTERN DOMINICAN REPUBLIC: USE OF INDICATORS BASED ON SCLERACTINIAN CORALS AND BENTHIC FUNCTIONAL GROUPS **(Student)**

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Coral reefs have an important ecologic, social and economic value; identifying strategic coral reefs and sustaining conservation efforts is essential. We assessed coral reef condition indicators in reefs within and adjacent to MPAs in the southeastern Dominican Republic, considering scleractinian corals composition, diversity (α, β and γ), recruitment, mortality, and bleaching. Overall, sites within MPAs had greater coral cover than sites at the unprotected area. Additionally, other benthic components such as macroalgae and abiotic substrate were lower in MPAs. The relative proportion of bleaching and mortality within MPAs was lower than unprotected area. It is important to highlight that southeastern Dominican Republic showed no evidence of massive bleaching during El Niño-Southern Oscillation (ENSO) 2015 - 2016. MPAs had greater specific richness, γ and β diversity. However, α diversity was higher in the unprotected area. This underlines the importance of conserving multiple MPAs as part of a complex and connected system to ensure greater diversity, functionality and resilience.

Los arrecifes de coral tienen un valor ecológico, social y económico importante; es esencial identificar los arrecifes de coral estratégicos y continuar con los esfuerzos de conservación. En este estudio se evaluaron los indicadores del estado de los arrecifes coralinos en los sitios dentro y adyacentes a las AMPs en el Sureste de República Dominicana, se consideró la composición de los corales escleractínios, la diversidad (α, β y γ), el reclutamiento, la mortalidad y el blanqueamiento. En general, los sitios dentro de las AMPs tenían una mayor cobertura coralina que los sitios en el área no protegida. Además, otros componentes bentónicos como las macroalgas y el sustrato abiótico fueron menores en las AMPs. La proporción relativa de blanqueamiento y la mortalidad dentro de las AMPs fue menor que en el área no protegida. Es importante destacar que el Sureste de República Dominicana no mostró evidencia del evento de blanqueamiento masivo durante el fenómeno de El Niño-Oscilación Sur (ENOS) para la temporada 2015 - 2016. Las AMPs tenían una mayor riqueza específica, γ y β diversidad. Sin embargo, la diversidad fue mayor en el área no protegida. Esto subraya la importancia de conservar múltiples AMPs como parte de un sistema complejo y conectado para asegurar una mayor diversidad, funcionalidad y resiliencia del ecosistema.

Keywords: biodiversity, Caribbean, conservation, management, marine protected area, resilience

USE, APPLICABILITY, AND IMPORTANCE OF BENTHIC FORAMINIFERA AS ENVIRONMENTAL BIOINDICATORS

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Numerous organisms have been used successfully to bio-monitor the impacts of natural and anthropogenic stressors. However, in some cases the type of study and the organism to be used is not that cost effective and outweighs its benefits because it might have an adverse impact to the environment during sampling. The main purpose of this talk is to share and demonstrate the applicability of benthic foraminifers as a highly effective tool related to environmental micropaleontological studies. These benthic foraminifers are shelled protists with a unique set of characteristics that makes them invaluable bioindicators: (1) short life cycle, (2) numerous/cosmopolitan (hundreds per gram of sediment), (3) high ecological diversity, (4) susceptible to environmental changes with a rapid ecological response, and (5) high level of preservation in the sedimentary record. One of the bigger challenges in environmental studies is determining the ecological settings pre-impact. Since benthic foraminifers are calcareous, their tests are easily and well preserved in the sediments and when studying sediment core, important information is obtained on the "evolution" of environmental changes. Benthic foraminifers have been used as sentinel species of pollution and for other environmental changes for the past 50 years. Initiatives like the FOBIMO (FOraminiferal Bio-MOnitoring) international working group have established standardized protocols for sampling, processing and analysis of sediment samples. Similarly, ecological indices have been developed and implemented to assess the level of environmental impact and change (Ammonia-Elphidium Index, FORAM-AMBI, FORAM Index, among others) in coastal and coral reefs environments.

Un sinnúmero de organismos han sido utilizados para monitorear el impacto de contaminantes antropogénicos en zonas costeras. Dependiendo del tipo de estudio y el organismo a utilizar, con frecuencia el costo frecuentemente supera los beneficios, pudiendo incluso empeorar las condiciones del área de estudio durante la fase de muestreo. El propósito de esta presentación es demostrar el uso y aplicabilidad de foraminíferos bentónicos como una herramienta eficaz y costo-efectiva en estudios relacionados a micropaleontología ambiental. Los foraminíferos bentónicos son protistas calcáreos con características que los hacen únicos y de inestimable valor como bioindicadores: (1) ciclo corto de vida, (2) numerosos (cientos por gramo de sedimento), (3) alta diversidad ecológica, (4) susceptibles a los cambios ambientales, mostrando una rápida respuesta, y (5) alto nivel de preservación en el registro sedimentario. Uno de los grandes retos en estudios ambientales consiste en la determinación de las condiciones ecológicas pre-impacto ambiental. Como los foraminíferos son calcáreos, sus testas se conservan en el sedimento y cuando se realizan muestreos mediante barrenados se logra obtener información de la "evolución" de los cambios ambientales del área de estudio. Los foraminíferos bentónicos han sido utilizados como centinelas ante contaminación y otros cambios ambientales por los últimos 50 años. Iniciativas como la del grupo internacional FOBIMO (FOraminiferal Bio-MOnitoring), están estableciendo protocolos estandarizados para el muestreo, procesamiento, y análisis de muestras. A su vez se han desarrollado e implementado índices ecológicos para determinar el nivel de impacto ambiental (Ammonia-Elphidium Index, FORAM-AMBI, FORAM Index, entre otros) en ambientes costeros y arrecifales.

Keywords: meiofauna, ecology, protist, sentinel, biomonitor

ARE MPAS IN VENEZUELA MAKING A DIFFERENCE PROTECTING BENTHIC AND FISH COMMUNITIES? **(Student)**

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Rapid coral reef decline has been reported worldwide. The implementation of MPAs has been suggested as a tool to mitigate the effect of coral reef threats, especially for fish and invertebrate species that have been overfished. However, MPAs establishment doesn't necessarily lead to an improvement of live coral cover because processes others than overfishing may be also determining declining trends. In Venezuela, fish and benthic communities have never been compared inside and outside MPAs. This paper aims to elucidate if differences in fish and benthic communities can be assigned to levels of protection. For this, we sampled seven localities along the Venezuelan coast, three MPAs and four non MPAs and at least three reef sites within each locality. A total of four 30m-long transects were surveyed using the GCRM methodology for describing the benthic community (i.e., 15, 90x80cm, photoquadrats per transect) whereas fish assemblages were characterized by visual censuses. We found no evidence of positive effects of MPAs for any of the variables measured. Instead differences in fish density (Pseudo-F = 2.735, df = 29, p = 0.001), fish biomass (Pseudo-F = 2.041, df = 29, p = 0.001), benthic cover (Pseudo-F = 5.3275, df = 29, p = 0.001), coral species relative cover (Pseudo-F = 3.9565, df = 29, p = 0.001), density and biomass (Pseudo-F = 2.9272 and 2.3364, df = 29, p = 0.001) of interest group fishes (e.g. commercial and key herbivores) were dependent of each site regardless their level protection. Our results suggest that Venezuelan MPAs aren't related with increases in fish density and biomass, nor in benthic and coral cover in comparison with non MPAs. This result emphasizes the importance of small scale processes in fish and benthic communities and the necessity of different management approaches adapted to local scenarios.

Se ha reportado una rápida disminución de los arrecifes de coral en todo el mundo. La implementación de las AMPs se ha sugerido como una herramienta para mitigar el efecto de las amenazas a los arrecifes coralinos, especialmente para las especies de peces e invertebrados que han sido sobrepescadas. Sin embargo, el establecimiento de las AMPs no necesariamente conduce a una mejora de la cobertura de coral vivo, ya que otros procesos distintos a la sobrepesca también pueden determinar tendencias decrecientes. En Venezuela, las comunidades bentónicas y de peces nunca se han comparado dentro y fuera de las AMPs. Este artículo pretende dilucidar si las diferencias en las comunidades bentónicas y de peces se pueden asociar a su nivel de protección. Para esto, muestreamos siete localidades a lo largo de la costa venezolana, tres AMPs y cuatro áreas marinas no protegidas y al menos tres sitios dentro de cada localidad. Se colocaron cuatro transectos de 30m de largo utilizando la metodología GCRM para describir la comunidad bentónica (es decir, 15 foto cuadrantes de 90X80cm por transecto) mientras que la comunidad de peces se caracterizó con censos visuales. No encontramos evidencia de efectos positivos de las AMP para ninguna de las variables medidas. En cambio, diferencias en la densidad de peces (Pseudo-F = 2.735, df = 29, p = 0.001), biomasa de peces (Pseudo-F = 2.041, df = 29, p = 0.001), cobertura bentónica (Pseudo-F = 5.3275, df = 29, p = 0.001), cobertura relativa de

especies de coral (Pseudo-F = 3.9565, df = 29, p = 0.001), densidad y biomasa (Pseudo-F = 2.9272 y 2.3364, df = 29, p = 0.001) de grupos de interés en peces (p. ej., herbívoros clave y peces comerciales) dependían de cada sitio independientemente de su nivel de protección. Nuestros resultados sugieren que las AMPs venezolanas no están relacionadas con aumentos en la densidad y biomasa de peces, ni en la cobertura bentónica y coralina en comparación con las áreas marinas no protegidas. Este resultado enfatiza la importancia de los procesos a pequeña escala en las comunidades de peces y bentónicas, y la necesidad de diferentes enfoques de manejo adaptados a los escenarios locales.

Keywords: MPA, coral reefs, benthic communities, fish communities, Venezuela.

THE EARLY EFFECTS OF MARINE RESERVE DESIGNATION AND FISHERIES MANAGEMENT REFORM ON FISH BIOMASS, DIVERSITY, AND ABUNDANCE WITHIN THE TURNEFFE ATOLL, BELIZE

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The Turneffe Atoll has been an un-managed, accessible area for an open fishery to all Belizean fisherfolk with neither restrictions in place nor permissions necessary to enter. A national decline in fisheries production aided in the push for the designation of the entire atoll as a marine reserve in 2012, with defined zoning that permits or restricts fishing access. Active management of the reserve began in 2016, with only fishers approved by the Belize Fisheries Department being allowed to fish the atoll. From 2010-2018, visual fish surveys of species abundance and size consistent with the Mesoamerican Barrier Reef System synoptic monitoring protocol were conducted at nine localities within the Atoll, both within and outside of fishing restricted zones. One of the Atoll's specific management objectives is an increase from the 2010 estimated commercial and herbivorous fish biomasses (495.1g/100m2 and 643.4 g/100m2) by 2020. Estimated commercial fish biomass in 2018 (423.9 g/100m2) is quite close to 2010's estimate, and 2018 herbivorous fish biomass (1,976.9 g/100m2), though increased, is below what is considered healthy in the Mesoamerican region. However, there is an increasing abundance of fish in larger size classes in later years. In nearly a decade of monitoring, there is no appreciable increase in overall fish species composition, sizes, biomass, or density in the atoll. There is also no distinction in fish assemblages between access and replenishment zones. It may be too soon to assess the effectiveness of the reserve management, however, based on regional reef health measures, the quantities and sizes of these monitored species suggest susceptibility of the commercial stock to overexploitation.

El atolón Turneffe ha sido un área accesible a la pesca. La ausencia de restricciones y permisos para el ingreso han sido evidentes. La disminución de la pesquería a nivel nacional, incentivó la declaración del atolón como reserva marina en el 2012, restringiendo la pesca en áreas definidas. El manejo activo de la reserva inició en el 2016, permitiendo el acceso solo a pescadores aprobados por el Departamento de Pesca de Belice. Del 2010 al 2018, se monitorearon nueve localidades, dentro y fuera de las zonas de pesca, determinando, la especie, la abundancia y el tamaño de peces de acuerdo con el protocolo

de monitoreo sinóptico del Sistema de Barrera de Arrecifes Mesoamericano. Uno de los objetivos específicos de manejo es el incremento de la biomasa de peces comerciales y herbívoros para el 2020 respecto a la del 2010 (495.1 g/100m2 y 643.4 g/100m2 respectivamente). No obstante, para el 2018 la biomasa de peces comerciales fue 423.9 g/100m2, similar a la del 2010, mientras que para peces herbívoros fue de 1,976.9 g /100m2. Aunque se observa una mayor biomasa, aún se encuentra por debajo de lo que se considera saludable en la región mesoamericana. Sin embargo, en los últimos años, se observó un incremento en la abundancia de peces en las clases de tamaños más grandes. En casi una década, no es posible determinar un aumento significativo en la composición, el tamaño, la biomasa o la densidad de peces en todo el atolón, incluyendo las zonas de restricción. Es posible que sea demasiado pronto para evaluar la efectividad de la designación y el manejo de la reserva. La medida de salud de los arrecifes regionales, así como la cantidad y tamaño de las especies monitoreadas, sugieren una susceptibilidad del stock comercial y signos de deterioro del ecosistema.

Keywords: biodiversity, biomass, ecosystem health, fisheries management, marine reserve, Turneffe

SEASCAPE ECOLOGY, VARIATION, AND INTENSITY OF USE, FOR THE SPATIAL CONSERVATION PRIORITIZATION OF A MARINE PROTECTED AREA IN THE MEXICAN CARIBBEAN **(Student)**

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Marine Protected Areas (MPAs) are recognized as the most effective tools for the conservation of biodiversity. However, despite their importance, the design, establishment and evaluation of protected areas in Mexico still lack of robust spatially explicit methodologies that allow to define clear conservation objectives. In here, a systematic prioritization method, based on satellite images coupled with Geographic Information Systems (GIS), was used to identify priority conservation areas in the Cozumel Reefs National Park (CRNP). This protected area is one of the most popular areas for SCUBA diving in the country, with an average of > 1000 visitors per day. The percentage of coverage of different benthic substrates (obtained from ground-truthed data), and hierarchical analysis, were used to identify seven habitat types (sand, coral reefs, dominated by seagrass, high seagrass cover, medium seagrass cover, dominated to high coverage of macroalgae and medium coverage of macroalgae). Ground-truthed data, grouped by habitat type, was then used to perform a supervised classification on a SPOT 7 satellite image obtained in 2017, and construct the thematic map of the coral reef seascape. An overall accuracy of 84% (Kappa of 0.80), was obtained. The thematic map was used to obtain habitat compactness, connectivity, and ß-diversity maps. In addition, a change detection analysis, using an IKONOS satellite image from 2004 as reference data, and an intensity of use map, based on interviews with dive service

providers, were also obtained. The maps were then used to perform a weighted overlay analysis. Several areas in the Southeast of the CRNP were identified as candidates to be considered as areas where conservation efforts should be maximized. However, the zonation in the CRNP management plan does not necessarily reflect the conservation priorities identified from the spatially explicit analysis. Our results can help to establish cost-effective management and conservation strategies on this important and heavily visited protected area.

Las Áreas Naturales Protegidas son reconocidas como la herramienta más efectiva para la conservación de la biodiversidad. Sin embargo, a pesar de su importancia, el diseño, establecimiento y evaluación de éstas en México, aún no hace uso de técnicas espacialmente explícitas robustas que permitan establecer objetivos claros de conservación. En este trabajo se utiliza un método de priorización sistemática basado en imágenes satelitales acopladas a Sistemas de Información Geográfica (SIG) para identificar áreas prioritarias de conservación en el Parque Nacional Arrecifes de Cozumel (PNAC). A partir de los porcentajes de cobertura de los distintos substratos bentónicos obtenidos en campo y técnicas de análisis jerárquico, se identificaron siete tipos de hábitat (arena, arrecife, dominancia de pastos, cobertura alta de pastos, cobertura media de pastos, dominado-alto de macroalgas y cobertura media de macroalgas). Éstos se utilizaron como sitios de entrenamiento para llevar a cabo una clasificación supervisada sobre una imagen satelital SPOT 7 correspondiente al año 2017 y generar el mapa temático del paisaje bentónico con una precisión general del 84% (Kappa de 0.79). El mapa temático obtenido se utilizó para construir mapas de métricas del paisaje (compactación, conectividad y ß-diversidad). Además, se construyeron mapas de análisis de cambio, con base en la comparación con una imagen satelital IKONOS del año 2004, y de frecuencia de visita arrecifal, basado en entrevistas a prestadores de servicio de buceo. Los mapas obtenidos, se utilizaron para realizar un análisis de superposición ponderada. Se identificaron distintas zonas en el Sureste del PNAC donde las actividades de manejo y conservación deben de ser estrictas. La subzonificación y zonificación en el plan de manejo vigente, no necesariamente refleja las prioridades de conservación identificadas a partir del análisis espacialmente explícito. Los resultados obtenidos permitirán que el manejo y conservación de esta importante área protegida, sea más eficiente.

Keywords: GIS and remote sensing, Systematic conservation planning, Marine Protected Areas

SPATIO-TEMPORAL PATTERNS OF MICROHABITAT USE BY THE CLEANER GOBIES *ELACATINUS EVELYNAE* AND *E. PROCHILOS* IN BARBADOS (**Student)**

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Cleaner gobies, *Elacatinus evelynae*, (shark nose goby) and *E. prochilos* (broad striped goby) are small, ecologically similar reef fish that consume fish ectoparasites. Both gobies use barrel sponges and scleractinian corals as microhabitat and both species can overlap in microhabitat use. A key interest in

ecology is assessing co-existence mechanisms in such ecologically similar species. In this study, we investigate this by using these two cleaner gobies as model system. Here, we monitored the abundance and microhabitat use of co-occurring populations of both gobies. Monitoring entailed 89 biweekly surveys from January to December 2018 of a permanent 900m2 reef plot in Barbados. Surveys entailed noting goby abundance and size across 878 corals and 153 barrel sponges. Of those microhabitat units, 304 (35%) corals and 141 (92%) sponges were occupied at least once by gobies. Overall, *E. prochilos* (0.70 individuals per microhabitat unit per survey) was four-fold more abundant than *E. Evelynae* (0.17). Both gobies differed in the relative use of both microhabitats: the majority of *E. Evelynae* resided on corals (63.0%), whereas the majority of *E. prochilos* resided on sponges (88.6%). This led to *E. prochilos* being nine times more abundant than *E. Evelynae* on sponges, yet *E. Evelynae* was only 1.5 times more abundant than *E. prochilos* on corals. Thus, these data suggest some level asymmetrical spatial partitioning between species, whereby *E. Evelynae* is more likely to interact with *E. prochilos*, than *E. prochilos* with *E. Evelynae*. Over time, *E. Evelynae* peaked in abundance in May and September-October, while *E. prochilos* had its highest abundance in October-November, indicating some level of temporal partitioning. This is the first long-term uninterrupted study of the population dynamics of any cleaner goby in the Caribbean region and the first study examining the concurrent use of corals and sponges by two sympatric cleaner gobies.

Human related issues including fisheries

IMPACTS OF SEAFLOOR EROSION ON THE FLORIDA REEF TRACT: PAST, PRESENT AND FUTURE

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Regional-scale loss of seafloor elevation and volume over the past several decades have accelerated the rate of relative sea level rise along the Florida Reef Tract. Current water depths have increased to levels not predicted until near the year 2100, placing these ecosystems and nearby communities at elevated and accelerating risk to coastal hazards such as storms and erosion. We used historical bathymetric data from the 1930's and light detection and ranging (lidar)-derived bathymetric data acquired in 2002 to calculate changes in seafloor elevation associated with coastal seafloor habitats in the Upper Florida Keys. Based on results from that analysis, we determined rates of annual elevation change and then projected future seafloor elevation changes in 25, 50, 75 and 100 years from 2002. These projections indicate that mean seafloor elevation for the Upper Florida Keys study site could decrease by 20 cm in 100 years. However, more than 50% of data points in 8 of 13 habitat classes show mean erosion of more than 1 meter in 100 years. We created idealized reef models at past, present and future elevations based on our elevation analyses and projections. We applied the USGS Coastal Ocean Atmosphere Wave Sediment Transport model to these idealized reefs to examine the potential impact of elevation loss on breaking waves during storm and non-storm wave conditions. Our results show that

breaking waves have already intensified and will continue to intensify at the shoreline during both storm and non-storm conditions. These data and methods are currently being used to extend estimates of future seafloor elevation loss along the South Florida Coastline from Port St. Lucie to Key West for application in coastal flooding risk assessment models.

Keywords: Coral reef, erosion, sea level rise

THE IMPACT OF HURRICANE IRMA ON THE DENSITY AND VOLUME OF THE GIANT BARREL SPONGE POPULATION ON THE SOUTHEAST FLORIDA REEF TRACT (**Student**)

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Xestospongia muta is a key component of the marine benthic community on the Southeast Florida Reef Tract (SEFRT). This species provides increased habitat complexity and stability, and filters large volumes of water, enhancing water quality and facilitating nutrient cycling. In September 2017, Hurricane Irma, a category 4 storm with estimated 100 km/h winds, passed over the SEFRT resulting in damage to the benthic community. The objective of this study was to identify the impact of Irma on the X. muta population utilizing density and volume data from the Southeast Coral Reef Evaluation and Monitoring Project (SECREMP). Data were collected at 20 permanent monitoring sites along the SEFRT before (summer 2017) and after (summer 2018) Irma. Results revealed significant declines in population density and volume from 2017 to 2018. Individual sponges were lost and total biomass reduced, suggesting a decrease in the ecosystem services provided to reefs by X. muta. As climate change increases the frequency and intensity of hurricanes, understanding the effects of storms on X. muta is vital for understanding the status of the population on the SEFRT, as well as the effects on the benthic community from the potential decline in benthic structure, water quality, and nutrient cycling.

Xestospongia muta es un componente clave en la comunidad bentonica marina en el Southeast Florida Reef Tract (SEFRT). Esta especie proporciona complejidad del habitat y estabilidad, y filtra grandes volumenes de agua, mejora la calidad del agua y facilita el ciclo de nutrientes. En septiembre de 2017, Huracan Irma, una tormenta clasificada como categoria 4 con vientos de 100 km/h, disipo el SEFRT que causo destruccion a la comunidad bentonica. El objetivo de este estudio fue identificar el impacto del Irma en la poblacion de X. muta, utilizando los datos de densidad y volumen del Southeast Coral Reef Evaluation and Monitoring Project (SECREMP). Los datos fueron recolectados por el SEFRT en 20 sitios permanentes antes de (verano 2017) y despues de (summer 2018) Irma. Los resultados mostraron la disminucion significativa en la densidad y volumen de la poblacion entre anos 2017 y 2018. Esponjas individuales eran perdidas y la biomasa total disminue, lo que sugiere una disminucion en los servicios de ecosistema que X. muta proporciona a los arrecifes. El cambio del clima esta causando un aumento en la frecuencia e intensidad de los huracanes, entoncces necesitamos comprender los efectos de las tormentas en X. muta para comprender el estado de la poblacion en el SEFRT, tambien los efectos en

la comunidad bentonica con la disminucion potencial en la estructura bentonica, la calidad de agua, y el ciclo nutriente.

Keywords: Xestospongia muta, Florida Reef

QUEEN CONCH REGIONAL POPULATION TRENDS AND HURRICANE EFFECTS AROUND SOUTH CAICOS, TURKS AND CAICOS ISLANDS

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Queen conch (Lobatus gigas) have been fished for many centuries in the Caribbean, where they play an important role in regional culture, economies, and food, but queen conch populations have declined in many Caribbean fisheries in recent decades. In the Turks and Caicos Islands (TCI), commercial catches appeared to be sustainable for many years, but catches decreased significantly after 2009, when two major hurricanes affected the South Caicos fishery. In 2017, two major hurricanes again passed through the TCI. We studied queen conch abundance and distribution in the region south of South Caicos, TCI over the past decade using a fishery-independent survey conducted by faculty, staff, and students of the School for Field Studies. Total conch density was variable over time, but within a given year, overall densities were higher inside a local protected area. The year with the highest estimated density of total conch was 2017, with 574 conch per hectare, whereas conch density was 63 per hectare in 2013. The majority of individuals found within the surveyed region were juveniles. There was a significant relationship from 2011 through 2017 between mature conch abundance and abundance of small juveniles the following year, but not between 2017 adults and 2018 juveniles. Hurricanes Irma and Maria occurred in the fall of 2017. Predominant habitat type differed significantly between pre- and post-2017 hurricanes in an area used by local fishers, though habitat data were not recorded immediately before these storms. Density of reproductively mature adults in the surveyed region is around, and in some years below, the minimum density required for successful reproduction in other regions of the Caribbean, suggesting ongoing queen conch monitoring is warranted, particularly as effects of recent hurricanes unfold, as are studies of source-sink queen conch population dynamics within the Caribbean region.

Keywords: queen conch, hurricanes, fisheries, TCI, MPAs

QUEEN CONCH: CHALLENGES WITH A JUVENILE FISHERY

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Iconic because of its cultural and economic value, Queen Conch (Lobatus gigas) represents one of the most important fishery resources in the region. The Turneffe Atoll has historically been important for L. gigas extraction. The large expanse of seagrass, sand flats and algal beds throughout the atoll fills a critical role as nursery and feeding areas for the commercially important species. In Belize, L. gigas area fished small scale by artisanal methods, characterized by small skiffs and sail boats, and managed through a minimum shell length of 178mm, a minimum clean meat weight of 85.04g, a closed fishing season (July 1st to September 30th) and a fishing quota determined by the Belize Fisheries Department. Additionally, the Turneffe Atoll is divided into conservation (no-extraction) and general use (extraction allowed) zones, with some of the conservation zones having priority for no L. gigas extraction. Here we present the results of five years of L. gigas surveys conducted at the Turneffe Atoll Marine Reserve (TAMR). Fisheries independent surveys were conducted at the closing of the open season (July) and prior to its reopening (September). Preliminary results show trends in habitat distribution with juveniles being found in the shallow sand and algal flats and adults in deeper fore reef habitat, a decrease in shell length of 20mm (±8.15mm) for L. gigas with >1mm lip thickness, and variations in juvenile and adult abundance throughout the years. Our results are consistent with data from other marine reserves, showing that the national population consists primarily of juveniles. Data collected during these biannual surveys are used to inform management on the status of this commercially important species. Based on the results, it is recommended that consideration be given to reduce fishing pressure by area specific quotas, as well as including lip thickness limitations.

Lobatus gigas (caracol rosado) representa uno de los recursos pesqueros más importantes de Belice, debido a su valor económico y cultural. Históricamente, la extracción de L. gigas ha sido importante en el atolón Turneffe; las grandes extensiones de pastos marinos, arenales y tapetes de algas lo dotan de un papel fundamental en la crianza y alimentación de especies comercialmente importantes. En Belice, el departamento de pesca establece una talla mínima de pesca de 178 mm (longitud de la concha), un peso mínimo de 85.04 g (carne limpia), una temporada de veda (del 01 de julio al 30 de septiembre) así como una cuota de pesca. Actualmente Turneffe es una reserva marina (TAMR) con áreas de pesca y de conservación, incluyendo zonas prioritarias que prohíben la extracción de L. gigas. Aquí presentamos los resultados de cinco años de monitoreo de L. gigas, realizados en TAMR al cierre de la temporada abierta (julio) y antes de su reapertura (septiembre). A pesar de que la pesca se ha realizado en pequeña escala y utilizando métodos artesanales, los resultados muestran tendencias en la disminución de la abundancia, así como en los patrones de distribución; individuos juveniles fueron encontrados en extensiones de arena y tapetes de algas, mientras que los adultos en zonas más profundas. Así mismo, se observó una disminución de 20 mm (±8.15mm) en la longitud de la concha para individuos con un grosor de labio menor a 1mm. Los datos encontrados son consistentes a los reportados por otras reservas marinas, mostrando que la población de L. gigas en Belice consiste principalmente en individuos juveniles. La información recolectada, pose gran importancia en el manejo de esta especie,

se recomienda considerar la reducción de la presión de pesca mediante cuotas específicas de área, así como incluir las limitaciones del grosor de labio.

Keywords: Queen conch, artisanal fishery, Turneffe Atoll, Belize

RELATIONSHIP BETWEEN VIRAL LOAD AND INFECTION IN CARIBBEAN SPINY LOBSTERS EXPOSED TO PANULIRUS ARGUS VIRUS 1

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The drivers of host-pathogen interactions are multifaceted, as is the case for Panulirus argus Virus 1 (PaV1). PaV1 is the only virus known to naturally infect any species of lobster worldwide and specifically infects most life history stages of the Caribbean spiny lobster Panulirus argus. PaV1 infections show variability in pathology with lobster size, causing rapid pathology in the smallest juveniles, progressing more slowly among increasingly larger juveniles, and remaining asymptomatic in most adults. Our goals were to test viral load as a factor driving this variability and to determine the minimum infectious dose required to initiate infection for lobsters of different size classes. We hypothesized that larger lobsters would develop a lower viral load over time than smaller lobsters, when exposed to the same concentration of PaV1 virions. Moreover, both small and large juveniles would have higher viral loads when inoculated with high concentrations of PaV1 relative to low concentrations. A TaqMan real-time quantitative PCR (qPCR) assay was used to measure the response of lobsters to different levels of PaV1 exposure. Two size classes of juvenile lobsters (small and large) were collected from Florida Keys, FL (USA) and screened using qPCR. Next, PaV1-negative lobsters were injected with diluted or undiluted hemolymph collected from clinically-infected lobsters. All lobsters, excluding those among the control groups, tested positive for PaV1 post-inoculation. Because all of the experimental lobsters became infected, we were unable to determine the minimum infectious dose for the two size classes of lobsters. However, the small lobsters had a higher overall net increase in viral load as compared to that of the large lobsters, supporting our hypothesis. The small lobsters also suffered higher mortality relative to their larger conspecifics. The high viral load associated with small lobsters may explain why PaV1 infections are size-dependent and are fatal to small juveniles.

Los controladores de las interacciones host-patógeno son multifacéticos, como es el caso del virus 1 de Panulirus argus (PaV1). PaV1 es el único virus conocido que infecta naturalmente cualquier especie de langosta en todo el mundo e infecta específicamente la mayoría de las etapas de la historia de la langosta espinosa del Caribe, Panulirus argus. Las infecciones por PaV1 muestran una variabilidad en la patología con el tamaño de la langosta, causando una patología rápida en los juveniles más pequeños, progresando más lentamente entre los juveniles cada vez más grandes y permaneciendo asintomática en la mayoría de los adultos. Nuestros objetivos fueron probar la carga viral como factor que impulsa esta variabilidad y determinar la dosis infecciosa mínima requerida para iniciar la infección de langostas

de diferentes clases de tamaño. Nuestra hipótesis es que las langostas más grandes desarrollarían una carga viral más baja con el tiempo que las langostas más pequeñas, cuando se exponen a la misma concentración de viriones de PaV1. Además, tanto los juveniles pequeños como los grandes tendrían cargas virales más altas cuando se inoculen con altas concentraciones de PaV1 en relación con concentraciones bajas. Se utilizó un ensayo de PCR cuantitativa en tiempo real TaqMan (qPCR) para medir la respuesta de las langostas a diferentes niveles de exposición a PaV1. Se recolectaron dos clases de tamaño de langostas juveniles (pequeñas y grandes) de Florida Keys, FL (EE. UU.) Y se seleccionaron usando qPCR. A continuación, las langostas PaV1 negativas se inyectaron con hemolinfa diluida o sin diluir recolectada de langostas clínicamente infectadas. Todas las langostas, excluyendo aquellas entre los grupos de control, dieron positivo para PaV1 después de la inoculación. Debido a que todas las langostas experimentales se infectaron, no pudimos determinar la dosis infecciosa mínima para las dos clases de tamaño de langostas. Sin embargo, las langostas pequeñas tuvieron un mayor aumento neto general en la carga viral en comparación con la de las langostas grandes, lo que respalda nuestra hipótesis. Las langostas pequeñas también sufrieron una mayor mortalidad en comparación con sus conspecíficos más grandes. La alta carga viral asociada con las langostas pequeñas puede explicar por qué las infecciones por PaV1 dependen del tamaño y son fatales para los juveniles pequeños.

Keywords: Panulirus argus Virus 1, dose, response, qPCR, lobster

SPATIAL VARIATION AND TROPHIC STRUCTURE OF DEMERSAL FISH COMMUNITIES: A CASE STUDY FROM THE DELTA OF THE ORINOCO'S RIVER (**Student**)

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Demersal fish communities are important for they represent the major source of income of thousands of people living nearby the marine-estuarine area associated with the Orinoco's River. Despite its economic and ecological relevance, the trophic structure of these fish remains poorly understood in this region. In this study, we studied the spatial variability of the trophic community by characterizing diets and trophic networks properties. For this, we sampled the demersal fish community at three localities: (1) Golfo de Paria, (2) Boca de Serpiente and (3) Boca Grande; each one with different environmental features. Fish were collected by trawling from a vessel at 10 knobs, between April and May of 2015. A total of 315 stomachs contents belonging to 29 fish species were processed. We estimated spatial variation in community structure and characterized the trophic networks within and between localities using Bray-Curtis index as similarity metric, a compound Index of Relative Importance (IRI) as a measure of diet composition and prey relevance for each fish species for complex network analysis. Trophic structure of demersal fishes was variable within and between localities. Changes in prey items and IRI values demonstrate that diet composition varies between localities for species such as the white croaker (Micropogonias furnieri), the Atlantic spadefish (Chaetodipterus faber), and weakfishes (Cynoscion virescens and Cynoscion similis). Prey items such as Crustaceans and Fishes consistently provided higher stability to the trophic networks. Our results illustrate how the removal of any of these items would have deep impacts for the survival of other species. Results from our study can be useful for future

resource management and conservation plans for they offer a baseline study of key elements in commercially-important trophic networks.

Los peces demersales son importantes porque de ellos representan la mayor fuente de ingresos para miles de personas que viven cerca del Rio Orinoco. A pesar de su importancia económica y ecológica, la estructura trófica de estos peses permanece sin ser comprendida en esta región. En este trabajo evaluamos la variabilidad especial de la estructura trófica de la comunidad de peces de peces demersales mediante la caracterización de sus dietas y las propiedades de las redes. Para ello, muestreamos la comunidad de peces demersales en 3 localidades con características ambientales diferentes: (1) Golfo de Paria, (2) Boca de Serpiente and (3) Boca Grande. Los peces se muestrearon con arrastres a 10 nudos entre Abril y Mayo de 2015. Un total de 315 estómagos pertenecientes a 29 especies de peces fueron analizados. Estimamos la variabilidad espacial en la estructura de la comunidad y caracterizamos las redes tróficas entre y dentro de localidades utilizando el índice de Bray Curtis como métrica de similitud, un índice compuesto de importancia relativa (IRI) como medida de la composición dietaria e importancia de las presas para cada especie de pez para la construcción de la red trófica. La estructura de la comunidad de peces demersales cambio entre localidades pero fue variable entre sitios. Los cambios en los ítems de presas y los valores de IRI demuestran que la composición de dietas varía entre localidades para especies de peces como el “White croaker” (Micropogonias furnieri), el “Atlantic spadefish” (Chaetodipterus faber), and los “Weakfishes” (Cynoscion virescens y Cynoscion similis). Los crustáceos y los peces fueron los ítems que le dieron mayor estabilidad a las redes tróficas. Nuestros resultados muestran que la remoción de estos ítems tendría un impacto profundo sobre la supervivencia de otras especies. Los resultados de este estudio pueden ser útiles para los planes de manejo y conservación de los recursos pesqueros en el futuro, dado que representan una línea base de los elementos que conforman las redes tróficas de interés comercial.

Keywords: Demersal fishes, Community structure, Diet Composition, Trophic networks, Estuary, Orinoco’s River Delta

REDUCING LAND-BASED SOURCES OF MARINE DEBRIS THROUGH COMMUNITY ENGAGEMENT ACTIVITIES IN THE U.S. VIRGIN ISLANDS

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Marine debris is a global problem and one felt locally in the U.S. Virgin Islands (USVI), where land-based sources of marine debris result from high residential waste production, lack of large-scale recycling, scarcity of bulk waste disposal locations, and inefficient roadside waste collection. With funds from the National Oceanic & Atmospheric Administration’s Marine Debris Program and Coral Reef Conservation Program, we developed a targeted, ridge-to-reef educational and outreach program to change knowledge and attitudes towards marine debris and lead to its reduction. In 2016 and 2018, we hosted two

professional development workshops for territorial educators, University of the Virgin Islands (UVI) Masters of Marine & Environmental Science (MMES) students, and additional, territorial stakeholders with marine debris, STEM education, and inclusion interests. The workshop introduced new, USVI-specific curricula adapted from Oregon Sea Grant's "Marine Debris STEAMSS" that highlights Caribbean ecosystems and local research. Seven Community Transfer Projects (CTPs), co-developed by educators and UVI MMES students, were funded and implemented during Spring 2017 to engage USVI youth and the broader community in creative, culturally-relevant projects to reduce land-based sources of marine debris in the Territory. CTPs model place-based, knowledge-to-action best practices for underserved populations that may serve as useful examples for others. In September 2017, Hurricanes Irma and Maria greatly impacted the islands, creating massive amounts of debris. In April 2018, we held the first annual Great Mangrove Cleanup, an event that attracted >120 volunteers who removed >3,000 lbs of marine debris from mangrove shorelines in a marine protected area on St. Thomas. The majority of marine debris items collected were plastic, originating from land-based sources, and similar in composition to what is found on USVI beaches but at densities 2-19 times greater. These events highlight the challenges to marine debris in the Territory, but also promising, potential solutions.

Keywords: marine debris, plastic pollution, community engagement, broadening participation, educator professional development, ridge-to-reef

Session: Reef Monitoring – AGRRA: Science to Action

COMPLETE RESILIENCE IN A CARIBBEAN CORAL REEF ECOSYSTEM: LESSONS FROM A 15 YEAR CASE STUDY FROM BONAIRE.

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Coral reefs are among the world's most endangered ecosystems. Coral mortality can result from ocean warming and coral bleaching or other climate-related events such as intense hurricanes. While resilient coral reefs have been documented throughout the tropical Indo-Pacific, no similar reef-wide recovery has ever been reported for the Caribbean. Climate change-related coral mortality is unavoidable, but local management actions can improve conditions for regrowth and for the establishment of juvenile corals, thereby enhancing the recovery resilience of these ecosystems. It is known that herbivory limits macroalgae and improves conditions for coral recruitment and regrowth. Management that reduces algal abundance increases the recovery potential for both juvenile and adult corals on reefs. We quantified patterns of distribution and abundance of reef fish, coral, algae, and juvenile corals along replicate fixed transects at 10 m depth at multiple sites from 2003 to 2017 on Bonaire's reefs. Beginning with our first exploratory study in 2002 until 2007 coral was abundant (45% cover) and macroalgae were rare (6%

cover). Consecutive disturbances, from Hurricane Omar in October 2008 and a coral bleaching event in October 2010, resulted in a 22% decline in coral cover and a sharp threefold increase in macroalgal cover to 18%. Juvenile coral densities declined to about half of their previous abundance. Herbivorous parrotfishes had been declining in abundance but stabilized around 2010, the year fish traps were phased out and fishing for parrotfish was banned. Bonaire's average parrotfish biomass from 2010 to 2017 was more than twice that reported for coral reefs of the Eastern Caribbean. During this same period, macroalgae declined and both juvenile coral density and total adult coral cover returned to pre-hurricane and bleaching levels. To our knowledge, this is the first example of a resilient Caribbean coral reef ecosystem that fully recovered from severe climate-related mortality events.

Los arrecifes de coral se encuentran entre los ecosistemas más amenazados del mundo. La mortalidad de los corales puede deberse al calentamiento del océano y la decoloración de los corales u otros eventos relacionados con el clima, como y los huracanes intensos. Si bien se han documentado arrecifes de coral resistentes en todo el Indo-Pacífico tropical, nunca se ha reportado una recuperación similar en todo el arrecife para el Caribe. La mortalidad de los corales relacionada con el cambio climático es inevitable, pero las acciones de manejo local pueden mejorar las condiciones para el rebrote y el establecimiento de corales juveniles, lo que mejora la capacidad de recuperación de estos ecosistemas. Se sabe que la herbivoría limita las macroalgas y mejora las condiciones para el reclutamiento y el recrecimiento de los corales. El manejo que reduce la abundancia de algas aumenta el potencial de recuperación de corales tanto juveniles como adultos en arrecifes. Cuantificamos los patrones de distribución y abundancia de peces de arrecifes, corales, algas y corales juveniles a lo largo de transectos fijos replicados a 10 m de profundidad en múltiples sitios desde 2003 hasta 2017 en los arrecifes de Bonaire. Comenzando con nuestro primer estudio exploratorio en 2002 hasta 2007, el coral era abundante (45% de cobertura) y las macroalgas eran raras (6% de cobertura). Las perturbaciones consecutivas, provocadas por el huracán Omar en octubre de 2008 y un evento de blanqueamiento de corales en octubre de 2010, dieron como resultado un descenso del 22% en la cobertura de coral y un fuerte incremento triple en la cobertura de macroalgas al 18%. Las densidades de coral juvenil disminuyeron a aproximadamente la mitad de su abundancia anterior. Los peces loro herbívoros habían estado disminuyendo en abundancia, pero se estabilizaron alrededor de 2010, el año en que se eliminaron las trampas para peces y se prohibió la pesca de peces loro. La biomasa promedio del pez loro de Bonaire desde 2010 hasta 2017 fue más del doble que la registrada en los arrecifes de coral del Caribe oriental. Durante este mismo período, las macroalgas disminuyeron y tanto la densidad de los corales juveniles como la cobertura total de corales adultos volvieron a los niveles de pre-huracán y decoloración. Por lo que sabemos, este es el primer ejemplo de un ecosistema de arrecifes de coral del Caribe resistente que se recuperó completamente de los graves eventos de mortalidad relacionados con el clima.

Keywords: Bonaire, Resilience, Coral Bleaching, Hurricanes, Management, Herbivory

STATUS AND TRENDS OF CORAL REEFS IN ANTIGUA, BARBUDA AND REDONDA

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Antigua, Barbuda and Redonda have experienced major degradation of their coral reef ecosystems over the past 40 years. The primary drivers of this degradation are multiple and highly linked to anthropogenic influences inclusive of overexploitation and poor management of marine resources. The ECMMAN Project's (2016) Coral Reef Report Cards for six participating Eastern Caribbean countries ranked Antigua and Barbuda's overall reef condition as poor and on the lower end of the Caribbean reef health scale. It also inadvertently highlighted the scarcity of available reef data for the islands, and that available data area highly scattered. The government of Antigua, Barbuda and Redonda recognized the need for a marine data collection program to better inform the designation and management of Marine Protected Areas to improve the condition of its marine ecosystems. The Atlantic and Gulf Rapid Reef Assessment (AGRRA) program has proven invaluable to our efforts, given the comparability with previously collected data, and the fast turnover of data-analysis products. AGRRA surveys have been carried out in two Antiguan protected areas (NEMMA, 2017, in the northeast; NDNP, 2019, in the south) since the 2016 report. While these results mirror the conclusions published in 2016, variation among areas has been highlighted–differences which can be crucial to identifying and designating management zones. Additionally, marine surveys have been conducted for the first time off Redonda, which has recently (2018) experienced tremendous recovery of its terrestrial environments due to the removal of invasive species, and these data are being directly incorporated into management planning for the island. Several other areas have been ear-marked for AGRRA surveys by the government to improve the knowledge available on the health of the marine ecosystems, inform the revision of existing management plans, and to aid in the creation of new management zones.

Antigua, Barbuda y Redonda han experimentado un gran deterioro de sus arrecifes coralinos en los últimos 40 años. Los principales generadores de esta degradación son múltiples y están altamente ligados a influencias antropogénicas, incluyendo la sobrexplotación y manejo deficiente de los recursos marinos. Las Tarjetas de Reporte de Arrecifes de Coral del Proyecto ECMMAN (2016) para seis países participantes del Caribe Oriental, clasificaron la condición general de arrecifes de Antigua y Barbuda como pobre y en el extremo inferior de la esala de salud de los arrecifes del Caribe. También resaltó inadvertidamente la escasez de datos de arrecifes disponibles para las islas y que los datos disponibles están muy dispersos. El gobierno de Antigua, Barbuda y Redonda reconocií la necesidad de un programa de recolección de datos marinos para informar mejor la designación y el manejo de las Áreas Marinas Protegidas para mejorar la condición de sus ecosistemas marinos. El programa de Evaluación rápida de arrecifes en el Atlántico y el Golfo (AGRRA) ha demostrado ser invaluable para nuestros esfuerzos, dada la comparabilidad con los datos recopilados anteriormente y la rápida rotación de los productos de análisis de datos. Las muestreos AGRRA se han llevado a cabo en dos áreas protegidas de Antigua (NEMMA, 2017, en el noreste; NDNP, 2019, en el sur) desde el informe de 2016. Si bien estos resultados reflejan las conclusiones publicadas en 2016, se ha destacado la variación entre áreas, diferencias que pueden ser cruciales para identificar y designar zonas de gestión. Además, por primera vez se llevaron a cabo estudios marinos costa afuera de Redonda, que recientemente (2018) experimentó una gran recuperación de sus ambientes terrestres debido a la eliminación de especies

invasoras y estos datos se están incorporando directamente en la planificación de la gestión de la isla. Otras áreas se han asignado para muestreos AGGRA por parte del gobierno para mejorar el conocimiento disponible sobre la salud de los ecosistemas marinos, informar la revisión de los planes de manejo existentes y ayudar en la creación de nuevas zonas de manejo.

Keywords: AGRRA, Coral Reefs, MPA, Marine Surveys, Management Zones

ECOLOGICAL AND SOCIO-ECONOMIC INDICATORS OF FISHING PRESSURE ON CORAL REEFS IN THE PORTLAND BIGHT PROTECTED AREA, JAMAICA

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Jamaica's fisheries are among the most intensely overfished in the Caribbean. No-fishing zones called Special Fishery Conservation Areas (SFCA) aspire to improve the sustainability of the fishing industry. The Portland Bight Protected Area (PBPA) has three, land-attached SFCA's that collectively lack any coral reef habitat. In 2018 ecological and socio-economic assessments were carried out to determine suitable areas for an additional SFCA to include reefs. AGRRA fish and benthic surveys of reef condition in five sites were augmented by interviews of 219 fishers at key landing sites to ascertain fisher activity. Coral cover (16.3 – 20.3%) and fish density (up to 167.3/100m2) were fair to good at the regional level (Reef Health Index). However, the total fishable biomass was critically low overall and dominated by small parrotfishes (up to 50%), and juvenile fishes. Macroalgal cover varied from low (2.3%, Pigeon Island) to dense (31.9%, Pigican Shoal) with overall low (< 0.5/m2) urchin densities. Fishing activity across all the surveyed reefs was principally by spears and nets, with younger spear fishers targeting parrotfish and older fishers typically fishing at night using nets. All fishers caught snapper, parrotfish, grunt, doctorfish and jack. All species irrespective of their diminutive numbers, size, or whether they are sexually mature or spawning are targeted by unregulated fishing activity across the PBPA reefs. Local fishers are reliant on the reefs for livelihood security and wellbeing, presenting a challenge for effective management. Based on its coral reef health and dominant fishery, Pigeon Island's reefs and (its) associated habitats are ecologically suitable for the establishment of a SFCA. The attitude of fishers towards its protection varies according to fishing sites, techniques and sociodemographic factors that should be considered to minimize socioeconomic trade-offs – information that is being provided in our initial recommendations to the Jamaican Government for selecting a new SFCA site.

Las pesquerías de Jamaica se encuentran entre las de mayor intensidad de sobrepesca en el Caribe. Las zonas de no pesca denominadas Áreas Especiales de Conservación de la Pesca (SFCA) aspiran a mejorar la sostenibilidad de la industria pesquera. El área protegida de Portland Bight (PBPA) tiene tres SFCA adosadas a la tierra que colectivamente carecen de hábitat de arrecifes de coral. En 2018 se llevaron a cabo evaluaciones ecológicas y socioeconómicas para determinar las áreas adecuadas para un SFCA adicional, para incluir los arrecifes. Muestreos AGRRA de peces y bentos sobre la condición

de los arrecifes en cinco sitios, se aumentaron mediante entrevistas a 219 pescadores en sitios de desembarque clave para determinar la actividad de los pescadores. La cobertura de coral (16.3 - 20.3%) y la densidad de peces (hasta 167.3 / 100m2) fueron favorables a buenas a nivel regional (Índice de salud de arrecifes). Sin embargo, la biomasa total de captura de peces fue críticamente baja en general y estuvo dominada por peces loro pequeños (hasta un 50%) y peces juveniles. La cobertura macroalgal varió de baja (2.3%, Pigeon Island) a densa (31.9%, Pigican Shoal) con densidades de erizo bajas en general (<0.5 / m2). La actividad de pesca en todos los arrecifes estudiados se realizó principalmente por medio de lanzas y redes, con pescadores más jóvenes enfocados en el pez loro y pescadores más viejos normalmente pescando de noche usando redes. Todos los pescadores capturaron pargo, pez loro, pez ronco, pez cirujano doctor y pez gato. Todas las especies, independientemente de su pequeño número, tamaño, o si son sexualmente maduras o desovan, son el objetivo de la actividad de pesca no regulada en los arrecifes de PBPA. Los pescadores locales dependen de los arrecifes para la seguridad y el bienestar de los medios de vida, lo que representa un desafío para una gestión eficaz. Basados en la salud de sus arrecifes de coral y en la pesquería dominante, los arrecifes de la isla Pigeon y sus hábitats asociados, son ecológicamente adecuados para el establecimiento de un SFCA. La actitud de los pescadores hacia su protección varía según los sitios de pesca, las técnicas y los factores socio demográficos que deben considerarse para minimizar las intercambios socioeconómicos: información que se proporciona en nuestras recomendaciones iniciales al Gobierno de Jamaica para seleccionar un nuevo sitio de SFCA.

Keywords: Portland Bight Protected Area, Jamaica, coral reef health, fishers, marine protected areas, Special Fishery Conservation Areas

SWITCHING BETWEEN STANDARD CORAL REEF BENTHIC MONITORING PROTOCOLS IS PROBLEMATIC

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Monitoring programmes are an important component in the conservation, management and sustainable use of coral reef ecosystems. In this study, the performance of the photoquadrat (PQ) method adopted by the newly re-activated Global Coral Reef Monitoring Network (GCRMN – Caribbean) was compared against the linear point intercept (LPI) method utilized by the long-term Barbados Reef Survey Programme, in order to make an informed decision on whether or not the PQ protocol should be adopted. Fifteen sites across bank, fringing and patch reefs were surveyed using both methods concurrently, and (1) the percent cover of major benthic categories, (2) species diversity and (3) time required to obtain data in usable form were compared. At a coarse scale, the methods produced broadly similar results. However, at a more detailed level results differed significantly depending on major benthic category and

reef type. The PQ method detected fewer species, lower percent cover of hard corals, sponges, and macroalgae, and higher percent cover of gorgonians, encrusting algae and turf algae than the LPI method. Furthermore, whilst data collection times in the field were similar between PQ and LPI, analysis of the photographs took, on average, double the time needed for LPI data entry. As the differences between methods are not limited to the method itself, but dependent on benthic category and reef type, the two methods are not easily comparable. As such, we warn against transition between these two methods in long-term reef survey programmes.

Los programas de monitoreo son un componente importante en la conservación, manejo y uso sostenible de los ecosistemas de arrecifes de coral. En este estudio, se comparó el rendimiento del método photoquadrat (PQ) adoptado por la Red Global de Monitoreo de Arrecifes de Coral (GCRMN - Caribe) recientemente reactivada con el método de intercepción de punto lineal (LPI) utilizado por el estudio a largo plazo de Barbados Reef Survey Programa, con el fin de tomar una decisión informada sobre si debe o no adoptarse el protocolo PQ. Se estudiaron quince sitios en bancos, franjas y arrecifes de parches utilizando ambos métodos simultáneamente, y (1) se compararon los porcentajes de cobertura de las principales categorías bentónicas, (2) la diversidad de especies y (3) el tiempo requerido para obtener datos en forma utilizable. En una escala aproximada, los métodos produjeron resultados muy similares. Sin embargo, a un nivel más detallado, los resultados diferían significativamente según la categoría béntica principal y el tipo de arrecife. El método PQ detectó menos especies, menor porcentaje de cobertura de corales duros, esponjas y macroalgas, y mayor porcentaje de cobertura de gorgonias, incrustando algas y algas de césped que el método LPI. Además, si bien los tiempos de recolección de datos en el campo fueron similares entre PQ y LPI, el análisis de las fotografías tomó, en promedio, el doble del tiempo necesario para el ingreso de datos LPI. Como las diferencias entre los métodos no se limitan al método en sí, sino que dependen de la categoría bentónica y el tipo de arrecife, los dos métodos no son fácilmente comparables. Como tal, advertimos contra la transición entre estos dos métodos en los programas de estudios de arrecifes a largo plazo.

Keywords: Coral reefs, Caribbean, survey methods, photoquadrats, linear point-intercept

REEF HEALTH AND WATER QUALITY OF THE PORT ROYAL CAYS, JAMAICA: TOOLS FOR INFORMING EFFECTIVE CORAL REEF MANAGEMENT STRATEGIES

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Coral reefs worldwide are threatened by multiple stressors. The Port Royal Cays (PRC) reefs are located south of Kingston Harbour, Jamaica, the world's seventh largest natural harbour, making them particularly vulnerable to degradation from coastal development. AGRRA coral and benthic surveys were conducted to assess the status at two depth intervals (5-8 and 9-14m) of five sites with differing

proximities to the harbour entrance and shipping channel. The PRC reefs have moderately good coral cover (20-28%), but overall are in poor to fair condition and within-site variability is high. The inshore patch reef closest to the entrance had nutrient concentrations of 1.9µM NO_3 L^{-1} and 0.25µM PO_4L^{-1}, surpassing recommended optimal thresholds for corals. Nevertheless, its macroalgal cover was relatively low (10%), although non-reef building aggressive invertebrates (21%) overgrew several corals, and *Echinometra viridis* densities (6.6 urchin/m^2) suggested a potential for high rates of bioerosion. Highest net sedimentation rates (15.6 g/cm^2/day) occurred on the inner patch reef closer to the shipping channel, where macroalgal cover was 31% and turf algal-sediment mats encroached over small areas of most corals. The outer spur-and-groove reefs, which were the least influenced by nutrients and sedimentation, had relatively few macroalgae (14% cover) and “ecologically reasonable” densities of *Diadema* (2.3 urchins/m^2) at two sites; but macroalgae were abundant (43% cover) at the third, easternmost site. The comparatively poor condition of the patch reef near the shipping channel underscores the urgent need for protective mitigation strategies. Consequently, this research will be used to: (i) recommend improvements both in silt screen usage during future dredging operations, and in municipal sewage treatment, to the Kingston Freeport Terminal Limited’s Fisheries Resource Technical Working Group; and (ii) justify the proposed selection of the outer reefs as a Special Fishery Conservation Area to the Jamaican Government.

Los arrecifes están amenazados mundialmente por múltiples estresores. Los arrecifes de Cayos *Port Royal* (CPR) están ubicados al sur de Puerto Kingston, Jamaica, el séptimo puerto natural más grande del mundo, haciéndolos vulnerables a la degradación por desarrollo costero. Evaluaciones AGRRA de coral y bentos fueron realizadas para estudiar su estatus a dos intervalos de profundidad (5-8 y 9-14 m) en cinco sitios con diferentes proximidades a la entrada del puerto y canal de navegación. Los arrecifes CPR presentan cobertura coralina moderadamente buena (20-28%), aunque condiciones de pobre a regular con alta variabilidad entre sitios. El parche arrecifal más cercano a la entrada superó los umbrales de concentraciones de nutrientes óptimos para corales: 1.9 µM NO_3 L^{-1} y 0.25 µM PO_4 L^{-1}. Aunque la cobertura de macroalgas fue baja (10%), los invertebrados agresivos no-constructores (21%) sobrecrecían varios corales y las densidades de *Echinometra viridis* (6.6 erizos / m2) sugieren altas tasas bioerosivas. El arrecife más cercano al canal registró las tasas más altas de sedimentación neta (15.6 g / cm2 / día), cobertura de macroalgas del 31% y algas cespitosas ocupando pequeñas áreas de la mayoría de los corales. Los arrecifes surco y espolones externos, con menor influencia de nutrientes y sedimentación, presentaron bajas coberturas de macroalgas (14%) y densidades "ecológicamente razonables" de *Diadema* (2,3 erizos / m^2) en dos sitios; pero las macroalgas fueron abundantes (43%) en el sitio más al este. La condición comparativamente deficiente del arrecife cerca del canal subraya la urgencia de estrategias de mitigación de protección. Los resultados permiten (i) recomendar al Grupo de Trabajo Técnico de Recursos Pesqueros *Kingston Freeport Terminal Limited* mejoras en el tratamiento de aguas residuales y uso de pantallas de sedimento a futuro, (ii) justificar a los arrecifes externos como Área de Conservación de Pesca Especial al Gobierno de Jamaica.

Keywords: Port Royal Cays, Jamaica, AGRRA, Coral Reef Health, Nutrients, Sedimentation

REVERSING THE DECLINE OF BAHAMIAN CORAL REEFS: ASSESSING REEF HEALTH FOR EFFECTIVE MANAGEMENT AND RESTORATION

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The Bahamas is a vast archipelago with more coral reef area than any other Caribbean nation. Over the past decade we have launched a major effort to assess coral reef condition or "health" throughout The Bahamas. Atlantic and Gulf Rapid Reef Assessment (AGRRA) surveys have been conducted at over 320 sites that cover a wide range of reef types, reef zones and management strategies. An overview of what these surveys reveal about key indicators of coral reef health throughout The Bahamas, including metrics related to coral populations, benthic communities and fish assemblages is provided. For several locations, data collected over the past 10-20 years illuminate the role that hurricanes, bleaching events, various human impacts and restoration efforts have played in changing Bahamian reef seascapes. We discuss how information from AGRRA surveys has been used to: evaluate the efficacy of marine protected areas; contribute to the designation and management of new marine protected areas in The Bahamas; and guide coral restoration and reef rehabilitation efforts. Several ways survey results have been used to inform decision-makers, key stakeholders, and the general public about the importance of coral reefs and how they can help preserve coral reefs are described.

Las Bahamas es un archipiélago vasto con más área de arrecifes de coral que cualquier otra nación en el Caribe. Durante la última década, hemos comenzado un gran esfuerzo para evaluar la condición o "salud" de los arrecifes de coral en las Bahamas. Usamos la metodología llamada Atlantic y Gulf Rapid Reef Assessment (AGRRA por sus siglas en inglés) que evalúa rápidamente la condición en más de 320 sitios que cubren diferentes tipos de arrecifes, zonas de arrecifes y bajo diferentes categorías de manejo. Se presenta una descripción general de estos monitoreos y lo que indican sobre los indicadores clave de la salud de los arrecifes de coral en las Bahamas, incluyendo los parámetros relacionadas con las poblaciones de coral, las comunidades bentónicas y las asociaciones de peces. En varios áreas los datos recabados durante los últimos 10 a 20 años ilustran el impacto que juegan los huracanes, los eventos de blanqueamiento, los diferentes impactos humanos y esfuerzos de restauración en el cambio de los arrecifes de coral de las Bahamas. Discutimos cómo se ha utilizado la información de los monitoreos AGRRA para: evaluar la eficacia de las áreas marinas protegidas (AMPs); contribuir a la designación y manejo de nuevas áreas protegidas; y guiar los esfuerzos de restauración y rehabilitación de arrecifes de coral en las Bahamas. Describimos como hemos usado los resultados del monitoreo para informar a los tomadores de decisiones, a los actores clave y al público en general sobre la importancia de los arrecifes de coral y sobre cómo pueden ayudar a preservar los mismos.

Keywords: AGRRA, MPA, Restoration, Monitoring, Coral Reefs

LONG-TERM CORAL REEF MONITORING AS A MANAGEMENT TOOL: TWENTY YEARS OF DATA FROM THE DOMINICAN REPUBLIC

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Coral reefs in the Dominican Republic (DR) currently face a number of threats that compromise their survival. Even though the degradation of these ecosystems is evident, surprisingly few studies have measured this change over time. Coral reef health data collected from 1995 to 2018 was analyzed from three locations along the southeast portion of the island that varied greatly in both management approaches and socio-economic backgrounds to assess the change experienced by these reefs over the past two decades. When percent live coral and macroalgal cover data, as well as parrotfish densities, were compared, the results showed clear differences in reef health trends over time and among locations. Reefs located in areas of less coastal development proved to be more resilient by recovering better (or faster?) after major impacts such as hurricanes and bleaching events. The main challenge found was the lack of a standardized monitoring effort for the country. Data had been collected by different organizations using different protocols and, in most cases, the same team did not return to the same location in different years. This highlights the importance of long-term monitoring programs, such as the yearly national monitoring organized since 2015 by Fundación Propagas with the University of Maine and Reef Check DR. We hope our ongoing studies will stimulate improved management strategies that, in turn, will result in more sustainable uses of coral reefs and the environmental services they offer to tropical islands.

Los arrecifes de coral en la República Dominicana actualmente se enfrentan a una serie de amenazas que comprometen su supervivencia. A pesar de que la degradación de estos ecosistemas es evidente, sorprendentemente pocos estudios han medido este cambio en el tiempo. Se recopilaron datos de salud de los arrecifes de coral entre los años 1995 y 2018 para tres localidades a lo largo de la parte sureste de la isla con el fin de evaluar las tendencias de cambio experimentadas por estos arrecifes en las últimas dos décadas. Los datos consistieron en porcentaje de cobertura de coral y por macroalgas, así como las densidades de peces loro, y estos se compararon a lo largo del tiempo y entre localidades. Las tres varían drásticamente, tanto en los enfoques de gestión como en factores socioeconómicos. Los resultados mostraron claras diferencias en las tendencias de salud de los arrecifes a lo largo del tiempo y entre localidades. Los arrecifes ubicados en áreas de menor desarrollo costero demostraron ser más resilientes, ya que se recuperaron mejor después de impactos importantes como huracanes y eventos de blanqueamiento. El principal desafío encontrado fue la falta de un esfuerzo de monitoreo estandarizado para el país: Los datos fueron recopilados por diferentes organizaciones utilizando diferentes protocolos y, en la mayoría de los casos, el mismo equipo no regresó al mismo lugar en diferentes años. Esto resalta la importancia de los programas de monitoreo a largo plazo, como el monitoreo nacional anual organizado por la Fundación Propagas con la Universidad de Maine y Reef Check RD. Esperamos que estos resultados estimulen mejores estrategias de manejo, lo que resultará en un uso más sostenible de los arrecifes de coral y los servicios ambientales que ofrecen a las islas tropicales.

Keywords: coral reefs, long term, resilience, monitoring, Dominican Republic

STORY OF AN MPA: TELA BAY, FROM UNKNOWN REEFS TO MARINE WILDLIFE REFUGE IN HONDURAS

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Aided by local fishers, Capiro Banks in Tela Bay, Honduras was first visited by divers during an HRI/CORAL/AGRRA training workshop in 2011. Given the high turbidity (its 10-m crest is rarely visible at the surface), finding the 8-km long, high-relief, spur-and- groove reef was a stunning discovery. Thirty-five coral species covered 70% of the substratum in some areas and were dominated by *Agaricia tenuifolia* and *A. agaricites* having unusual morphologies in the low ambient illumination. *Diadema antillarum* had densities of ~2/m^2 at 8-13 m (7 sites) in 2013 AGRRA surveys, but parrotfish and surgeonfish biomass estimates averaged only 496 and 228 gm/100m^2, respectively. The mean benthic cover of live corals (43%), crustose coralline algae (19%) and sparse turf algae (15%) in 2013 each exceeded that of "aggressive" invertebrates (7%), fleshy macroalgae and turf algal sediment mats (both 2%), peyssonnelids and conspicuous cyanobacteria (both 1%). HRI, CORAL and AMATELA (a new "friends group") promptly initiated what became a seven-year effort to protect this amazing reef tract. A well-attended press event, with Capiro-caught lionfish ceviche, markedly changed how Tela inhabitants viewed its coral reefs. A commission, that included the local municipality, NGO and chamber of tourism, national government and national university, secured its designation as a municipal MPA in less than six months; and then as a Site of Wildlife Importance within 18 months. As interest in the reefs mushroomed, a Tela Bay Protected Areas Technical Committee was formed with additional representatives from the surrounding municipalities and federal government (fisheries, agriculture, navy, police, district attorney and protected areas). By May, 2018, all the needed steps were taken to acquire complete congressional protection of a new >800 km^2 national marine park; the newly formed AMATELA NGO will produce its management plan and work with partners to enforce regulations.

Señalado por pescadores locales, Banco Capiro en la Bahía de Tela, Honduras, fue visitado por primera vez por buceadores durante un taller de capacitación HRI / CORAL / AGRRA en 2011. Dada la alta turbidez (su cresta de 10 m rara vez es visible en la superficie), encontrar un banco arrecifal, de alto relieve, fue un descubrimiento sorprendente. *Agaricia tenuifolia* y *A. agaricites* predominan sobre 35 especies de coral con morfologías inusuales, dada la baja penetración de luz solar. Los corales vivos cubren el 70% del sustrato en algunas áreas. *Diadema antillarum* tuvo densidades de ~ 2 / m2 a 8-13 m (7 sitios) en los monitoreos AGRRA de 2013, pero las estimaciones de la biomasa de peces loro y pez cirujano promediaron solo 496 y 228 g/100m2, respectivamente. La cobertura bentónica media de los corales vivos (43%), las algas coralinas crustosas (19%) y las algas dispersas (15%) encontradas en 2013 superó la de los invertebrados "agresivos" (7%), las macroalgas carnosas y pastos de algas con sedimentos (TAS, ambos en 2%), y las peyssonnelidas y cianobacterias (ambos 1%). HRI, CORAL y el recién formado (2013) AMATELA iniciaron rápidamente lo que se convirtió en un esfuerzo de 7 años para proteger este asombroso banco arrecifal. Un evento de prensa con buena asistencia, con un ceviche de pez león capturado en Capiro, cambió de manera notable la forma en que los habitantes de Tela veían sus arrecifes de coral. Una pequeña comisión que incluía al municipio local, ONGs y cámara de turismo, gobierno nacional y la universidad nacional unieron esfuerzos para lograr su designación

como AMP municipal en menos de seis meses; y luego como un Sitio de Importancia de Vida Silvestre dentro de los siguientes 18 meses. A medida que aumentaba el interés en los arrecifes, se formó un Comité Técnico de Áreas Protegidas de la Bahía de Tela, con representantes adicionales de los municipios circundantes y el gobierno federal (pesca, agricultura, marina, policía, fiscal y de áreas protegidas). En mayo de 2018, se publicó la designación, por parte del Congreso Nacional, del Refugio de Vida Silvestre Marino Bahía de Tela con más de 800 km^2, y la recién creada ONG AMATELA trabaja en elaborar su plan de manejo y colabora con todos los socios para hacer cumplir las regulaciones.

Keywords: MPA, Tela, Honduras, stakeholders, collaborations, Mesoamerican Reef

A RAPID SPREAD OF A WHITE PLAGUE DISEASE OUTBREAK IN THE MEXICAN CARIBBEAN

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Caribbean reef corals have experienced unprecedented declines from climate change, anthropogenic stressors and infectious diseases in recent decades. Since 2014 a highly lethal, new disease, called stony coral tissue loss disease (SCTLD), has impacted many species in Florida. On July 3, 2018, we found similar species exhibiting similar disease patterns at the “Fish Market” fore reef near Puerto Morelos in the Mexican Caribbean. The severity of this outbreak, and its spread in Fish Market and other 86 sites across the entire Mexican Caribbean, were assessed with AGRRA’s coral protocol. Eight of the 16 species afflicted at Fish Market on July 11 showed a high prevalence (30% to 95%) of SCTLD. Only 50 days later, nearly 20% of the severely afflicted species were dead and disease prevalence was still very high for the remaining colonies. Similarly, ~70% of 23 tagged *Pseudodiploria strigosa* on an *Acropora*-dominated back-reef died during a four-month period. At a larger scale, our results revealed the spread of SCTLD across the ~450 km Mexican Caribbean coastline, but with a great variability of prevalence and tissue mortality that was not attributable to any geographical gradient. For example, the western Cozumel coast remained unaffected for most of 2018; however, an outbreak has gradually spread across the island since early 2019. Using long-term data we determined that: (i) there is no evidence of such high coral disease prevalence anywhere in the region before 2018; and that (ii) this event has severely changed the structure and functioning of its reefs in just a few months. Given the high prevalence and lethality of this disease, and the high number of susceptible species, we encourage reef researchers, managers and stakeholder to accord it the highest priority for the near future.

Los corales del Caribe han experimentado descensos sin precedentes en las últimas décadas. Desde 2014, una nueva enfermedad altamente letal, la enfermedad de pérdida rápida de tejido (SCTLD), ha impactado a muchas especies en Florida. El 3 de julio de 2018, encontramos las mismas especies exhibiendo patrones de enfermedades similares en el sitio "Fish Market" (FM) en Puerto Morelos. Utilizando el protocolo AGRRA evaluamos la gravedad de este brote y su propagación en FM y otros 86 sitios a lo largo del Caribe mexicano. El 11 de julio, 8 de las 16 especies afectadas en FM mostraron una alta prevalencia (30%-95%) de SCTLD. Solo 50 días después, casi el 20% de las especies gravemente afectadas estaban muertas y la prevalencia de la enfermedad seguía siendo muy alta para las colonias restantes. De manera similar, aproximadamente el 70% de 23 *Pseudodiploria strigosa* marcadas en un arrecife dominado por *Acropora* murieron durante un período de cuatro meses. A una escala mayor, encontramos que el SCTLD se ha extendió a lo de toda la región, pero con una gran variabilidad de prevalencia y mortalidad de tejido que no es atribuible a ningún gradiente geográfico. La costa oeste Cozumel fue el ultimo lugar en ser afectado a principios de 2019. Al usar datos a largo plazo, determinamos que: (i) no hay evidencia de una prevalencia tan alta de la enfermedad de coral en ninguna parte de la región antes de 2018; y que (ii) este evento ha cambiado gravemente la estructura y el funcionamiento de sus arrecifes en solo unos meses. Dada la alta prevalencia de la enfermedad, el número de especies susceptibles y la alta mortalidad de los corales afectados, alentamos a los investigadores, administradores y usuarios de los arrecifes a considerar esto como la máxima prioridad para el futuro cercano.

Keywords: White plague, coral mortality, disease prevalence, Monitoring, Long-term data, reef functioning

QUANTIFYING CHANGE FROM HURRICANES AND CORAL DISEASES ON TWO REEF SYSTEMS

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Coral diseases and hurricanes cause major disruptions to coral reefs. The US National Park Service (NPS) has been monitoring reefs in the Dry Tortugas National Park (DRTO) and Virgin Islands National Park (VIIS) for over 20 years with current monitoring quantifying the effects of these drivers. The DRTO terrace reef communities are among the most complex and highest coral cover within the US NPS system. Coral disease outbreaks of 2016 and 2018 at two sites caused a 26.8% and 28.8% decline in coral cover, respectively. Disease prevalence peaked in 2018 when 20.3% and 7.7% of their respective coral colonies showed disease lesions. During these outbreak years, 82.7% of the disease lesions were on *Orbicella franksi*, and 15.3% occurred on the other major reef building corals *(O. faveolata, Siderastrea siderea* and *Colpophyllia natans).* Two category 5 Hurricanes (Irma and Maria) passed over the Virgin Islands in September 2017. Post-storm monitoring at five NPS reef sites showed coral cover declines at

all sites, but only one (Yawzi Reef) had a significant decrease (31%) from pre-storm (2016) surveys. Immediate post-hurricane effects included broken, toppled and displaced corals and poor water quality from terrestrial runoff and nutrient influx. This combination contributed to post-storm macroalgal cover exceeding 50%, the highest ever recorded at VIIS sites. Additionally, post-storm monitoring showed an apparent 55% decrease in cover by sponges; however much of that is attributed to sponges being temporarily obscured by a canopy of macroalgae during image analysis. Despite the direct impact of these two hurricanes, disease remains a more significant factor in the decline of the VIIS's corals. During the 2005-2007 mass bleaching and disease event, average coral cover at the five monitoring sites declined by >60%. The subsequent collapse of reef framework observed in post-hurricane monitoring is attributed to the disease-induced loss of live corals.

Las enfermedades de los corales y los huracanes causan trastornos importantes en los arrecifes de coral. El Servicio de Parques Nacionales de los Estados Unidos (NPS) ha estado monitoreando los arrecifes en el Parque Nacional Dry Tortugas (DRTO) y el Parque Nacional de las Islas Vírgenes (VIIS) durante más de 20 años, con el monitoreo actual que cuantifica los efectos de estos conductores. Las comunidades de arrecifes de terraza DRTO se encuentran entre las coberturas de coral más complejas y más altas dentro del sistema NPS de EE. UU. Los brotes de enfermedades coralinas de 2016 y 2018 en dos sitios causaron una disminución del 26.8% y 28.8% en la cobertura de coral, respectivamente. La prevalencia de la enfermedad alcanzó su punto máximo en 2018, cuando el 20,3% y el 7,7% de sus respectivas colonias de coral mostraron lesiones por enfermedad. Durante estos brotes, el 82.7% de las lesiones de la enfermedad fueron en *Orbicella franksi*, y el 15.3% ocurrió en los otros corales principales que forman arrecifes (*O. faveolata, Siderastrea siderea* y *Colpophyllia natans*). Dos huracanes de categoría 5 (Irma y María) pasaron por las Islas Vírgenes en septiembre de 2017. El monitoreo posterior a la tormenta en cinco sitios del arrecife NPS mostró caídas en la cobertura de coral en todos los sitios, pero solo uno (arrecife Yawzi) tuvo una disminución significativa (31%) a partir de encuestas previas a la tormenta (2016). Los efectos inmediatos posteriores a los huracanes incluyeron corales rotos, derribados y desplazados y la mala calidad del agua de la escorrentía terrestre y la afluencia de nutrientes. Esta combinación contribuyó a una cobertura de macroalgas post tormenta que superó el 50%, la más alta jamás registrada en los sitios VIIS. Además, el monitoreo posterior a la tormenta mostró una disminución aparente del 55% en la cobertura de las esponjas; sin embargo, gran parte de eso se atribuye a las esponjas que están temporalmente ocultas por un dosel de macroalgas durante el análisis de la imagen. A pesar del impacto directo de estos dos huracanes, la enfermedad sigue siendo un factor más importante en el declive de los corales del VIIS. Durante el evento de blanqueamiento masivo y enfermedad de 2005-2007, la cobertura promedio de coral en los cinco sitios de monitoreo disminuyó en> 60%. El colapso subsiguiente del marco de arrecifes observado en el monitoreo posterior al huracán se atribuye a la pérdida de corales vivos inducida por la enfermedad.

Keywords: Coral Monitoring, Coral Disease, Hurricanes, US National Parks

BENTHOS ASSESSMENT IN REEFS FROM MORROCOY NATIONAL PARK AND CUARE WILDLIFE REFUGE VENEZUELA, AFTER MORE THAN TWO DECADES OF THE MASSIVE DIE OFF

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Morrocoy National Park (MNP), located in the southern Caribbean, had the highest coral diversity and abundance of Venezuelan coastal reefs until 1996, when a massive die-off event killed 90% of its benthic fauna. MNP adjoins Cuare Wildlife Refuge (CWR), a RAMSAR site in which reefs were unaffected by the event. Twenty years later, the status of their coral reefs was unknown. In order to assess the current condition of the most representative reefs, AGGRA surveys were conducted in depths of 8-11 m at 10 sites in MNP (including the northern, central and southern sectors and shallow banks) and at two control sites in CWR in July and November, 2018. Live coral cover ranged between 56% (CWR) and 7% (MNP banks). Significant differences were found only between the CWR control sites and the remaining sectors of the MNP (PERMANOVA, pair-wise test, $t < 2.02$, $p < 0.02$), with the exception of the central area, where cover was similar to the CWR. These results are consistent with the proportion of “promoters” and “detractors” of coral growth (sensu AGRRA) found in each sector. Octocorals were important on the MNP banks (up to 23% cover) and fleshy macroalgae (especially *Dictyota*, up to 18% cover) at CWR and the southern MNP sector. The results underscore the benefit of maintaining the more restrictive wildlife refuge adjacent to MNP, and our recommendation to the local authorities and stakeholders will be to reduce the influx of tourists into the central sector of the park. Our project includes a social component engaging the community in Chichiriviche village near MNP on the importance of coral reefs and of the key frame-building *Orbicella* spp.

El Parque Nacional Morrocoy (PNM) ubicado en el sur del Caribe tenía la mayor la mayor diversidad y abundancia de corales de los arrecifes costeros venezolanos, hasta 1996, cuando un evento de mortandad masiva mató al 90% de su fauna bentónica. El PNM colinda con el Refugio de Fauna Silvestre Cuare (RFSC), un sitio RAMSAR en el que los arrecifes no se vieron afectados por el evento. Viente años después, el estatus de sus arrecifes de coral era desconocido. Para evaluar la condición actual de los arrecifes más representativos, se realizaron muestreos AGGRA a profundidades de 8-11 m en 10 sitios del PNM (incluidos los sectores norte, centro y sur y bancos de poca profundidad y en dos sitios control en RFSC en Julio y Noviembre de 2018. La cobertura de coral vivo osciló entre 56% (CWR) y 7% (bancos) y solo se encontraron diferencias significativas entre el sitio control (RFSC) y los sectores restantes (PERMANOVA, prueba por pares, $t < 2.02$, $p < 0.02$) a excepción del area central, donde la cobertura fue similar a la del Refugio de Fauna. Estos resultados son consistentes con la proporción de "promotores" y "detractores" para el crecimiento coralino (SENSU AGRRA) encontrados en cada sector. Los octocorales fueron importantes en los bancos (hasta 23% de cobertura) y las macroalgas carnosas (especialmente *Dictyota*, hasta 18% de cobertura) en RFSC y el sector sur del PNM. Los resultados resaltan el beneficio de mantener el refugio de fauna silvestre más restrictivo adyacente al PNM y la recomendación a las autoridades y comunidades locales será la de reducir la afluencia de turistas en el

sector central del parque. Nuestro proyecto incluye un componente social que involucra a la comunidad en el pueblo de Chichiriviche, cerca del PNM, sobre la importancia de los arrecifes de coral y de los corales claves formadores de arrecife *Orbicella* spp.

Key words: benthonic, cover, AGRRA, Morrocoy, Cuare, Venezuela

THE CARICOMP NETWORK OF CARIBBEAN MARINE LABORATORIES (1985-2007): HISTORY, KEY FINDINGS AND LESSONS LEARNED

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CARICOMP was a basin-wide cooperative, international network of marine laboratories established in 1985. Recognizing major trends of change in coastal ecosystems and the importance of their linkages, our goal was to monitor synoptically with standardized methods the physical environment and to document trends in measures of the structure and functioning of coral reefs, seagrasses and mangroves. Between 1985 and 1993, the CARICOMP Steering Committee established a data management center and wrote a methods manual. Marine laboratories joined the program by appointing a Site Director and signing an agreement specifying the cost sharing and responsibilities of the laboratory. In 1992, the program became fully functional and ultimately more than 30 institutions in 21 Caribbean countries participated for 15 years in some cases. Annual CARICOMP meetings, organized at a different laboratory each year, were essential in standardization of methods and maintaining interest. Open access to the data was a goal from the start, although the members imposed an embargo to allow time to publish major results. At some of the sites, monitoring continues to this day, generating among the longest coastal monitoring data sets in the Caribbean, and possibly in the world. Over time, multi-authored papers were prepared for the Proceedings of the International Coral Reef Symposia and other journals, and independent scientists drew on the open database for regional analyses of ecosystem trends. Recently, active members have written summary papers based on the monitoring data covering physical parameters, coral reefs, seagrasses, and mangroves. Overall, the data reveal major differences across the region and changing rates and trends showing the dynamism and vulnerability of coastal ecosystems. The longer the monitoring continues, the more valuable the dataset becomes as a tool to discern the underlying factors driving the structure and functioning of Caribbean coastal ecosystems.

CARICOMP fue una red internacional cooperativa de laboratorios marinos establecida en 1985. Entendiendo las tendencias de cambio de los ecosistemas costeros y la importancia de sus

interconexiones, nuestro objetivo fue hacer un seguimiento sinóptico con métodos estandarizados del ambiente físico y documentar las tendencias de la estructura y función de los arrecifes de coral, pastos marinos y manglares. Entre 1983 y 1993 el comité directivo de CARICOMP estableció un sitio para el manejo de datos y produjo el manual de métodos. Los distintos laboratorios se unieron a la red al elegir un director de sitio y firmando un acuerdo de responsabilidades. En 1992, el programa se hizo completamente funcional y finalmente 30 instituciones en 21 países Caribeños participaron durante 15 años en algunos casos. Las reuniones anuales de la red se organizaron en diferentes laboratorios fueron esenciales para la estandarización de los métodos y para mantener el interés. La política de datos abiertos fue nuestro norte desde el principio, a pesar de que los miembros impusieron un embargo en los datos para dar un tiempo para su publicación. En algunos sitios, el programa de seguimiento se mantiene, generando así la base de datos más larga para ecosistemas marino-costeros del Caribe; y posiblemente del mundo. Con el tiempo, diferentes autores han preparado trabajos presentados en las memorias del “International Coral Reef Symposium” y otras revistas indexadas. Por su parte, algunos autores utilizaron la política de datos abiertos para realizar análisis regionales de las tendencias de los ecosistemas marino costeros del Caribe. Recientemente, miembros activos han escrito trabajos que resumen las tendencias de variables físicas, arrecifes de coral, pastos marinos y manglares. En general los datos revelan grandes diferencias en el Caribe que muestran el dinamismo y la vulnerabilidad de estos ecosistemas. Mientras más tiempo permanezca activo el programa será más útil para discernir los factores que determinan la estructura y función de estos ecosistemas.

Keywords: CARICOMP network, standardized monitoring, Caribbean, coral reefs, seagrasses, mangroves, lessons learned

DEVELOPMENT OF UNDERWATER LANDSCAPE MOSAICS FROM NOVELTY TO MANAGEMENT TOOL

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Underwater landscape mosaics are constructed from numerous (100s, 1000s, or more) overlapping images to create a single, seamless view of a much larger area of the seabed than can be appreciated either in person, by a diver, or captured in a single image by a camera. Over the past approximately 20 years, a confluence of technologies has enabled the creation and use of such mosaics to transition from an exciting novelty to a viable management tool. This presentation will review the development of technology needed to create underwater landscape mosaics as well as the current state-of-the-art and outstanding development needs. Examples of application to damage assessment, acroporid restoration, and coral bleaching monitoring will also be presented

“Underwater landscape mosaics” se construyen a partir de numerosas (100, 1000 o más) imágenes superpuestas para crear una vista única y sin fisuras de un área mucho más grande del fondo marino que se puede apreciar en persona, por un buceador, o capturada en una sola imagen por una camara. En los últimos 20 años aproximadamente, una confluencia de tecnologías ha permitido la creación y el uso de dichos mosaicos para pasar de una novedad emocionante a una herramienta de administración viable. Esta presentación revisará el desarrollo de la tecnología necesaria para crear mosaicos de paisajes subacuáticos, así como el estado actual de la técnica y las destacadas necesidades de desarrollo. También se presentarán ejemplos de aplicación a la evaluación de daños, restauración de acroporid y monitoreo de blanqueamiento de coral.

Keywords: mosaic, structure from motion, grounding, restoration, bleaching

USING PHOTOGRAMMETRY AND THREE-DIMENSIONAL (3D) MODELLING FOR MAPPING AND MONITORING JAMAICA'S CARICOMP SITE

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The Caribbean Coastal Marine Productivity (CARICOMP) program was a regional cooperative scientific network of Caribbean marine laboratories, established in 1985 to monitor the changing trends in coastal ecosystems throughout the Caribbean. In Jamaica, the CARICOMP sites have been monitored since 1993. At the coral reef site on the West Fore Reef in Discovery Bay, 10 permanently marked transects have been repeatedly monitored, capturing changes in community structure including impacts of recurring bleaching events and disease outbreaks as well as the gradual rebounding of *Diadema antillarum*. The CARICOMP monitoring protocol for reef communities has been supplemented over the years with the use of photography, videography and more recently, photogrammetry. Photogrammetry and 3D modelling of coral reef habitats are tools that can be used to obtain a suite of metrics ranging from volumetric measurements and live surface area of individual coral colonies, topography and rugosity of reef areas, as well as orthomosaics of entire reef tracts. With improved capacity to more accurately measure growth rates of individual coral colonies, assess whole-colony partial mortality rates, and track temporal changes in biophysical variables of reef habitats, monitoring research can help managers to better assess the structural complexity of reefs locally and quantify impacts of bleaching and other stressors over large areas in short periods of time. Spatially explicit data and reef maps derived from photogrammetric surveys can readily be integrated into new and existing geodatabases to track study sites, identify hotspots, and provide contextual information for local and regional trends.

El programa de Productividad Marina Costera del Caribe (CARICOMP) es una red científica cooperativa regional de laboratorios marinos del Caribe, establecida en 1985 para monitorear las tendencias cambiantes de los ecosistemas costeros en todo el Caribe. En Jamaica, los sitios de CARICOMP han sido monitoreados desde 1993. En el sitio arrecifal en West Fore Reef en Discovery Bay, se han monitoreado repetidamente 10 transectos marcados permanentemente, capturando cambios en la estructura de la comunidad, incluidos los impactos de eventos de blanqueamiento recurrentes y brotes de enfermedades, así como también, el regreso gradual de *Diadema antillarum*. El protocolo de monitoreo CARICOMP para las comunidades de arrecifes se ha complementado a lo largo de los años con el uso de la fotografía, la videografía y, más recientemente, la fotogrametría. La fotogrametría y el modelado 3D de los hábitats de arrecifes de coral son herramientas que se pueden usar para obtener un conjunto de métricas (o medidas) que van desde mediciones volumétricas y área de superficie viva de colonias de coral individuales, topografía y rugosidad de áreas de arrecifes, así como también, orto-mosaicos de zonas de arrecifes completas. Con una capacidad mejorada para medir con mayor precisión las tasas de crecimiento de las colonias de coral individuales, evaluar las tasas de mortalidad parcial de toda la colonia y rastrear los cambios temporales en las variables biofísicas de los hábitats de arrecifes, la investigación de monitoreo puede ayudar a los administradores a evaluar mejor la complejidad estructural de los arrecifes a nivel local; y cuantificar los impactos de blanqueamiento y otros factores de estrés en grandes áreas en cortos períodos de tiempo. Los datos espacialmente explícitos y los mapas de arrecifes derivados de encuestas fotogramétricas se pueden integrar fácilmente en las bases de datos geo-referenciadas nuevas y existentes, para rastrear los sitios de estudio, identificar puntos de acceso y proporcionar información contextual para las tendencias locales y regionales.

Keywords: photogrammetry, 3D modelling, monitoring, coral growth, structural complexity

HEALTHY REEFS INITIATIVE'S COLLABORATIVE NETWORK RESPONDING TO THREATS TO THE MESOAMERICAN REEF

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Healthy Reefs for Healthy People Initiative (HRI) is an international collaborative program of over 73 research, management, and conservation organizations dedicated to safeguarding the Mesoamerican Reef (MAR). For over a decade HRI has used scientific data to produce and disseminate collaborative, appealing, politically influential Report Cards and Eco-Audits. Improving scientific understanding of the functioning of the reef has promoted management interventions and the application of evaluation tools that regional leaders, local partners, and policymakers can use to protect and enhance the health of the MAR. Over the years, numerous additional MPAs, fully-protected replenishment zones, management plans and important species protection (parrotfish) have been achieved thanks to this effort. In order to generate sound scientific data, HRI strengthens the long-term capacity of local organizations by offering

AGRRA monitoring trainings as well as its first 'training of trainers' course resulting in 221 surveyors and 16 certified trainers from the MAR and beyond. The active network formed by these partners allows for rapid response to a variety of threats including bleaching and disease. Following NOAA's Coral Bleach Watch Alert in 2015, HRI and partners implemented an emergency monitoring response that has shown to be effective and its results are now helping to calibrate bleaching-resiliency models. During the 2018 reef-health monitoring season, teams in Mexico began to report incidences of the Stony Coral Tissue Loss Disease previously observed in Florida. Using the bleach watch experience and emergency funds, monitoring teams along the Mexican coast have rapidly initiated both field monitoring and treatment experiments. Information exchanges have been facilitated through the rapid collaboration with international colleagues through AGRRA, Smithsonian and GCFI. Over 10 years of historical disease prevalence data in our AGRRA database will prove invaluable to compare the extent and uniqueness of this current disease outbreak, and to facilitate any possible management responses.

La Iniciativa Arrecifes Saludables para Gente Saludable (HRI, por sus siglas en inglés) es un programa de colaboración internacional de más de 73 organizaciones de investigación, manejo y conservación dedicadas a la protección del Sistema Arrecifal Mesoamericano (SAM). Durante más de una década, HRI ha utilizado datos científicos para producir y difundir reportes de salud y auditorías ecológicas colaborativos y políticamente influyentes. La mejora de la comprensión científica del funcionamiento del arrecife ha promovido intervenciones de gestión y la aplicación de herramientas de evaluación que los líderes regionales, los socios locales y los formuladores de políticas públicas pueden utilizar para proteger y mejorar la salud del SAM. A lo largo de los años, gracias a este esfuerzo, se han logrado la declaración de numerosas AMP adicionales, zonas de recuperación pesquera, planes de manejo y protección de especies importantes (pez loro). Para generar datos científicos sólidos, HRI fortalece las capacidades a largo plazo de las organizaciones locales al ofrecer capacitaciones de monitoreo AGRRA, así como su primer curso de "capacitación de capacitadores", que formaron a 221 monitoreadores y 16 capacitadores certificados en el SAM y más allá. La red activa formada por estos socios permite una respuesta rápida ante una variedad de amenazas como el blanqueamiento o las enfermedades. Tras la alerta de Coral Bleach Watch de la NOAA en 2015, HRI y sus socios implementaron una respuesta de monitoreo de emergencia que ha demostrado ser efectiva y sus resultados ahora están ayudando a calibrar los modelos de resiliencia y blanqueamiento. Durante la temporada de monitoreo de arrecifes del 2018, los equipos en México comenzaron a reportar casos de la enfermedad de pérdida de tejido de coral observada anteriormente en Florida. Utilizando la experiencia del Coral Bleach Watch y con fondos de emergencia, equipos de monitoreo a lo largo de la costa mexicana han salido rápidamente a monitorear y realizar pruebas de tratamiento. Los intercambios de información se han facilitado a través de la rápida colaboración con colegas internacionales a través de AGRRA, Smithsonian y GCFI. Más de 10 años de datos históricos de prevalencia de enfermedades en nuestra base de datos AGRRA serán invaluables para comparar el alcance y la singularidad de este brote actual de la enfermedad, y para facilitar cualquier respuesta de manejo.

Keywords: Monitoring-Network-Emergency Response-Report Card-Mesoamerican Reef-Coral Disease

Session*: Historical Ecology & Mangrove and Seagrass Ecosystems*

HARNESSING HISTORICAL DATA FOR CONSERVATION

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The field of historical marine ecology developed from the fundamental observation that marine ecosystems had been changed by human actions long before scientists began to study them. Information taken from historical written records—including photographs, newspaper articles, restaurant menus, and nautical charts— has revealed changes to species distributions and population structure farther back in time than was previously possible and provided new understandings of ecosystem function in the absence of pervasive human influence. Many of these findings have application to conservation, and the growth of historical ecology research has sparked an increased use of these data in applied contexts. This talk will describe the application of historical archival data to marine conservation, with a focus on using historical data to help set recovery targets for fisheries and endangered species and restoration goals for coral reef ecosystems, as well as future directions for applied historical ecology.

El campo de la ecología marina histórica se desarrolló a partir de la observación fundamental de que los ecosistemas marinos habían sido modificados por acciones humanas mucho antes de que los científicos comenzaran a estudiarlos. La información obtenida de registros históricos escritos, incluidas fotografías, artículos periodísticos, menús de restaurantes y cartas náuticas, ha revelado cambios en la distribución de las especies y la estructura de la población más atrás en el tiempo de lo que era posible anteriormente y nos brindó nuevos conocimientos sobre la función de los ecosistemas en la ausencia de la influencia humana. Muchos de estos hallazgos tienen aplicación en la conservación, y el crecimiento de la investigación en ecología histórica ha provocado un mayor uso de estos datos en contextos aplicados. Esta charla describirá la aplicación de los datos históricos de archivo a la conservación marina, con un enfoque en el uso de datos históricos para ayudar a establecer objetivos de recuperación para la pesca y especies en peligro y objetivos de restauración para los ecosistemas de arrecifes de coral, así como las direcciones futuras para la ecología histórica aplicada.

Keywords: historical ecology, shifting baselines, recovery, conservation

CORAL REEF COMMUNITY STRUCTURE AND THE FIDELITY OF FOSSIL RECONSTRUCTION

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Ecological community reconstruction requires, in addition to species ecologies, the structural frameworks within which species interact and evolve. Those frameworks include taxonomic and functional diversities, organizational hierarchy above populations and functional groups, and trophic relationships among species. Here we examine the fidelity with which past coral reef communities can be reconstructed from fossil and sub-fossil data. We developed high resolution models of modern communities from the Greater Antilles and, using documented fossil occurrences, simulated fossilization of those communities. We then determined the extent to which system-level information was lost, and the ability to reconstruct features from the fossil data, including species richnesses of functional groups, trophic chains, trophic levels, and modularity. The data included 728 species aggregated into 265 trophospecies, with 4105 inter-trophospecific interactions. Simulated fossilization, based on fossil occurrences of genera within the data, resulted in a community comprising 433 species, 172 trophospecies and 1737 inter-trophospecific interactions. Forty-two trophospecies exhibited biased preservation, with groups such as nanno-zooplankton and gorgonians being underrepresented, and scleractinian corals and bivalves having above average preservation. The loss of trophic interactions was similarly biased. Zooplanktivores, including mixotrophic corals, had significantly fewer than expected preserved interactions, whereas benthic durophages had significantly more. Trophic level distribution was reduced significantly, and trophic chains reduced for specialized predators and zooplanktivores. Nevertheless, the distribution can be recovered by modeling trophic interactions with hyperbolic distributions used frequently in paleoecological modeling. Analysis of the modularity, or number of sub-communities, revealed four modules, distinguished primarily by different producer bases. All modules were preserved in the fossil community. Modularity, however, is exaggerated by the extirpation of high trophic level fishes, who reduce modularity when present. Finally, we explore the role of the invasive lionfish in community modularity, possibly replacing functionality lost due to extirpation of native predators.

La reconstrucción de la comunidad ecológica requiere, además de las ecologías de las especies, los marcos estructurales dentro de los cuales las especies interactúan y evolucionan. Esos marcos incluyen diversidades taxonómicas y funcionales, jerarquía organizacional sobre poblaciones y grupos funcionales, y relaciones tróficas entre especies. Aquí examinamos la fidelidad con la que se pueden reconstruir las comunidades de arrecifes de coral a partir de datos de fósiles y subfósiles. Desarrollamos modelos de alta resolución de comunidades modernas de las Antillas Mayores y, utilizando sucesos fósiles documentados, simulamos la fosilización de esas comunidades. Luego, determinamos en qué medida se perdió la información a nivel del sistema y la capacidad de reconstruir las características a partir de los datos fósiles, incluida la riqueza de especies de grupos funcionales, cadenas tróficas, niveles tróficos y modularidad. Los datos incluyeron 728 especies agregadas en 265 trofospecies, con 4105 interacciones intertrofospecíficas. La fosilización simulada, basada en la aparición de fósiles de géneros

dentro de los datos, dio lugar a una comunidad que comprende 433 especies, 172 trofospecias y 1737 interacciones intertrofospecíficas. Cuarenta y dos trofospecies exhibieron preservación sesgada, con grupos como el nano-zooplancton y las gorgonias sin representación suficiente, y los corales escleractinios y los bivalvos tienen preservación por encima del promedio. La pérdida de interacciones tróficas fue sesgada de manera similar. Los zooplanctivores, incluidos los corales mixotróficos, tuvieron significativamente menos interacciones conservadas que las esperadas, mientras que los durófagos bentónicos tuvieron significativamente más. La distribución del nivel trófico se redujo significativamente, y las cadenas tróficas se redujeron para depredadores especializados y zooplanktivores. Sin embargo, la distribución se puede recuperar modelando interacciones tróficas con distribuciones hiperbólicas usadas frecuentemente en el modelado paleoecológico. El análisis de la modularidad, o número de subcomunidades, reveló cuatro módulos, que se distinguen principalmente por diferentes bases de productores. Todos los módulos fueron conservados en la comunidad fósil. Sin embargo, la modularidad se ve exagerada por la extirpación de peces de alto nivel trófico, que reducen la modularidad cuando están presentes. Finalmente, exploramos el papel del pez león invasor en la modularidad de la comunidad, posiblemente reemplazando la funcionalidad perdida debido a la extirpación de depredadores nativos.

Keywords: coral reefs, community structure, fossil, trophic

SHIFTS IN SHARK ASSEMBLAGES OVER THE LAST 7000 YEARS IN BOCAS DEL TORO, PANAMA (**Student)**

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Many Caribbean shark populations have declined steeply over the last several decades, but longer records of change are unavailable. This hinders our ability to determine baseline shark abundance, understand natural variation in shark assemblages over time and space, and interpret sharks' functional roles on coral reefs in natural and human-impacted systems. Dermal denticles, the small tooth-like scales that cover the bodies of sharks and rays, accumulate in marine sediments and could offer a new approach for reconstructing historical shark assemblages. Here, we compare the denticle assemblages preserved in mid-Holocene (7000- to 6500-year-old) fossil reefs in Bocas del Toro, Panama with modern reefs in the same area to reconstruct pre-human shark baselines and investigate how they have changed over time. Preliminary data suggest that denticle accumulation rates (number of denticles per amount sediment per unit of time) were, on average, five-fold higher on the fossil reefs than on the modern reefs, implying that these reefs supported many more, or larger sharks, 7000 years ago. Furthermore, there was a significant shift in the relative abundance of denticle morphotypes over time. "Abrasion strength" denticles belonging to demersal sharks (e.g. nurse sharks) increased in relative abundance on the

modern reefs, whereas “drag reduction” denticles, which are associated with fast-swimming species (e.g. requiem and hammerhead sharks), decreased in relative abundance, suggesting a major shift in the dominant ecological roles played by sharks on these reefs today. By defining the range of variation in shark assemblages before major human impact and tracking change over long stretches of ecological time, these new data can help guide management targets informed by local historical conditions.

Muchas poblaciones de tiburones en el Caribe han disminuido drásticamente en las últimas décadas, pero no existen registros de cambio más prolongados. Esto limita nuestra capacidad para determinar la abundancia de tiburones en el pasado, entender la variación natural de sus comunidades a través del tiempo y del espacio e interpretar sus funciones en los arrecifes de coral en sistemas naturales e impactados por los humanos. Los dentículos dérmicos, pequeñas escamas que cubren los cuerpos de tiburones y rayas, se acumulan en los sedimentos marinos y pueden ser una nueva herramienta para reconstruir las comunidades históricas de tiburones. Aquí, comparamos colecciones de dentículos que se preservan en los arrecifes fósiles del Holoceno medio (desde 7000 a 6500 años de edad) en Bocas del Toro, Panamá, con las de arrecifes modernos en la misma región para reconstruir datos de referencia de las comunidades de tiburones prehumanas e investigar cómo han cambiado a través del tiempo. Los datos preliminares sugieren que la velocidad de acumulación de dentículos (número de dentículos por cantidad de sedimento por unidad de tiempo) fue, en promedio, cinco veces más alta en los arrecifes fósiles que en los modernos, lo que implica que estos arrecifes soportaron muchos más tiburones, o tiburones más grandes, hace 7000 años. Además, hubo un cambio significativo en la abundancia relativa de los morfotipos de dentículos a lo largo del tiempo. La abundancia relativa de dentículos de “resistencia a la abrasión” que pertenecen a los tiburones demersales (p.ej., tiburones nodriza) aumentó en los arrecifes modernos, mientras que la abundancia relativa de dentículos de “reducción de arrastre”, que se asocian a especies de natación rápida (p.ej., tiburones réquiem y martillo), disminuyó, lo que sugiere un cambio en las funciones ecológicas dominantes que tienen los tiburones en estos arrecifes actualmente. Al definir la variación en las comunidades de tiburones antes de este gran impacto humano y cuantificar los cambios a lo largo de períodos amplios de tiempo ecológico, estos datos nuevos pueden ayudar a detectar objetivos clave para la gestión específica de esta área.

Keywords: baseline, coral reef, dermal denticle, fossil record, shark

MULTI-MILLENNIAL STABILITY OF SEAGRASS MEADOWS RECORDED IN SURFICIAL MOLLUSK SHELL ACCUMULATIONS

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Surficial shell accumulations represent archives potentially suitable for assessing histories of local ecosystems over multi-millennial time scales. We assessed the value of this approach using two case studies involving seagrass meadows set in radically different settings: (1) around San Salvador Island (a

small oceanic island surrounded by a tropical carbonate platform) and (2) along Florida‘s Gulf Coast (a subtropical continental shelf covered by terrigenous sediments). On San Salvador Island, we sampled surface sediments along 12 transects (60 samples, 20301 specimens, 180 species). Radiocarbon dating of individual shells indicated that surficial shell accumulations represented a multi-millennial record of local communities. Multivariate ordinations separated samples of mollusks by transect, habitat, and regional context (leeward vs. windward setting), with the faunal composition of samples from seagrass being less variable than the composition of samples from sand. Along Florida’s Gulf Coast, we sampled shallow coastal seagrass meadows and sandy bottoms. Again, radiocarbon dating indicated that surficial shell accumulations represented a multi-millennial archive of local communities. The results also indicated that life assemblages from seagrass sites were characterized by elevated alpha diversity and depressed beta diversity, death assemblages differed significantly between the two habitats, and live-dead faunal agreement was significantly greater for seagrass habitats. Despite major differences between the two study systems, multiple commonalities emerge. In both cases, surficial shell accumulations represented multi-millennial archives of local ecosystems. In both systems, local biodiversity and spatial stability were elevated in structured seagrass habitats. The fact that time-averaged shell assemblages have retained an interpretable spatial pattern suggests that regional ecosystems must have been stable over multi-centennial time scales. The two case studies also suggest that non-invasive sampling strategies targeting dead mollusks can be an effective approach for assessing the spatial distribution of faunal associations and elucidating processes that drive spatial structuring of communities over centennial-to-millennial timescales.

Keywords: conservation-paleobiology, seagrass, mollusks, radiocarbon, Holocene

UNRAVELING PAST ENVIRONMENTAL CONDITIONS OF CARIBBEAN CORAL REEFS USING TEMPORAL CHANGES IN MICROGASTROPODS AND THEIR SHELL STABLE ISOTOPE SIGNAL

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Caribbean coral reefs have suffered long-term degradation from a suite of stressors, such as alterations in land use and hypoxic events. Many of these stressors began long before environmental data was collected making it hard to tease apart natural vs. anthropogenic drivers of reef change. Shallow and semi-enclosed hypoxic systems with minimal tidal disturbances and higher water temperatures like Almirante Bay (Bocas del Toro) amplify global change effects and therefore offer the opportunity to evaluate the vulnerability and resilience of Caribbean coastal ecosystems to near future climate change using the fossil record. Microgastropod assemblages were extracted from two reefs in Almirante Bay using 3 m long reef matrix cores at ~2 and ~5 m depths to explore their utility to reconstruct past events over millennia. Core chronologies were constructed using U-Th dating. An increase in the relative abundance of sponge parasites over time supports evidence that sponges are increasing in abundance

because of increased anthropogenic nutrients. Ascidian feeding and herbivorous gastropods decreased which may have been driven by increasing freshwater input as the identified species are susceptible to hypoxia and low salinities. Interpretation of these patterns were facilitated through the use of oxygen and carbon isotopes to characterize environmental conditions such as freshwater input and human-derived sources of nutrients. In non-parasitic taxa, the overall δ18Oshell trend toward recent times in the deeper cores could indicate a decrease of salinity of perhaps 3-4 psu, suggesting an increase of freshwater input. Lower values of δ13Cshell in more recent shells suggest increased freshwater input, increased deposition of sedimentary organic matter, and/or decreased dissolved oxygen (i.e., hypoxic events). Our data provide the first description of past environmental conditions for Caribbean coral reefs using microgastropod assemblages.

Los arrecifes de coral del Caribe han sufrido una degradación significativa a largo plazo debido a una serie de factores, como alteraciones en el uso de la tierra y eventos hipóxicos. Muchos de estos factores comenzaron mucho antes de que se recopilaran datos ambientales, lo que dificulta la distinción entre los factores naturales y antropogénicos de cambio en arrecifes. Los sistemas hipóxicos poco profundos y semicerrados con perturbaciones mínimas de las mareas y con altas temperaturas del agua como las de la Bahía de Almirante (Bocas del Toro) amplifican los efectos del cambio global y, por lo tanto, ofrecen la oportunidad de evaluar la vulnerabilidad y resiliencia de los ecosistemas costeros del Caribe frente al cambio climático a corto plazo a través del registro fósil. Los ensamblajes de microgasterópodos se extrajeron de dos arrecifes en la Bahía de Almirante utilizando núcleos de 3 m de largo a 2 y 5 m de profundidad para explorar su utilidad en la reconstrucción de eventos pasados durante milenios. Las cronologías de los núcleos fueron determinadas a partir de la datación mediante U-Th. Un aumento en la abundancia relativa de parásitos de la esponja a lo largo del tiempo apoya la evidencia de que las esponjas están aumentando en abundancia debido al incremento de nutrientes de origen antropogénico. Los depredadores de ascidias y los gasterópodos herbívoros disminuyeron, lo que puede haber sido impulsado por un aumento de agua dulce ya que las especies identificadas son susceptibles a la hipoxia y bajas salinidades. La interpretación de estos patrones se facilitó mediante el uso de isótopos de oxígeno y carbono para caracterizar las condiciones ambientales, como la entrada de agua dulce y fuentes de nutrientes de derivación humana. En los taxones no parasitarios, la tendencia general del δ18O hacia tiempos más recientes en los núcleos más profundos podría indicar una disminución en la salinidad aproximada de 3-4 psu, lo que sugiere un aumento de entrada de agua dulce. Los valores más bajos de δ13C en las conchas más recientes sugieren un aumento de entrada de agua dulce, un aumento de deposición de materia orgánica sedimentaria y / o una disminución del oxígeno disuelto (por ej. eventos hipóxicos). Nuestros datos proporcionan por primera vez una descripción de las condiciones ambientales del pasado en arrecifes de coral utilizando ensamblajes de microgasterópodos.

Keywords: microfossils, environmental proxies, stable isotopes, historical ecology, hypoxia, Caribbean Sea

HOW VARIABLE WERE CARIBBEAN REEFS BEFORE HUMANS? AN EXAMPLE FROM BOCAS DEL TORO, PANAMA

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No reef in the Caribbean is alike and we can assume that pre-human reefs were no less variable. Nonetheless, little is known about how variable reefs were before human impact and this limits our ability to understand pre-human baselines. In this study we used a suite of 7000 year old fossil coral reefs in Caribbean Panama to quantify the Historical Range of Variation (HRV) in community structure and compared that to variation on adjacent modern reefs. We find that most modern reefs have transitioned to alternative stable states, driven not only by the ecological extirpation of the staghorn coral Acropora cervicornis, but also by changes in other coral members. Surprisingly though, we uncover one modern reef that is indistinguishable in coral community structure to those 7000 years ago. The state of this reef is far from what many would consider "pristine". Without historical context, this "historical bright spot" reef would be overlooked. This finding demonstrates the importance of using historical data to move baselines away from idealized static reference points and instead quantify what is natural and what is novel on Caribbean coral reefs.

Ningún arrecife en el Caribe es igual y podemos asumir que los arrecifes pre-humano no eran menos variables. No obstante, se sabe muy poco acerca de que variable eran los arrecifes antes del impacto humano y esto limita nuestra capacidad para comprender las líneas de base. En este estudio, utilizamos un conjunto de arrecifes de coral fósil de alrededor de 7000 años de antigüedad en el Caribe panameño para cuantificar el Rango Histórico de Variación (HRV por su siglos inglés) en la estructura de la comunidad y lo comparamos con la variación en los arrecifes modernos adyacentes. Encontramos que la mayoría de los arrecifes modernos han transicionados a "estados estables alternativos", impulsados no solo por la extirpación ecológica del coral cuerno de ciervo Acropora cervicornis, sino también por cambios en otros miembros del coral. Sin embargo, descubrimos un arrecife moderno que no se puede distinguir en la estructura de la comunidad de coral de aquellos hace 7000 años. Sorprendentemente, el estado de este arrecife está lejos de lo que muchos consideran "prístino". Sin el contexto histórico, este arrecife de "historic bright spot " sería pasado por alto. Este hallazgo demuestra la importancia de usar datos históricos para alejar de pensar que las líneas de base son puntos de referencia estáticos, y en cambio, cuantificar lo que era natural y lo que es novedoso en los arrecifes de coral del Caribe.

Keywords: Baseline, Corals, fossil record, Bocas del Toro, pristine

STATUS OF CORAL REEF BENTHIC COMMUNITIES IN LA PARGUERA TEN YEARS AFTER THE 2005-07 MASS MORTALITIES **(Student)**

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La Parguera Natural Reserve has one of the best-developed coral reef ecosystems in Puerto Rico, sustaining an important socio-ecological system. However, coral reefs were drastically impacted by the 2005 high thermal anomaly that produced intensive and extensive bleaching and disease epizootics in the northeastern Caribbean. The consequence was a dramatic decline in live coral cover (53%) between 2004-2007. Ten years after this event, changes in the benthic community structure were assessed using the same permanent transects and depths in six reefs located across a nearshore-offshore gradient studied back in 2004-2007. Main sources of variation [factors] in the monitoring design were years, reef zones, reef sites, and depth. Permanent transects (N=82) were sampled using the same six randomly placed, 1m2 photoquadrats (N=492). Coral Point Count area/length analysis was used to obtain the cover percentage of scleractinian species and other benthic functional groups. Spatiotemporal changes were assessed with multivariate analyses. At deep habitats (13-22m), PERMANOVA results showed significant differences in the composition of scleractinians and other functional groups across years and reef zones. The scleractinian and functional groups composition at the outer shelf zone showed more resistance to change with no significant change between 2007-2016 (P(Monte Carlo) > 0.05). In contrast, in the middle shelf zone, turf algae, macroalgae, and octocorals contribute most to dissimilarities between 2007 and 2016 (Pair-wise P(Monte Carlo) = 0.01; SIMPER 72% cumulative dissimilarity). In the shelf-edge deep habitats, *Orbicella franksi* consistently dominates the scleractinian community across years, however, *Montastraea cavernosa*, *Porites astreoides*, and *Siderastrea siderea* contribute most to dissimilarities between 2007 and 2016 (Pair-wise P (Monte Carlo) = 0.007; SIMPER 48% cumulative dissimilarity). These results suggest that shifts in benthic community composition are occurring differentially across the middle and outer shelf zones, but they do not necessarily show recovery or resilience yet.

La Reserva Natural La Parguera tiene uno de los ecosistemas de arrecifes de coral mejor desarrollados en Puerto Rico, que sostiene un importante sistema socio-ecológico. Sin embargo, los arrecifes de coral fueron impactados drásticamente por la anomalía térmica de 2005 que produjo blanqueamiento extenso y enfermedades en el noreste del Caribe. La consecuencia fue una disminución dramática en la cobertura de coral vivo (53%) entre 2004-2007. Diez años después de este evento, se evaluaron los cambios en la estructura de la comunidad béntica utilizando transectos y profundidades permanentes en seis arrecifes ubicados en un gradiente de distancia a la costa que se estudió entre 2004-2007. Los factores en el diseño de monitoreo fueron años, zonas, sitios y profundidad. Los muestreos de transectos permanentes (N = 82) se realizaron con los mismos seis fotoquadrantes de 1 m^2 colocados al azar (N = 492). El análisis de área/longitud de Coral Point Count se utilizó para obtener el porcentaje de cobertura de las especies de escleractinidos y otros grupos funcionales bentónicos. Los cambios espaciotemporales se evaluaron con análisis multivariados. En los hábitats profundos (13-22 m), los resultados de PERMANOVA mostraron diferencias significativas en la composición de los escleractínidos y otros grupos funcionales a través de los años y las zonas de arrecifes. La composición

de los grupos escleractinios y funcionales en la zona de la plataforma externa mostró una mayor resistencia al cambio sin un cambio significativo entre 2007-2016 (P (Monte Carlo)> 0.05). En contraste, en la zona media de la plataforma, las algas de césped, macroalgas y octocorales son las que más contribuyen a las diferencias entre 2007 y 2016 (P (Monte Carlo) = 0.01; SIMPER 72% de disimilitud acumulada). En los hábitats profundos del borde de la plataforma, *Orbicella franksi* domina consistentemente a la comunidad escleractina a través de los años, sin embargo, *Montastraea cavernosa*, *Porites astreoides* y *Siderastrea siderea* contribuyen más a las diferencias entre 2007 y 2016 (P (Monte Carlo) = 0.007; SIMPER 48% de disimilitud acumulada). Estos resultados sugieren que los cambios en la composición de la comunidad bentónica se producen de manera diferencial en las zonas media y exterior de la plataforma, pero todavía no muestran necesariamente recuperación o resistencia.

Keywords: scleractinians, La Parguera Natural Reserve, resilience, resistance, recovery

THE EFFECT OF SIMULATED GREEN TURTLE GRAZING ON THALASSIA TESTUDINUM PRODUCTIVITY, BENTHIC COMMUNITY COMPOSITION, AND STINGRAY FORAGING BEHAVIOR **(Student)**

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Green turtle (*Chelonia mydas*) abundance in the Caribbean is estimated to only be 0.33% of what it was in pre-Colombian times (McClenachan et al. 2006). The severe reduction of this formerly abundant herbivore has likely dramatically altered the ecology of the seagrass beds where *C. mydas* feeds, but the conclusions of past studies of the effect of sea turtle grazing in the Caribbean have varied by location. We conducted our experiment in Bahía Almirante, in Bocas del Toro, Panamá. This experimental site receives notably more rainfall than the site of any other published grazing experiment in the Caribbean. To simulate grazing, we clipped turtle grass (*Thalassia testudinum*) with scissors in a way that imitated grazing by *C. mydas*. Highly grazed plots were clipped every two weeks, lightly grazed plots were clipped every four weeks, and ungrazed plots were never clipped. Seagrass production was assessed in each plot opportunistically. Plots were also photographed monthly to quantify ecological succession. Grazing had the effect of generally reducing seagrass production per unit area and seagrass percent cover. No other species of seagrass or rhizophytic algae colonized the resulting empty space. Stingray foraging increased in both highly and lightly grazed plots compared to ungrazed ones, but did not differ between highly grazed and lightly grazed plots. Analysis of seagrass tissue suggests that seagrasses in this study were more limited by light than by nutrients, suggesting that the main limiting factor for seagrass growth at this site is low ambient light due to low water clarity. This has not been observed in other grazing studies in the Caribbean, but may be explained by this site's elevated levels of runoff due to high rainfall.

Se estima que la abundancia de la tortuga verde (*Chelonia mydas*) en el Caribe es solamente 0.33% de la abundancia pre-colombiana (McClenachan et al. 2006). La reducción severa de este herbívoro probablemente ha alterada dramáticamente la ecología de las praderas marinas caribeñas dónde pastorea *C. mydas*, pero los estudios anteriores del efecto del pastoreo por la tortuga verde en el Caribe han variado en lugares distintos. Hicimos un experimento en Bocas del Toro, Panamá. Este sitio experimental recibe mucha más lluvia que los sitios de otros estudios del pastoreo por *C. mydas* en el Caribe. Se cortaban el pasto de las tortugas (*Thalassia testudinum*) con tijeras para imitar el pastoreo por *C. mydas*. Se cortaban los terrenos altamente pastoreados cada dos semanas, se cortaban los terrenos ligeramente pastoreados cada cuatro semanas, y los terrenos no pastoreados nunca se cortaban. Se medía la producción de los pastos marinos en cada terreno y se fotografiaban los terrenos para cuantificar la sucesión ecológica. El pastoreo hizo bajar la producción de los pastos marinos y también el área en cada terreno ocupada por los pastos marinos. Ninguna otra especie de pasto marino ni de alga colonizó el espacio vacío resultante. La bioturbación por las rayas aumentó en los terrenos ligeramente y altamente pastoreados en comparación con los no pastoreados, pero no había diferencia entre los niveles del pastoreo. El análisis del tejido de los pastos marinos sugiere que las plantas en este estudio se limitaban más por la luz que por los nutrientes. Este sugiere que el factor limitante más importante en este sitio es la baja luz ambiental. Eso no se observaba en los otros estudios del pastoreo en el Caribe, pero quizás se explica por los altos niveles de escorrentía en el sitio por causa de altos niveles de lluvia.

Keywords: seagrass, turtle, runoff, Panama, stingray

LONG-TERM PERSISTENCE OF PROPELLER AND ANCHOR DAMAGE ON SEAGRASS CANOPY, BENTHIC FAUNAL, AND FISH ASSEMBLAGES IN PUERTO RICO

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Recreational navigation is one of the most significant threats to shallow seagrass communities. Impacts from propeller scars, anchoring and trampling can be locally abundant and can foster rapid ecological change. However, little attention has still been paid to the long-term responses of seagrass and faunal communities to chronic boating and anchoring impacts. The objectives of this study were to assess the spatio-temporal effects of power boat propeller wash and anchoring impacts on percent seagrass cover, shoot density, blade size, and benthic faunal community structure during a 15-year time span (1996, 2011) at Mata de la Gata Island, La Parguera, Puerto Rico. Sampling was conducted in triplicate 10 x 1 m belt transects within the propeller scoured channel and compared to eastern and western seagrasses adjacent to the scoured zone (5 m away) and to seagrasses located 15 m away on each side of the channel. Permutational analysis of variance (PERMANOVA) showed a significant temporal ($p=0.0421$) and spatial ($p<0.0001$) variation in seagrass benthic community structure. Percent *Thalassia testudinum*

(p=0.0097) and open substrate cover (p=0.0071) showed a significant temporal decline. Percent macroalgal (p<0.0001) and cyanobacterial cover (p=0.0004) exhibited a significant temporal increase. These results suggest a net phase shift in benthic assemblage composition favouring dominance by brown macroalgae, *Dictyota* spp. Principal coordinates ordination (PCO) showed that benthic community trajectory was influenced by declining seagrasses and by increased macroalgal dominance. Simultaneously, PCO showed shifting benthic invertebrate and demersal fish assemblages with declining seagrasses. This study provides evidence that intensive recreational navigation can be a major driver of change in shallow seagrass assemblages and in their associated fauna. Such changes appear to be persistent at least on decadal time scales. Establishing limits of acceptable change is a fundamental management action for the conservation and recovery of seagrass essential fish habitats.

La navegación recreativa es una de las amenazas más importantes para las comunidades de pastos marinos poco profundos. Los impactos de las cicatrices de las hélices, el anclaje y el pisoteo pueden ser abundantes a nivel local y pueden fomentar un cambio ecológico rápido. Sin embargo, se ha prestado poca atención a las respuestas a largo plazo de las comunidades de pastos marinos y de su fauna asociada a los impactos crónicos de la navegación y el anclaje. Los objetivos de este estudio fueron evaluar los efectos espacio-temporales de los impactos de las hélices de las embarcaciones motor y del anclaje sobre el porcentaje de cobertura de pastos marinos, su densidad, el tamaño de la hoja y la estructura de la comunidad faunística béntica durante un período de 15 años (1996, 2011) en Isla Mata de la Gata, La Parguera, Puerto Rico. El muestreo se realizó por triplicado en transectos de cinturón de 10 x 1 m dentro del canal socavado por las hélices y el anclaje, comparándose con los pastos marinos adyacentes localizados al este y al oeste de la zona impactada (a 5 m de distancia), y con pastos marinos ubicados a 15 m de distancia a cada lado del canal. El análisis permutacional de la varianza (PERMANOVA) mostró una variación temporal significativa (p=0.0421) y espacial (p<0.0001) en la estructura de la comunidad bentónica de pastos marinos. El porcentaje de cobertura de *Thalassia testudinum* (p=0.0097) y la cobertura de sustrato abierto (p=0.0071) mostraron una disminución temporal significativa. El porcentaje de cobertura de las macroalgas (p<0.0001) y la de cianobacterias (p=0.0004) exhibió un aumento temporal significativo. Estos resultados sugieren un cambio neto de fase en la composición de la comunidad bentónica que favorece el predominio de las macroalgas pardas, *Dictyota* spp. La ordenación de las coordenadas principales (PCO) mostró que la trayectoria de la comunidad bentónica se vio influenciada por la disminución de los pastos marinos y por el aumento de la dominación de las macroalgas. Simultáneamente, el PCO mostró cambios significativos en la composición y distribución de especies de los invertebrados bentónicos y en la comunidad de los peces demersales con el declive en los pastos marinos. Este estudio proporciona evidencia de que la navegación recreativa intensiva puede ser un factor importante impulsor del cambio en las comunidades someras de pastos marinos y en su fauna asociada. Tales cambios parecen ser persistentes al menos en escalas de tiempo decenales. Establecer límites de cambio aceptables es una acción de manejo fundamental para la conservación y recuperación de los hábitats esenciales de peces en los pastos marinos.

Keywords: anchoring, benthic faunal assemblages, fish assemblages, long-term ecological change, recreational boating, seagrasses

CHANGES TO A CRITICAL MARINE FISH NURSERY HABITAT IN ST. CROIX, USVI: REASSESSMENT AFTER TWO DECADES OF MANGROVE HABITAT GAIN AND LOSS, INVASIVE SPECIES, HURRICANES, AND DROUGHT IMPACTS

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Fisheries in the U.S. Virgin Islands are threatened, and the island of St. Croix has added vulnerability due to spatial isolation and potential need for self-sufficiency in stock replenishment. This puts pressure on the island to maintain optimal juvenile fish habitats. Great Pond is one of a few remaining mangrove habitats on St. Croix and a 1995-97 study established it as an ecologically- and economically-important fin-fish nursery. Since then, fringing red mangrove expansion has nearly in-filled the open pond, increasing its potential as a nursery habitat. However, a recent mangrove die-off following severe drought in 2015 led to >70% tree death by 2017. To reassess nursery health given these structural changes, we replicated historical sampling using standardized traps and seine-netting Sep 2016-Aug 2017. Compared to historical data, results show significant decreases in abundance of trap- and seine-caught native marine fish, decreases in native species-diversity in traps (18 to 2) and seines (17 to 5), loss of commercial-species of snapper and jack, as well as significant increase in overall abundance of trap-caught fish due to invasive tilapia (n=9 to 1388). Sep 2017 hurricanes raised further nursery function concerns: die-off of most mangroves that were alive pre-storms and substantial tree-fall of those already dead. Post-storm sampling December 2017 to June 2018 showed persistence of tilapia and tripling of diversity of trap-caught native marine fish (2 to 6 spp.), followed by a massive fish-kill Apr 2018 likely caused by a second drought. These results demonstrate how interacting stressors (droughts, hurricanes, invasive species) can result in dramatic changes to fish communities over relatively brief time scales, suggesting the need for frequent assessment and potentially, active management to restore native marine fish nursery habitat.

Keywords: mangrove, invasive species, fish nursery, hurricane impacts

Session*: Novel Techniques in Remote Sensing & Reef Science*

REVOLUTIONARY AERIAL MAPPING TECHNOLOGIES TO ADVANCE COASTAL CONSERVATION AND RESTORATION

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Defining the location and condition of coastal habitats, including coral reef, mangroves, and seagrass, is essential for effective protection and management of these invaluable ecosystems. Producing detailed habitat maps over large spatial scales, however, has traditionally required large capital investments and the deployment of highly skilled local practitioners to remote geographies. We are bridging this critical knowledge gap by leveraging recent advances in remote sensing technologies and partnering with the organizations at the forefront of this rapidly developing field. In collaboration with Planet, whose fleet of around 200 satellites collects global data on a daily time step, and the Carnegie Airborne Observatory, whose high-fidelity imaging spectrometers and multiple laser scanners provide high fidelity habitat differentiation, we are pioneering coastal monitoring approaches to provide spatial, temporal, and taxonomic resolutions never before possible. eCognition, an object-oriented approach, is being used to delineate benthic habitats throughout the Caribbean using the Planet satellite imagery. In contrast to pixel-based classification methods, object-oriented image analysis segments satellite data into seascape objects that have ecologically-meaningful shapes, and classifies the objects across spatial, spectral, and textural scales. These objects represent distinct patches of uniform benthic habitat and are classified based on both spectral and non-spectral attributes of the imagery which include bathymetry, geomorphic zones, and corresponding texture, spatial, and contextual information. We integrated thousands of GPS-referenced field video transects, drone, and scuba diver data collected throughout the area to train the classification algorithm. This innovative, scalable approach to coastal ecosystem mapping and monitoring will provide the data needed to target coastal conservation actions to provide maximum human benefit, including ecosystem valuation, targeted conservation and habitat restoration, and effective marine spatial planning.

Keywords: Benthic Mapping, Satellite, Remote Sensing, Caribbean, Classification

RECENT INCREASES IN SEAFLOOR ELEVATION: FALSE HOPE FOR THE FLORIDA REEF TRACT

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Healthy coral reefs serve as natural barriers that protect adjacent shorelines from coastal hazards, such as wave impacts from storms. Recent predictions, however, assert that anthropogenic impacts and climate change will cause the global degradation of coral reefs, leading to a net-erosional state by 2050. In 2017 we published the first measurements of regional-scale elevation changes for coral reef

ecosystems. We developed analysis techniques that used both contemporary bathymetric LiDAR and historical sounding data to estimate spatial variability in the amount of accretion and erosion for 5 coral reef ecosystems in the Atlantic, Pacific and Caribbean over the last several decades. Regional-scale mean-elevation and volume losses were observed in all 5 study sites. We recently extended the study period for the Florida reef tract to include the years 2002 – 2016 using newly available bathymetric LiDAR. Almost all substrate types exhibited minimal elevation gains in contrast t o the results of our previous study. These modest elevation gains resulted in a minimum net volume change of 1.6 million-cubic-meters for the total site and 0.4 and 1.0 million-cubic-meters for coral-dominated and non-coral substrates, respectively. These increases seemingly indicate a reversal in the well-documented, long-term degradation of reefs in Florida and the wider Caribbean. Using coral reef survey data, photographic evidence, and storm-incidence history, however, we show that these increases are due to increases in octocorals and macroalgae, coral breakdown, and reduced sediment transport.

Keywords: seafloor erosion, lidar, elevation-change modeling

UTILIZING 3-D MODELING TO DETERMINE CORAL REEF CALCIUM CARBONATE PRODUCTION AT THE ARCH REEF SITE IN SOUTH CAICOS, TCI **(Student)**

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Coral reefs are biologically diverse ecosystems that provide a variety of services for humans and marine organisms. Within the next 30 years, a majority of coral reef ecosystems will be compromised due to climate-changed induced reductions in calcium carbonate production. Calcium carbonate production is essential for maintaining coral reef topographic complexity which subsequently provides higher levels of species biodiversity, primary productivity, and biomass. Topographic complexity has traditionally been measured with linear rugosity, but recent advances in affordable 3-D modeling allow for more accurate means of assessing complexity utilizing fractal dimension analysis. The lack of information regarding coral reef calcium carbonate ($CaCO_3$) production in the Turks & Caicos Islands, presented an opportunity to assess $CaCO_3$ production while exploring its relationship to topographic complexity, coral species diversity, and depth. Following ReefBudget methodology, overall rates of $CaCO_3$ production and bioerosion for a fringing reef (The Arch) in South Caicos were estimated at the transect level for 10 m and 20 m depth. The Arch reef was found to have a net negative budget (- 2.27 kg m-2 yr-1) with 66.7% of the transects having net negative $CaCO_3$e production. There was considerable variance in $CaCO_3$ productivity between 10 m (-2.62 kg m-2 yr-1) and 20 m (0.349 kg m-2 yr-1) depths. $CaCO_3$production and fractal dimensions values were inversely related (linear regression, p= 0.032) at both 10- and 20-meter depths. Linear rugosity (linear regression, n = 18, R2 = 0.50, p-value = 0.001) and fractal dimension (D1,2-0.6, D1.2-0.3, D 1.2-0.15, D1.2-0.05) increased with coral species diversity. Fractal dimensions obtained through 3D modeling should continue to be integrated with ReefBudget methodology to

determine if the unexpected negative relationship with calcium carbonate production holds true in other fringing reefs in the Caribbean.

Keywords: Reef budget, calcium carbonate, fractal, 3-D modeling, linear rugosity

EXPLAINING SPATIAL VARIATION OF FISH ASSEMBLAGES WITH STRUCTURAL COMPLEXITY: THE VALUE OF 3D RECONSTRUCTIONS **(Student)**

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Coral reefs are mega diverse ecosystems which support a large number of fish species. Traditional techniques for measuring the complexity of reefs, such as the chain method, the manual count of crevices and in situ estimation of coral colony size, require endless hours of field work and do not necessarily represent accurate proxies of habitat complexity. Recent advances in photometry techniques allow obtaining complex and more accurate measures in less time offering a higher cost-benefit. Here in we used 3D models of the benthic habitat to test whether spatial variation of reef fish communities can be explained by the structural complexity of reefs in three localities located along the Venezuelan coast (Morrocoy, Mochima and Chichiriviche) and four sites within each location. For this, we used a series of proxies of complexity (e.g. rugosity based on surfaces; mean, variance, kurtosis, asymmetry of heights and angles, and the maximum height) extracted from the 3D models. A two-factorial mixed design (Factor 1 [Location: fixed]: with three levels and Factor 2[Site: random and nested within location) was utilized to test our hypothesis. Distance based linear models (DistLM) were then used to find the proxies of structural complexity that better explained patterns of spatial variation of fish assemblages. Fish assemblages differed between locations ($F = 4.06$, $df = 2$ $p = 0.01$) and varied between sites ($F = 3.6$, $df = 9$ $p = 0.001$), whereas structural complexity only varied within locations ($F = 4.08$, $df = 9$, $p = 0.001$). The DistLM only explained 21% of observed spatial variability of fish assemblages; with rugosity accounting for 67% of the total variance explained by the linear model. Our results clearly indicate that structural complexity better explains changes in fish assemblages at the level of sites and not at larger spatial scales.

Los Arrecifes de coral con ecosistemas mega diversos que soportan un gran número de especies de peces. Las técnicas tradicionales para medir la complejidad estructural de los arrecifes, como el método de la cadena, el conteo manual de grietas y la estimación in situ del tamaño de las colonias de coral, requieren interminables horas de trabajo de campo y no representan necesariamente los indicadores más precisos de la complejidad del hábitat. Los avances recientes en técnicas de fotometría permiten obtener medidas complejas y más precisas en menos tiempo, ofreciendo un mejor costo-beneficio. Aquí utilizamos modelos 3D del hábitat béntico para probar si la variación espacial de las comunidades de peces de arrecife puede explicarse por la complejidad estructural de los arrecifes en tres localidades a

lo largo de la costa venezolana (Morrocoy, Mochima y Chichiriviche) y 4 sitios dentro de cada localidad. Para esto, utilizamos una serie de indicadores de complejidad (e.g, rugosidad basada en superficies; media, varianza, curtosis, asimetría de alturas y ángulos y la altura máxima) extraídos de los modelos 3D. Se utilizó un diseño mixto de dos factores (Factor 1 [Ubicación: fijo]: con tres niveles y Factor 2 [Sitio: aleatorio y anidado dentro de la ubicación) para probar nuestra hipótesis. Los modelos lineales basados en la distancia (DistLM) se utilizaron para encontrar los indicadores de complejidad estructural que explicaban mejor los patrones de variación espacial de los ensamblajes de peces. Los ensamblajes de peces difirieron entre localidades ($F = 4.06$, $df = 2$ $p = 0.01$) y variaron entre sitios ($F = 3.6$, $df = 9$ $p = 0.001$), mientras que la complejidad estructural solo varió dentro de las localidades ($F = 4.08$, $df = 9$, $p =$ 0,001). El DistLM solo explicó el 21% de la variabilidad espacial observada en los ensambles de peces; donde la rugosidad representa el 67% de la varianza total explicada por el modelo lineal. Nuestros resultados indican claramente que la complejidad estructural explica mejor los cambios en los conjuntos de peces a nivel de sitios y no a escalas espaciales más grandes.

Keywords: Habitat complexity, fish assemblages, 3D reconstructions, rugosity

Session: Climate change and multiple stressor impacts on coral reefs

FISHING, POLLUTION, CLIMATE CHANGE, AND THE LONG-TERM DECLINE OF CORAL REEFS OFF HAVANA, CUBA

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Understanding temporal and spatial variation of coral reef communities allows us to analyze the relative effects of local stressors, such as fishing and eutrophication, and global stressors, such as ocean warming. To test for spatial and temporal changes in coral reef communities, we combined recent benthic and fish surveys from 2016 with long-term data, dating back to the late 1990s, from four zones located at different distances from Central Havana, Cuba's largest population center. These changes may indicate the shifting importance of local versus global stressors affecting reef communities. Regardless of the distance from Havana, we found that coral cover was uniformly low (~10%), whereas macroalgal abundance was often high (~65%). Similarly, fish biomass was low across zones, particularly for herbivorous fishes (~12 g m-2) that are critical ecological drivers of reef structure and coral resilience. Analyses of longer-term trends showed that coral cover near Havana has been below ~10% since at least 1995, potentially because of local stressors. In contrast, reefs further from Havana maintained relatively high coral cover (~30%) until the early 2000s but declined more recently to ~15%, putting them near the Caribbean-wide average. These distinct spatial and temporal trajectories of reef communities may be the result of the expansion of local stressors away from Havana as the human population increased or fishers ventured farther away to exploit new resources. Alternatively, the more recent decline of reefs farther from population centers may have resulted from increasingly frequent global stressors, such as bleaching events and hurricanes.

STATUS OF CUBAN CORAL REEFS

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Cuban coral reefs have been called the “crown jewels of the Caribbean Sea,” but there are few comparative data to validate this claim. Here, we provide an overview of Cuban coral reefs based on surveys carried out between 2010 and 2016 on seven of the main Cuban coral reef systems: Havana, Artemisa, Los Colorados, Punta Francés, Los Canarreos Archipelago, Península Ancón, and Jardines de la Reina. Ecological indicators were evaluated for each of these areas at the community level. Results suggest differences among benthic communities (corals, sponges, and gorgonians) that are most evident for reefs that develop near highly urbanized areas, such as Havana, than for those far from the coast and less accessible. Offshore reefs along the south-central coast at Jardines de la Reina and Península Ancón exhibited high coral density and diversity. *Acropora cervicornis* (Lamarck, 1816) and the *Orbicella* complex corals were uncommon, possibly indicating losses prior to our study due to coral diseases or competition with macroalgae. *Siderastrea siderea* (Ellis and Solander, 1786) was the most consistently-abundant species at all reef sites. The ecological condition at Jardines de la Reina and Península Ancón is comparatively healthy. Our study supports claims that some Cuban coral reef systems are probably among the best preserved in the Caribbean basin, but other highly impacted areas exhibit many of the degradation patterns that are common to the rest of the Caribbean region. Strong conservation strategies are required with regard to subsistence fisheries and pollution at highly-impacted reefs to stop further degradation, and reefs that appear healthy need protection to avoid degradation and maintain resilience.

Los arrecifes de coral en Cuba han sido llamados "corona de diamantes del Mar Caribe", pero en realidad no existen muchos datos que validen esta información. En este trabajo, se brinda información de investigaciones desarrolladas entre el 2010 y el 2016 en siete de los principales sistemas arrecifale scubanos: Habana, Artemisa, Los Colorados, Punta Francés, Archipiélago de Los Canarreos, Península Ancón y Jardines de la Reina. En cada area se evaluaron indicadores a nivel de comunidad. Los resultados sugieren que existen diferencias entre las comunidades bentónicas (corales, espojas y gorgonias) que son más evidentes en sitios antropizados como La Habana que otros menos accesibles por encontrarse lejos de la costa. Los arrecifes de la región sur-central como Jardines de la Reina y Península Ancón exhiben alta densidad y diversiadad de corales. *Acropora cervicornis* (Lamarck, 1816) y el complejo *Orbicella* no fue comun, osiblemente indicando la perdida de este género antes de nuestros estudios debido a enfermedades o competencia con las macroalgas. *Siderastrea siderea* (Ellis and Solander, 1786) fue la especie más abundante en todos los arrecifes. La condición ecológica de Jardines de la Reina y Península Ancón es comparativamente saludable. Nuestros resultados sugieren que algunos de los arrecifes d ecoral cubanos son probablemente de los más preservados del Caribe, mientras que otros se encuentran muyimpactados y exhiben patrones de degradación comunes al resto de la región. Se requieren estrategias sólidas de conservación con relación a la pesca de subsisitencia

y a la contaminación para detener la degradación de los arrecifes severamente impactados, mientras que los arrecifes saludables, necesitan protección para evitar la degradación y mantener la resiliencia.

Keywords: Coral reefs, conservation, ecology, biodiversity, health

QUANTIFYING RESILIENT GENOTYPES OF ORBICELLA FAVEOLATA EXPOSED TO INCREASED TEMPERATURE, OCEAN ACIDIFICATION, AND THE STONY CORAL TISSUE LOSS DISEASE

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The Florida Reef Tract is a biologically and economically important ecosystem. Despite its importance, this ecosystem is threatened by various global and local stressors that have caused substantial decreases in coral cover. Three major stressors that have contributed to this are ocean warming, ocean acidification, and infectious disease outbreaks. Finding corals that are resilient to these stressors is vital for restoration practices, as these threats are likely to continue unabated. Here, we exposed different genotypes of Orbicella faveolata to increased temperature, reduced pH, and the Stony Coral Tissue Loss Disease. First, we conducted a wet lab experiment exposing six replicates of 12 genotypes to increased temperature and reduced pH for two months. We assessed the physiological response of each coral using PAM fluorometry, buoyancy weight, net photosynthesis and respiration via oxygen evolution methods, and calcification via the alkalinity anomaly technique. Then we exposed the corals to wild colonies infected with the Stony Coral Tissue Loss Disease. We assessed coral health by recording daily observations and photos of each individual fragment. Our results indicate that there are genotypic differences in response to treatments, with some genetic strains showing resistance to each stressor independently. Additionally, some of the genotypes showed resistance to increased temperature and reduced pH combined. Resistance to the Stony Coral Tissue Loss Disease appeared independent of resilience to increased temperature and reduced pH. These results suggest that these corals may be able to withstand future oceanic conditions, and incorporating these genotypes while also maintaining genetic diversity should be applied in coral restoration initiatives.

Keywords: Florida Reef Tract, Orbicella faveolata, Heat Tolerance, Ocean Acidification, Stony Coral, Tissue Loss Disease, Coral Restoration

MULTI-STRESSOR IMPACTS TO THE MESOPHOTIC CORAL MONTASTRAEA CAVERNOSA

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Corals globally are experiencing considerable threat including possible extermination due to climate change warming the upper water layers coupled to numerous anthropogenic pressures. In particular, the effects of heat stress are well documented, however, less is known about the climate coupled to oil pollution. Much less is known about how these two environmental stressors impact deeper mesophotic corals (i.e. 30 – 150 m). Here, we examined short term (72 hr.) versus long-term (480 hr.) heat stress plus oil on the mesophotic coral Montastraea cavernosa (Linnaeus 1767) at temperatures varying from 27 to 33°C over six hours versus increases from 27°C at 1.5°C increments every 72 hours until 33°C was reached. Quantitative real-time polymerase chain reaction (qRT-PCR) resulted in two distinct gene expression profiles. Short-term exposure resulted in the activation and upregulation of oxidative protective enzymes, molecular chaperones, and anti-apoptotic proteins. Long-term exposure only elicited responses at higher temperatures (i.e. 30°C). We speculate that 30°C is a temperature threshold for mesophotic M. cavernosa, and that these corals are equally susceptible to climate change and oil pollution regardless of depth.

Los corales de todo el mundo están experimentando una amenaza considerable, incluido el posible exterminio debido al cambio climático que calienta las capas superiores de agua junto con numerosas presiones antropogénicas. En particular, los efectos del estrés por calor están bien documentados, sin embargo, se sabe menos sobre el clima asociado a la contaminación por hidrocarburos. Se sabe mucho menos acerca de cómo estos dos factores de estrés ambiental impactan a los corales mesofóticos más profundos (es decir, de 30 a 150 m). Aquí, examinamos el estrés por calor a corto plazo (72 horas) versus el estrés térmico a largo plazo (480 horas) más el aceite en el coral mesofótico Montastraea cavernosa (Linnaeus 1767) a temperaturas que varían de 27 a 33°C durante seis horas versus aumentos de 27°C en incrementos de 1.5°C cada 72 horas hasta alcanzar los 33°C. La reacción en cadena de la polimerasa en tiempo real cuantitativa (qRT-PCR) dio como resultado dos perfiles de expresión génica distintos. La exposición a corto plazo dio como resultado la activación y la regulación positiva de enzimas protectoras oxidativas, chaperonas moleculares y proteínas antiapoptóticas. La exposición a largo plazo solo provocó respuestas a temperaturas más altas (es decir, 30°C). Especulamos que 30°C es un umbral de temperatura para M. cavernosa mesofótica, y que estos corales son igualmente susceptibles al cambio climático y la contaminación por hidrocarburos independientemente de la profundidad.

Keywords: Mesophotic, Montastraea, Climate, Oil, qRT-PCR, proteins

THE IMPACT OF SHORT-TERM, LOCAL STRESSORS ON SEXUAL RECRUITS OF REEF-BUILDING CORALS.

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Coral recruitment is a critical process in the life of corals because it is how new organisms join the reef community. Unfortunately, multiple factors have short-term impacts on the survival of early-stage coral sexual recruits, and hinder their use in restoration programs. To identify the effect of local factors, the survival of sexual recruits from five reef-building coral species in the Caribbean, Acropora palmata, Orbicella faveolata, O. annularis, Diploria labyrinthiformis and Pseudodiploria strigosa was evaluated. For each species, larvae were settled on artificial substrates with four types of microhabitats: channels, holes, protuberances and exposed surfaces; and three anchoring shapes: tetrapod, binder star and gear. One-month old sexual recruits without symbionts were outplanted at a density of 4 substrates per meter squared in a reef within the Mesoamerican Reef System, in Mexico. Recruit survival was recorded periodically. Local records of physical factors: temperature, PAR, precipitation, wind speed and direction were analysed. Biological factors were surveyed at the outplanting sites for benthic composition, potential predators, presence of coral diseases and acquisition of symbionts. In relation to physical factors, the results suggest that mortality is higher when the artificial substrates are displaced from their outplanting area, are covered by sediment or dragged by currents generated by Northerly winds that persist during the initial months after outplanting. Analysis of the biological factors indicates that the presence of potential predators such as small crustaceans and ophiuroids, as well as overgrowth by algae and sponges on the substrates is linked to the high recruit mortality. The acquisition of symbionts and unexposed microhabitats on the substrates are correlated with the recruit survival. These data suggest that an adjustment in the selection of outplanting sites, taking into account the effect of physical factors and the use of artificial substrates that anchor well into the reef will probably increase recruitment success and the permanence of these species on the reef.

El reclutamiento coralino es un proceso crucial en la vida de los corales ya que implica la unión de nuevos organismos a la comunidad arrecifal. Desafortunadamente, múltiples factores tienen impactos a corto plazo sobre la supervivencia de reclutas sexuales de coral que ponen en riesgo su existencia en el mundo, y dificulta su uso en programas de restauración a temprana edad. Con el objetivo de identificar la relación entre estos factores a nivel local, se evaluó la supervivencia de reclutas sexuales de cinco especies de corales constructores de arrecife en el Caribe: Acropora palmata, Orbicella faveolata, O. annularis, Diploria labyrinthiformis y Pseudodiploria strigosa. De cada especie se utilizaron reclutas sexuales previamente establecidos en sustratos artificiales con microhábitats: canales, huecos, protuberancias y superficies expuestas; y formas particulares para su anclaje al arrecife: tetrápodo, estrella y engranaje. Los reclutas fueron sembrados sin simbiontes a la edad de un mes, con una densidad de siembra de 4 sustratos por metro cuadrado en un arrecife del Sistema Arrecifal Mesoamericano, en México y se registró la supervivencia periódicamente. También se realizaron registros locales de factores físicos: temperatura, PAR, precipitación, velocidad y dirección del viento. Y factores biológicos del sitio de siembra: composición bentónica, depredadores potenciales, presencia de

enfermedades coralinas, asociación con Symbiodinium sp. En relación con los factores físicos, los resultados de monitoreos post-siembra sugieren que la mortalidad es mayor en los sustratos artificiales desplazados de su área de siembra, cubiertos por sedimento o arrastrados por las corrientes generadas por los vientos provenientes del norte que persisten durante los primeros meses post-siembra. Los registros de factores biológicos indican que la presencia de depredadores potenciales como pequeños crustáceos y ofiuros, así como el sobre crecimiento de algas y esponjas en los sustratos está vinculada a la alta mortalidad en reclutas. La adquisición de Symbiodinium y los microhábitats no expuestos del sustrato están correlacionados con la supervivencia de reclutas de coral. La adecuación en la selección del sitio, la temporalidad de la siembra y el uso de sustratos artificiales con mayor ensamblaje al arrecife incrementarían el éxito de reclutamiento y la permanencia de estas especies.

Keywords: Restoration, seeding, predation, wind, symbiosis, survival.

COASTS – CLIMATE AND OCEAN ACIDIFICATION SIMULATION TANK SYSTEM IN THE FLORIDA KEYS

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Coral reefs are one of the most biologically diverse and economically important ecosystems on the planet; however, they are sensitive to global and local environmental stressors. To study these stressors on coral reef organisms and ecosystems, we developed a state-of-the-art experimental tank system in the Florida Keys. The Climate and Ocean Acidification Simulation Tank System (COASTS) is a multi-user dedicated outdoor raceway experimental area that can be used to model future global (ocean acidification [OA] and climate change [CC]) and local (e.g. nutrients, disease) scenarios. The facility also includes an OA chemistry dry laboratory space as well as a general chemistry lab space allowing for on-site sample analysis of carbonate chemistry. This system is available for in-house staff, visiting scientists, students, and educational groups at the Mote Marine Laboratory Elizabeth Moore International Center for Coral Reef Research and Restoration (Mote IC2R3). The system uses seawater that is continuously pumped in from the Atlantic side of the Florida Keys, filtered through sand filters, large particle filters, and has options for UV sterilization and carbon filtration. It includes outdoor raceways (shallow and deep), shade control, networked controllers, pH control, and temperature control. Several large header tanks are used for holding treated seawater and manipulating pH and temperature control for up to three separate treatments. This is a flow-through system which allows for a continuous supply of “new” water throughout experiments and is continuously monitored for pH and temperature in each tank (header tanks and representative aquaria). The COASTS infrastructure allows for adaptation to a variety of experimental designs, giving users flexibility in experimental setup and giving the system the potential to host cutting-edge, innovative climate change and ocean acidification research in close proximity to one of the largest reef ecosystems in the world.

Keywords: ocean acidification, climate change, experimental system, coral, Florida Keys

CAN SEAGRASS AMELIORATE CORAL PHYSIOLOGICAL PERFORMANCE UNDER OA CONDITIONS?

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Coral reefs are one of the most biologically diverse and economically important ecosystems on the planet; however they are sensitive to environmental stressors such as ocean acidification (OA). OA lowers the saturation state of calcium carbonate utilized by calcifying organisms, potentially leading to dissolution of skeletons and reduced ability to form new calcium carbonate structures, as well as impacting general health and physiology. Many restoration efforts focus on growing coral fragments in field nurseries and transplanting fragments or colonies back to degraded reefs, though it is not fully understood yet how negative impacts of OA will affect current coral restoration efforts. Seagrass meadows, sometimes found adjacent to coral reefs in the Florida Keys, are mostly net autotrophic as a carbon sink and can use excess bicarbonate from OA for growth. This presents the possibility of locally mediating OA effects on corals downstream of seagrass meadows and may provide an area of refugia for coral restoration efforts. We performed a land-based study as well as an in-situ study to understand if seagrass could ameliorate coral physiological performance in general and under OA conditions. We tested the impacts of the presence of seagrass (Syringodium filiforme) on carbonate chemistry and coral health (Acropora cervicornis) in present day conditions and in OA scenarios expected to occur in this century in a land-based experimental setting. We also tested physiological performance of A. cervicornis within and outside of a natural mixed seagrass bed in the Florida Keys. Physiological responses were variable; however, growth and rates of photosynthesis were generally higher in the presence of seagrass. Results presented here describe the potential for seagrass to act as refugia for coral by buffering against negative effects from OA.

SEASONAL DNA METHYLATION VARIATION IN THE FLAT TREE OYSTER ISOGNOMON ALATUS FROM A MANGROVE ECOSYSTEM IN NORTH BISCAYNE BAY, FLORIDA

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Epigenetic analyses constitute an emerging approach for better understanding of the mechanisms underlying environmental responses and their role during acclimatization and adaptation across diverse ecosystems. The expansion of environmental epigenetic studies to a broader range of ecologically and environmentally relevant organisms will enhance the capability to forecast ecological and evolutionary processes, as well as to facilitate a retrospective assessment of stress exposures in biomonitor organisms through ‘‘epigenetic footprinting’’ analyses. With such purpose, the present study monitored

spatial and temporal variation in abiotic parameters (temperature, salinity, pH, and horizontal visibility) over a 2-y period in a mangrove ecosystem located in North Biscayne Bay (North Miami, FL). The obtained data were subsequently compared with epigenetic modifications (global genome-wide DNA methylation levels) in the flat tree oyster Isognomon alatus, used as a sentinel model organism across experimental sites. The obtained results revealed a certain level of seasonality in temporal DNA methylation patterns, which seem to be primarily associated with changes in temperature and horizontal visibility. These results constitute the first long-term study combining spatial and temporal epigenetic analyses in a marine organism in its natural environment, laying the initial groundwork to assess the biomonitoring potential of environmental epigenetic analyses.

Keywords: Biomonitoring, epigenetics, coastal oceans, DNA methylation, global climate change, stress

ABUNDANCE, DISTRIBUTION, AND GROWTH OF THE EXCAVATING SPONGE CLIONA DELITRIX ON BARBADOS' SOUTH AND WEST COASTS (**STUDENT**)

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Coral reef framework is being constantly eroded by physical and biological processes. Excavating sponges are among the most important bioeroders on Caribbean reefs and are of increasing concern as reefs continue to degrade. In this study, we sought to shed light on the population dynamics of the aggressive excavating sponge, Cliona delitrix, on Barbados' reefs. Surveys were conducted at six sites (>5km apart) selected to span the island's south and west coasts. At each site, six permanent 25m2 quadrats were established and surveyed approximately every 5 months over a 26-month period. Surveys included measuring the surface area and depth of substrate excavation of each C. delitrix outcrop and identifying the coral species colonized. Additionally, the potential role of anthropogenic nutrient inputs along the coasts as a driver of sponge growth was investigated using stable isotopes obtained from C. delitrix tissue. A total of 1019 outcrops were recorded during the study. There was considerable among-site variability in C. delitrix outcrop abundance (range: 93–217 outcrops per site), lateral growth rates (0.3–8.3cm2/year), outcrop surface area (1–600cm2 per outcrop), and growth into the substrate (0.5–12cm), but preliminary analysis shows no consistent differences in these metrics between the south and west coasts. Among-site variation in these metrics was not related to the sponge nitrogen stable isotope signatures, suggesting that land-based nutrients play a minor role in variation in growth. C. delitrix colonized ten coral species; the coral Siderastrea siderea was most commonly colonized, at a level disproportionate to its relative abundance. At sites <10m in depth, C. delitrix was predominantly found on live coral, while at deeper sites it was mainly found on dead coral substrate, suggesting that it kills corals more quickly at greater depths. These data provide the first large scale picture of C. delitrix population dynamics in Barbados.

Keywords: Cliona delitrix, excavating sponge, bioerosion, growth, Barbados, population dynamics

GEOGRAPHIC DISTRIBUTION PATTERNS OF REEF FISH ASSEMBLAGES HIGHLIGHT THE IMPORTANCE OF CONSIDERING BROAD-SCALE SPATIAL PROCESSES

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Understanding distribution patterns of reef-associated species represent a major challenge for effective management of coral habitats. Along the Venezuelan coast, reef habitats are common and diverse encompassing habitats dominated by a myriad of benthic organisms (e.g. corals, octocorals milleporids and sponges) where fish find shelter. Herein, we evaluated distribution patterns of reef fish assemblages across multiple spatial scales in Venezuelan. We used a nested design including region (separated by hundreds of km, three in total), localities (separated tens of km, seven in total) and sites (separated < 2 km, 36 in total) to evaluate the importance of each spatial scale to explain the variability of fish assemblages. For this, we conducted visual census along four transects separated by few meters in each site. Locality was the most important factor of variation ($F=4.47$, $df=4$, $p=0.0001$, $CV=28\%$) further suggesting that processes acting at tens of kilometers (e.g. upwelling) might be relevant for shaping these communities. We found that 38% of variation was associated to the residual (i.e., variation among transects), which suggest that processes acting at small spatial scales (e.g. structural complexity) might also be relevant for reef fish. Furthermore, ordination plots revealed five distinct fish assemblages with a similarity of 60%. A multivariate linear model which included large-scale predictors of natural and anthropogenic variables such as distance to populated areas or mangrove forest, particulate organic carbon in the water and sea surface temperature explained up to 53% of the variance of fish assemblages in Venezuelan reefs. Our results suggest that a combination of large and small scale processes might be extremely important to determine spatial variability of fish assemblages in Venezuela. This highlights the need to consider the uniqueness of each reef site together with large scale factors to achieve effective management and conservation effort for reef fish.

Entender los patrones de distribución de los organismos arrecifales representa uno de los principales retos para el manejo efectivo de los hábitats coralinos. A lo largo de la costa de Venezuela los ambientes arrecifales son comunes y diversos, comprendiendo ambientes dominados por diferentes organismos (ej. corales escleractínidos, octocorales, mileporidos y esponjas) en los cuales los peces buscan refugian. En el presente estudio evaluamos los patrones de distribución de los ensamblajes de peces de arrecife a lo largo de Venezuela a múltiples escalas espaciales. Usando un diseño anidado el cual incluyó región (separadas por cientos de km, tres en total), localidades (separados por decenas de km, siete en total) y sitio (separados <2 km, 36 en total) evaluamos la relevancia de cada escala espacial al explicar la variabilidad de dichos ensamblajes. Localidad fue el factor de variación más importante ($F=4.47$, $df=4$, $p=0.0001$, $CV=28\%$) lo cual sugiere que los procesos que actúan a escalas espaciales de decenas de kilómetros (ej. surgencia) pueden ser relevantes al determinar los ensamblajes de peces de arrecife. También encontramos que 38% de la variación estuvo asociada al residual (ej. variación entre replicas, transectos) lo cual sugiere que procesos actuando a pequeñas escalas espaciales son relevantes para los peces arrecifales (ej. complejidad estructural). Igualmente observamos a partir de gráficos de ordenación la formación de cinco tipos diferentes de ensamblajes de peces similares en un 60%. Un modelo linear multivariado usando 10 variables el cual incluyó variables actuando a escalas espaciales grandes naturales y de origen antropogénico (ej. distancia a centros poblados o bosques de manglares,

carbono particulado inorgánico, temperatura superficial) explicó 53% de la variabilidad observada en los ensamblajes de peces a nivel de sitio. Nuestros resultados sugieren que una combinación de variables actuando a grandes y pequeñas escalas espaciales puede estar interactuando para definir la estructura de los ensamblajes de peces arrecife en Venezuela. Esto resalta la necesidad de considerar las particularidades de cada arrecife junto con factores actuando a grandes escalas espaciales para lograr manejo y conservación efectivo de las comunidades de peces de arrecife.

Keywords: Reefs, Venezuela, Southern Caribbean, DistLM, Spatial variability

POSTER ABSTRACTS

DAY 1 – Monday, May 20th

Session: Coral reef disease and bleaching

ASSESSMENT OF PALYTOXIN ISOLATED FROM THE ZOANTHID PALYTHOA CARIBAEORUM

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Palytoxin or PTX has been described as a one of the most known potent marine toxins, and has been known to prevent predation from larger species (e.g. vertebrates) as well as the prevention of being overgrown from other coral species. PTX is a polyalcohol toxin with a very large and complex chemical structure that possesses both hydrophilic and lipophilic properties as seen in Fig. 1. Based on acute toxicity tests with brine shrimp (Artemia salina), PTX was previously shown to be moderately toxic, having a lethal concentration LC50 range of between 80 – 250 µg/ml (Melo et al., 2012). In fact, human fatalities due to the consumption of seafood contaminated with PTX has been recorded (Riobó and Franco, 2010). Studies have suggested that human lethal doses may range between 2.3 – 31.5 µg (Uemura 1991), where PTX has been known to affect the Na+/K+ pump mechanisms across cell membranes. This can lead to anaphylactic shock, rapid cardiac failure, and eventual death occurring within minutes. This study isolates a raw extract of PTX from Palythoa caribaeorum and examines the associated toxicity from a biogeography perspective from a variety of reef sites around Trinidad and Tobago that are popular for marine visitors. This research represents an acute study with the examination of PTX toxicity on A. salina, whilst exploring potential factors which may contribute to its toxicity, and the risk posed to users of these environment.

Keywords: Palytoxin, toxicity, Palythoa

ESTABLISHING DNA INTEGRITY WITHIN BLOOD MEALS OF FREE-LIVING STAGES OF FISH-PARASITIC GNATHIID ISOPODS (CRUSTACEA, ISOPODA, GNATHIIDAE) (**Student**)

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Gnathiid isopods are common ectoparasites of marine fishes. Each of three juvenile stages briefly attach to a host to obtain a blood meal and spend most of their time living in the substrate, thus making it difficult to determine patterns of host exploitation. Sequencing of host blood meals from wild-caught specimens is a promising tool to determine host identity. Although established protocols for this approach exist, certain challenges must be overcome when samples are subjected to typical field conditions that may contribute to DNA degradation. The goal of this study was to assess a key methodological issue associated with molecular-based host identification from free-living, blood-engorged gnathiid isopods - the degradation rate of blood meals. Juvenile gnathiids were allowed to feed on fish of known species and subsets were preserved at 4 hour intervals over 24 hours and then every 24 hours up to 5 days post-feeding. Host DNA extracted from gnathiid blood meals was sequenced to validate the integrity of host DNA at each time interval. DNA was also extracted from blood meals of wild-fed gnathiids for comparison. Attempts were also made to extract host DNA from metamorphosed juveniles. Using a COI universal fish primer set, fish host DNA sequences were successfully identified up to 5 days post-feeding, with the highest rate of success occurring when gnathiids were preserved within 24 h of collection. With 94 % of sequences from wild-fed gnathiid blood meals matching a sequence in GenBank, 69 % of hosts were identified as fishes. This is the first study to examine the degradation rate of gnathiid isopod blood meals. Determining the rate at which gnathiids digest their blood meal is an important step in ensuring the successful host identification by DNA-based methods in large field studies.

Keywords: Marine parasite, DNA degradation, Blood meal analysis, COI barcoding

INTERANNUAL AND INTERSPECIFIC VARIABILITY IN CORAL RESILIENCE TO THERMAL STRESS IN THE TURKS AND CAICOS ISLANDS DURING THE 2014-2017 GLOBAL CORAL BLEACHING EVENT (**Student**)

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Coral cover throughout the Caribbean has declined by approximately 80%. Most of which is likely attributable to the 2005 global bleaching event (GBE), one of three GBE that has recently affected reef biomes around the world. The 1998, 2005, and 2015 GBE coincide directly with El Niño warming phases in El Niño-Southern Oscillation (ENSO) cycle. Although the 2005 GBE was the most thermally intense, the 2015 GBE was perhaps the most traumatizing to reef ecosystems. This study investigates how

significantly coral reefs in the Turks and Caicos were affected by the 2014-2017 global bleaching event. Interannual and interspecific variability in coral health and bleaching offshore of South Caicos Island were evaluated over the 2012-2018 sampling interval using the CoralWatch citizen science Coral Health Chart method along belt transects at 8 dive and snorkeling coral reef sampling survey sites situated off-shore of the South Caicos Island, included in the curriculum of the School for Field Studies (SFS) Center for Marine Resource Studies. Our study includes 107 site surveys conducted from 15 October 2012 to 18 July 2018. Coral health was assessed at 8 SFS survey sites between 2012-2018 for the 35 principal coral taxa. In summary, our results indicate that all coral taxa at the South Caicos Island study site were resilient to the 2015-2017 GBE, and rebounded to their pre-GBE pigmentations within months of the anomalously-high thermal stress. However, because the CoralWatch methodology does not quantify total coral cover, our results only focus on surviving corals in the survey tracks.

Keywords: coral bleaching, ENSO, South Caicos

THE CORAL MICROBIOME OF PSEUDODIPLORIA STRIGOSA IS SPECIFIC TO EACH REEF ZONE AND ENRICHED WITH HEAT SHOCK GENES IN FLUCTUATING ENVIRONMENTS IN BERMUDA (**Student**)

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Coral reefs provide a variety of microhabitats characterized by different environmental conditions, which affect the local community from the scale of macro- to microorganisms. Fluctuating environments are potential sources of populations that have more stress response genes and a greater ability to withstand or recover from disturbances. Corals associate with a diverse microbiome which may play a key role in their acquired stress resilience. Whether the mucus microbiome is responding to environmental fluctuations occurring in different reef environments is an outstanding question. We collected the mucus of the coral Pseudodiploria strigosa and seawater samples from two different reef zones (six replicates/site) in Bermuda according to a gradient of environmental fluctuations and used whole shotgun sequencing to produce microbial metagenomes. Each reef zone offers a different pool of microbial taxa and functional genes in the water column which were incorporated to the mucus microbiome in different proportions. The phyla Deinococcus-Thermus was only found in coral mucus microbiomes from inner reefs. In addition, there was higher proportion of Thermofilum spp. and genes related to respiration and transcriptional regulation in the inner reef microbiomes. Coral metagenomes from outer reefs associated more with Alphaproteobacteria and functional genes related to metabolism of amino acids and stress response. Heat-shock genes, however, were found in higher relative abundances in the mucus microbiomes from inner reef sites, while in outer reefs the coral microbiome associates more with osmotic stress. The P. strigosa microbiome from inner reefs had a higher similarity of genera between colony replicates (average similarity: inner = 82.13 outer = 66.17) and was distinct to the microbiome in the surrounding water. In conclusion, a fluctuating environment is leading to a specific microbial community

structure enriched with genes related to heat stress response in the mucus of P. strigosa in Bermuda. Los arrecifes de coral proporcionan una variedad de microhábitats caracterizados por diferentes condiciones ambientales, que afectan a la comunidad local desde la escala de macro a microorganismos. Regiones expuestas a fluctuaciones son fuentes potenciales de poblaciones que tienen más genes de respuesta al estrés y una mayor capacidad para resistir o recuperarse de perturbaciones. Los corales se asocian con un microbioma diverso que puede jugar un papel clave en su resistencia al estrés. Poco se sabe acerca de cómo el microbioma en el moco de los corales se ve afectado por diferentes ambientes de arrecifes. Recolectamos el moco del coral Pseudodiploria strigosa y las muestras de agua de mar de dos diferentes zonas de arrecifes (seis réplicas / sitio) en Bermudas según un gradiente de fluctuaciones ambientales y utilizamos la secuenciación del genoma completo para producir metagenomas microbianos. Cada zona de arrecife ofrece un conjunto diferente de taxones microbianos y genes funcionales en la columna de agua que se incorporaron al microbioma en el moco de los corales en diferentes proporciones. El phyla Deinococcus-Thermus solo se encontró en microbiomas de moco de coral de arrecifes internos. Además, hubo mayor proporción de Thermofilum spp. y genes relacionados con la respiración y la regulación transcripcional en los microbiomas del arrecife interno. Los metagenomas de coral de los arrecifes externos se asocian más con Alfa-proteobacteria y los genes funcionales relacionados con el metabolismo de los aminoácidos y la respuesta al estrés. Sin embargo, los genes de choque térmico se encontraron en mayores abundancias relativas en los microbiomas mucosos de los sitios de arrecifes internos, mientras que en los arrecifes externos el microbioma de coral se asocia más con el estrés osmótico. El microbioma de P. strigosa de los arrecifes internos tuvo una mayor similitud de géneros entre las réplicas de colonias (similitud promedio: interno = 82.13 externo = 66.17) y era distinto del microbioma en el agua circundante. En conclusión, fluctuaciones ambientales están conduciendo a una estructura de comunidad microbiana específica y enriquecida con genes relacionados con la respuesta al estrés por calor en el moco de P. strigosa en las Bermudas.

Keywords: metagenomics, habitat variability, marginal reefs, thermal resilience

WHEN ASPERGILLUS IS MISSING IN SEA FAN ASPERGILLOSIS (**Student**)

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An alarming worldwide coral reef decline has recently been enforced by the rapid spread of coral diseases. Of the coral diseases reported thus far, sea fan aspergillosis was thought to be one of the best understood, with Aspergillus sydowii being the etiological agent. However, limited knowledge of the microbial ecology and mycoflora associated with healthy and diseased sea fans undermines a true understanding of this disease, and the role of A. sydowii as a primary pathogen has been challenged by its isolation from healthy sea fans. Our research aims to refine the sea fan aspergillosis case definition with a transdisciplinary approach combining cutting-edge microbial molecular techniques with classical histopathological examination. To this end, we collected biopsies from 20 sea fans (Gorgonia ventalina) with focal tissue loss and annular purple pigmentation, consistent with a field diagnosis of aspergillosis,

in three shallow fringing reefs of St Kitts. Fitting with the previously described histological case definition for aspergillosis, intra-axial fungal hyphae, morphologically uniform and consistent with Aspergillus spp., were present within purple pigmented areas of all sea fans. Macroscopic and microscopic characteristics of the mycelia and reproductive structures from isolates cultured were however consistent with Penicillium spp. Sequencing the ITS1 and ITS2 region and subsequent BLAST query confirmed their identity. No fungi were retrieved from apparently-healthy tissue and control healthy sea fans. Differentially affected tissues within diseased sea fans have also been processed for metagenomics to characterize the spatial effect of disease-associated microbiomes. We hypothesize that the presence of fungi alone may be not enough to cause disease and underlying microbial dysbiosis is likely to steer susceptibility of sea fans to fungal infiltration. Research is needed to characterize the stable and consistent components within the coral microbiome and address the current gap in our understanding of fungal colonization of sea fans.

Keywords: aspergillosis, Gorgonia ventalina, Caribbean Sea fan, coral disease, fungal culturing, coral microbiome

INSIDE THE PURPLE SPOT: MICROSCOPIC AND MOLECULAR APPROACH TO MULTIFOCAL PURPLE SPOTS IN SEA FANS (**Student**)

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Coral diseases have emerged over recent decades as a threat to coral reefs, resulting in a detrimental decline in coral cover and diversity. Yet elucidating disease causation remains a daunting task due to the nearly identical macroscopic appearance of lesions, limited diagnostic tools available and complex coral-associated microbiome. Multifocal purple spots (MFPS) has been described as an emerging disease in Caribbean Sea fans, characterized by the presence of multifocal 1-3mm circular flat purple nodules. This lesion pattern has been attributed to Aplonchytrium sp. labyrithulomycete and Sphaerippe sp. copepod infections. We examined 34 purple spots from 16 sea fans (Gorgonia ventalina) to establish histological and microbial case definitions for MFPS on two shallow fringing reefs of St Kitts. Lesions were examined under a dissecting scope and then divided for histology and microbiology. Surprisingly, no copepod or labyrinthulids were evident in any sample but barnacle infections were identified in 9 (56%) sea fans, algae in 7 (44%), fungi in 8 (50%) and cyanobacteria in 4 (25%). Fungi were typically not confined to the purple spot and fungal isolates retrieved from selective culturing were microscopically identified as Penicillium chrysogenum. Sequencing the ITS1 and ITS2 region and subsequent BLAST query confirmed their identity. These findings emphasize the heterogeneous nature of the MFPS lesion pattern in sea fans and the need for a comprehensive microscopic and molecular level investigation to achieve an accurate etiological diagnosis.

Keywords: MFPS, purple spots, barnacle, histopathology, Gorgonia ventalina, Caribbean Sea fan

ENVIRONMENT AND ONTOGENY ARE THE MAIN DRIVERS FOR SKIN MICROBIOME OF DAMSELFISHES OF STEGASTES ADUSTUS AND STEGASTES LEUCOSTICTUS (**Student**)

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Studies on the microbiome of fish mucosa show that microbial diversity can be important in determining disease susceptibility and that the microbiome can serve as a proxy for fish health. Indeed, bacterial pathogens known to cause mortalities in fish are naturally present in fish gut, skin and gill microbiomes. Here, we investigated the skin microbiome composition of Stegastes leucostisctus and S. adustus from the northeast Caribbean region. Our main aims were to determine whether host species, ontogeny and environment (i.e. locality and habitat) could be driving microbiome composition in these two closely related species, as well as to describe the prevalence and abundance of potential pathogens. To do so, we sampled adults and juveniles from both species and used a metabarcoding approach, sequencing the 16S rRNA V4 hypervariable region of bacterial genome from the skin microbial communities. S. leucostictus were collected from reef habitats in two different localities, La Parguera (Puerto Rico) and St Thomas (Virgin Islands); and S. adustus were sampled from two different habitats, reef and lagoon, from the latter locality. Although the two species shared the main bacterial taxa (i.e. those that were most represented), significant differences in microbiome structure were found between the two Stegastes species. Additionally, for S. leucostictus, sampling locality and ontogeny had a significant effect on microbiome diversity and composition, with sampling locality explaining the observed differences in the abundance of the main bacterial taxa. The effects of ontogeny and sampled habitat were less obvious in S. adustus, still, there was an effect of habitat in microbiome structure between individuals collected in the reef and lagoon (based on Bray-Curtis distance), and significant interactions between life-stage and habitat controlled for the abundance of main bacterial taxa.

Session*: Marine Population Connectivity in the Caribbean*

CHLOROPLAST IDENTIFICATION AND FEEDING SPECIFICITY OF THE SACOGLOSSAN SEA SLUG ELYSIA PAPILLOSA (**Student**)

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Elysia papillosa is a kleptoplastic, sacoglossan sea slug found throughout the Caribbean and west coast of Florida. Sacoglossans usually feed on only one species of algae which is the source of their symbiotic chloroplasts. However, some species of sacoglossans eat algal species that differ from the algae on which they were collected. So association alone cannot be used to accurately determine the chloroplast source of these slugs. Elysia papillosa at Tarpon Springs, FL are found with two species of the

siphonaceous green alga, Penicillus capitatus, and less frequently, with P. lamourouxii. Both algal species co-occur in mixed macrophyte beds at this site. In order to determine which algal species E. papillosa was consuming at that field site, total DNA was extracted from individual slugs immediately upon collection and the species matching the gene sequence of the chloroplast genomic gene, rbcL (large subunit of ribulose bisphosphate carboxylase) was determined by PCR analysis and BLAST searching. The molecular data indicated that E. papillosa were consuming the same algal species from which they were collected. Additionally, E. papillosa were more commonly associated with P. capitatus than P. lamourouxii. In order to determine if the growth rate of juvenile slugs differed when feeding on P. capitatus compared to P. lamourouxii, a laboratory feeding experiment was conducted. Over a three-week period, E. papillosa fed P. lamourouxii grew significantly longer than those fed P. capitatus (5.9±0.8mm n=9 versus 8.1±2mm n=10 respectively). Combined these findings suggest that although E. papillosa feeds on P. lamourouxii in the field and grows faster on it, P. capitatus is more attractive to slugs.

Keywords: Sacoglossan, kleptoplasty, Florida, Penicillus

GROWTH RATE AND SURVIVAL RATES OF JUVENILE ELYSIA SUBORNATA SEA SLUGS VARY DEPENDING ON ALGAL DIET (**Student**)

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Elysia subornata is a sacoglossan sea slug native to the Caribbean and Florida. This herbivorous slug feeds exclusively on siphonaceous green algae in the genus Caulerpa by piercing the algae with a radular tooth and then suctorially removing the contents. While most sacoglossans are feeding specialists, E. subornata is polyphagous, eating multiple species of Caulerpa. In this study, growth rates of juvenile E. subornata were observed amongst individuals hatched at the same time. Individual slugs were fed for five weeks on five different species of Caulerpa to determine if there was a difference in growth and survival rate based on diet. In order to test this, the lengths of the individual E. subornata were measured weekly. Starting lengths between each treatment were not significantly different. Over the course of the trial, juvenile E. subornata feeding on C. cupressoides and C. ashmeadii suffered 100% mortality. Slugs feeding on C. prolifera and C. racemosa had a 30% mortality rate, while all slugs feeding on C. sertularoides survived. Of the surviving juveniles there was a significantly longer final length for the slugs feeding on C. sertularoides compared to the other species. This indicates that although polyphagous, feeding on certain species of Caulerpa could improve juvenile survival and fitness. It is currently unknown if E. subornata displays feeding preference for algal species that provide optimal growth.

Elysia subornata es una babosa de mar sacoglossa nativa del Caribe y Florida. Esta babosa herbívora se alimenta exclusivamente de alga verde sifonácea en el género Caulerpa, perforando la alga con un diente radular y luego quitando sucesivamente el contenido. Mientras que la mayoría de los

sacoglossanos son especialistas en alimentación, E. subornata es polifago, comiendo múltiples especies de Caulerpa. En este estudio, se observaron tasas de crecimiento de E. subornata juvenil entre las babosas nacidas al mismo tiempo. Las babosas individuales fueron alimentadas para cinco semanas en cinco especies diferentes de Caulerpa para determinar si había una diferencia en el crecimiento y la tasa de supervivencia basada en la dieta. Para probar esto, se midieron semanalmente las longitudes de la E. subornata individual. Las longitudes de inicio entre cada tratamiento no fueron significativamente diferentes. Durante el transcurso del ensayo, E. subornata juvenil alimentándose de C. cupressoides y C. ashmeadii sufrió una mortalidad del 100%. Las babosas alimentándose de C. prolifera y C. racemosa tuvieron una tasa de mortalidad del 30%, mientras que todas las babosas alimentándose de C. sertularoides sobrevivieron. De los hornos que sobrevivieron hubo una longitud final significativamente más larga para las babosas alimentándose de C. sertularoides en comparación con las otras especies. Esto indica que a pesar de polífaga, la alimentación de determinadas especies de Caulerpa podría mejorar la supervivencia juvenil y el aptitud. Actualmente se desconoce si E. subornata muestra preferencia de alimentación para las especies de algas que proporcionan un crecimiento óptimo.

ISLAND HOPPING: CORAL REEF FISH PHYLOGEOGRAPHY ACROSS THE CARIBBEAN

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In the Caribbean, there was a long-standing paradigm of coral reef fish populations being open systems – a good deal of migrant exchange. This was supported by population genetic studies. However, in the past 10 years, this paradigm has shifted. It is now recognized that while some species of Caribbean coral reef fishes have little to no genetic structure among populations, some have substantial genetic subdivision throughout their ranges, and some have subtle, but present, population genetic structure. There is no longer a “one size fits all” rule for Caribbean coral reef fish population genetics. In this study, we tested for, and characterized population genetic structure in the Caribbean reef fish Acanthemblemaria aspera, the rough head blenny. Populations throughout the Caribbean, as well as the Yucatan were sampled. DNA sequence data was collected for mitochondrial and nuclear genes. These data were analyzed using new Bayesian methods that allow the inference of colonization history across a spherical plane. We used this to construct a model that inferred the place of the original population of A. aspera and the species’ dispersal pathways throughout the Caribbean Basin and Gulf of Mexico. In some scenarios, the original population, and the stepping stone populations, were inferred to be at locations where we had not yet collected samples. This has provided us with a framework to guide further collections and extend our work to other Caribbean reef fish species.

Existía un amplio paradigma asumiendo que las poblaciones de peces arrecifales del Caribe correspondían a un sistema abierto – con una gran cantidad de flujo de migrantes. Dicho paradigma fue apoyado por estudios de genética poblacional. Sin embargo, esto ha cambiado en los últimos 10 años. Ahora se reconoce que mientras algunas especies de peces arrecifales del Caribe poseen de escasa a ninguna estructura entre poblaciones, otras presentan una subdivisión genética importante a lo largo de

sus rangos de distribución, y otras exhiben solo una sutil estructura. Es decir, ya no existe una regla de genética poblacional que sea aplicable a todas las especies de peces arrecifales del Caribe. En este estudio, se probó y caracterizó la estructura genética poblacional del pez arrecifal Acanthemblemaria aspera, el sapito áspero. Para ello, se muestrearon las poblaciones a lo largo del Caribe, incluyendo la Península de Yucatán. Posteriormente se secuenciaron genes mitocondriales y nucleares. El análisis se realizó utilizando nuevos métodos Bayesianos que permiten la inferencia de colonizaciones a lo largo de un plano esférico. Al utilizar este modelo es posible inferir el punto de origen de A. aspera, y la ruta de dispersión de la especie a lo largo de la cuenca del Caribe y Golfo de México. En algunos escenarios, la población original y las poblaciones transicionales ("stepping stone populations") se infirieron en zonas de las cuales no existen recolectas. Esto provee de un punto de referencia para guiar futuras recolectas y extender el trabajo a otras especies de peces arrecifales del caribe.

Keywords: Population Genetics, Phylogeography, Reef Fish, Dispersal, Connectivity, Bayesian inference

THE ROLE OF DISTURBANCE IN THE DISPERSION OF THE INVASIVE SEA VINE, HALOPHILA STIPULACEA

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Sea vine, *Halophila stipulacea*, has successfully invaded and dispersed across seagrass communities though the eastern Caribbean region since 2002. It is a native of the Indian Ocean and has rapidly spread through the Mediterranean Sea in late XIX century before reaching the Caribbean. In most locations, it has successfully colonized native seagrass assemblages, with total displacement of native species within a short time span. However, dispersion and out-competition mechanisms are still poorly understood. In this study, we documented the dispersion patterns of *H. stipulacea* across seagrass communities in Culebra Island, Puerto Rico, that were severely impacted in September 2017 by two category five hurricanes, Irma and María. These generated strong wave action, localized mechanical disruption, and burial of native seagrass assemblages by sediment and rubble transport. The aim of the study was to address seagrass recovery ability. Within a time span of 4-7 months, impacted seagrass assemblages were rapidly colonized by *H. stipulacea*, with nearly total or total extirpation of *Thalassia testudinum* and *Syringodium filiforme*. Sea vine dispersion was significantly more dense (i.e., percent coverage, shoot density, canopy height, standing stock biomass) in areas previously exposed to: chronic anchoring by recreational vessels, recurrent runoff, high turbidity and high nutrient pulses. Also, habitats previously impacted by recurrent stranded masses of floating sargassum mats, as well as locations with partial seagrass burial showed signs of rapid colonization by *H. stipulacea*. Comparisons to other locations suggests that proximinity to runoff sources appears to foster a faster *H. stipulacea* recovery and colonization. Light attenuation experiments in progress have shown nearly total extirpation of even high-density stands of *H. stipulacea*. But preliminary evidence has shown rapid recolonization of bare

substrate, particularly under turbid, high-nutrient conditions. Long-term monitoring evidence has shown a major, progressive phase shift from dominance by native species towards *H. stipulacea*. Also fish assemblages exhibit significant differences in *H. stipulacea*-dominated habitats, suggesting an alteration of one of the critical ecological role of seagrasses in maintaining biodiversity and resilience of coastal habitats. This has become a growing regional management challenge. Its long-term consequences will be discussed.

La vid marina, *Halophila stipulacea*, ha invadido y se ha dispersado con éxito a través de las comunidades de pastos marinos en la región del Caribe oriental desde 2002. Es nativa del Océano Índico y se extendió rápidamente por el Mar Mediterráneo a fines del siglo XIX antes de llegar al Caribe. En la mayoría de los lugares, ha colonizado con éxito las comunidades de pastos marinos nativos, con un desplazamiento total de las especies nativas en un período corto de tiempo. Sin embargo, los mecanismos de dispersión y de competencia aún son poco conocidos. En este estudio, documentamos los patrones de dispersión de *H. stipulacea* en las comunidades de pastos marinos en la Isla Culebra, Puerto Rico, que fueron impactados severamente en septiembre de 2017 por dos huracanes de categoría cinco, Irma y María. Estos generaron una fuerte acción de las olas, una disrupción mecánica localizada y el entierro de las agrupaciones de pastos marinos nativos mediante el transporte de sedimentos y escombros. El objetivo del estudio fue abordar la capacidad de recuperación del pasto marino. En un lapso de tiempo de 4 a 7 meses, las comunidades de pastos marinos impactados se colonizaron rápidamente por *H. stipulacea*, con extirpación casi total o total de *Thalassia testudinum* y *Syringodium filiforme*. La dispersión de la vid marina fue significativamente más densa (es decir, porcentaje de cobertura, densidad de brotes, altura del dosel, biomasa de material en pie) en áreas previamente expuestas a: anclaje crónico por embarcaciones recreativas, escorrentía recurrente, alta turbidez y pulsos de alto contenido de nutrientes. Además, los hábitats previamente afectados por masas recurrentes de agregaciones flotantes de Sargassum, así como los lugares con entierro parcial de pastos marinos mostraron signos de colonización rápida por *H. stipulacea*. Las comparaciones con otras ubicaciones sugieren que la proximidad a las fuentes de escorrentía parece fomentar una recuperación y colonización más rápidas de *H. stipulacea*. Los experimentos de atenuación de la luz en progreso han mostrado una extirpación casi total, incluso de rodales de alta densidad de *H. stipulacea*. Pero la evidencia preliminar ha demostrado una rápida recolonización del sustrato desnudo, particularmente en condiciones turbias y de alto contenido de nutrientes. La evidencia de monitoreo a largo plazo ha mostrado un cambio de fase importante y progresivo desde el predominio de las especies nativas hacia *H. stipulacea*. También los conjuntos de peces exhiben diferencias significativas en los hábitats dominados por *H. stipulacea*, lo que sugiere una alteración de uno de los roles ecológicos críticos de los pastos marinos en el mantenimiento de la biodiversidad y la resiliencia de los hábitats costeros. Esto se ha convertido en un creciente desafío de gestión regional. Se discutirán sus consecuencias a largo plazo.

Keywords: Culebra Island, disturbance, *Halophila stipulacea*, hurricanes, out-compete, seagrass community dynamics

PILOTING A CITIZEN SCIENCE APPROACH TO MONITOR PELAGIC SARGASSUM LANDINGS IN SOUTH FLORIDA (**Student)**

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Citizen science is becoming an effective approach to monitor phenomena in large geographical areas over long periods of time. The influx of pelagic sargassum is a regional problem throughout the Atlantic, from Brazil to Florida. While satellite imagery can estimate sargassum blooms on a regional level, it is difficult to have systematic *in situ* abundance observations. The impacts of sargassum in the Caribbean vary between geographical locations. To test the use of citizen sciences techniques to monitor sargassum, we piloted a study using the app platform "CitSci." Thus, the "Sargassum Watch" project was established. Observations made through CitSci included uploading a photograph, recording name of area, geographical coordinates, and date of observation, and reporting abundance using a category table (designed by UNAM). Between March 2018 and February 2019, a total of 40 sargassum landing events were collected in South Florida, with four other observations in the Caribbean. The category table was robust enough to distinguish "very little to no Sargassum" (40% of observations) to "low accumulation" (45% of observations). In the Caribbean, one observation was categorized as "high accumulation" and three observations were "very high accumulation". The major challenge detected with the use of this app is the need for stable internet connection to record and upload the observation *in situ*. The second challenge is the lack of simplicity in the app's usage. Finally, there is a need for a server to work as a repository. Overcoming these challenges requires training and calibration of the app, and active feedback between the managers and participants of the project to simplify the app. Regardless of the challenges, this citizen science program is an opportunity to expand the geographical range of sargassum monitoring efforts to a regional level.

Keywords: Sargassum, Citizen Science, Monitoring

SPATIAL GENETIC STRUCTURE OF THE OVERHARVESTED QUEEN CONCH FISHERY IN THE CARIBBEAN WITH A FOCUS ON THE JAMAICAN FISHERY

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Queen conch, Lobatus gigas, supports a lucrative industry throughout the Caribbean. The history of this resource is marked by intense exploitation and stringent measures on international trade implemented

under CITES. Management of L. gigas within the region has been limited to conducting abundance surveys, the collection of catch/effort and morphometric data. This however, does not consider the genetic connectivity of the species within individual territories or on a larger regional scale. This information is fundamental for the conservation and sustainable management of commercially important species as it provides insight into the potential for stock replenishment via larval distribution. The genetic connectivity of the species was examined on a regional scale and within a selected Caribbean territory using nine microsatellite markers. A total of 643 individuals from 19 locations across the Caribbean (Anguilla, the Bahamas, Caribbean Netherlands, Jamaica, Mexico, Turks and Caicos and the USA) and 459 individuals from 12 locations within Jamaica's Exclusive Economic Zone were genotyped. Across the Caribbean, significant levels of genetic differentiation were detected within countries, between countries and among sample sites irrespective of geographic location. Oceanic distance between populations has restricted gene flow, resulting in isolated populations. In the Jamaican context, the L. gigas populations are weakly differentiated with the commercially important stock on Pedro Bank being genetically differentiated from mainland populations. Mainland populations were also weakly differentiated north and south of the island. Recruitment to Pedro Bank is largely unknown but is suggested to be a combination of local recruitment and from sources external and distinct from mainland Jamaican populations. An analysis of surface currents within Jamaica's EEZ supports these findings. This research provides critical insight into local and regional connectivity patterns of the species for its sustainable management.

Keywords: Lobatus gigas, genetic structure, microsatellites, connectivity, queen conch

THE ALGAL FOOD SOURCE AND SYMBIOTIC CHLOROPLAST DONOR OF THE SACOGLOSSAN SEA SLUG ELYSIA CRISPATA VARIES THROUGHOUT THE CARIBBEAN

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Several species of sacoglossan sea slugs store chloroplasts taken from their algal food for photosynthesis within specialized cells in the digestive tubules of the slug. The diets of most sacoglossan species are often very specialized, with many only feeding on only species of algae. However, some sacoglossan species use a much wider range of food sources. Elysia crispata is a large sacoglossan sea slug ranging throughout the Caribbean which is able to feed on multiple species of green siphonaceous algae. This slug can retain sequestered chloroplasts for up to three to months after feeding. In this study, we used the PCR determined sequence of the chloroplast gene ribulose bisphosphate carboxylase/oxygenase (rbcL) to identify the algae consumed by Elysia crispata from five (Curacao, Barbados, Virgin Islands, Panama and Dry Tortugas) locations throughout its range within the wider Caribbean. Results indicate that E. crispata has a broader diet than previously realized and several new species of algal food were identified for the slug, including some potentially invasive species. Diet also was unique among locations. Although E. crispata is widespread throughout the Caribbean, it does

not show a consistent dietary pattern across its range. These could be due to either local adaptation or an opportunist feeding strategy by the slug. Sampling from additional locations throughout the Caribbean could expand understanding of the feeding ecology of this organism and may also help to identify new algal invasions into the region.

STATUS OF LIONFISH (PTEROIS VOLITANS) ALONG THE VENEZUELAN COAST: 10 YEARS AFTER THE FIRST REPORT OF INVASION (**Student**)

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Invasive species represent one of the greatest threats to biodiversity worldwide. In the Caribbean, the lionfish invasion (*Pterois volitans*) has been extensively studied. In Venezuela, it was reported for the first time in 2009 only in two sites (i.e., Cepe and Cayo Norte). Only a few years later this species had been seen at multiple sites along the Venezuelan coast. This paper aims to update the status of the lionfish (in terms of abundance and distribution) and to measure spatial variation of this species across multiple Venezuelan coastal and oceanic sites. For this, visual censuses were conducted on 36 sites located at 7 locations and in multiple reef habitats between 5 m to 12 m along the Venezuelan coast and some of its islands. Furthermore, we developed models based on environmental data and the features of the benthic habitats to predict lionfish occurrence in Venezuela. The results indicate that after ten years, this species has increased its distribution range as it was found in many of the surveyed sites (10/36). Furthermore, the retrospective analysis of data shows the species has spread out, since this species has been reported in 41 sites since its first report. Currently, the highest variability in abundance occurs among sites within localities (Pseudo-F = 2,31; df = 29 p = 0,001, CV = 36.5%), and among transects (CV = 63.5%). Our results demonstrate that the lionfish has indeed successfully established and has become conspicuous along the Venezuelan coast, however, within each site its distribution seems to be patchy at least in shallow to intermediate coral reef habitats.

La presencia de especies invasoras representa una de las mayores amenazas para la biodiversidad en todo el mundo. En el Caribe, la invasión del pez león (Pterois volitans) ha sido ampliamente estudiada. En Venezuela se reportó por primera vez en 2009 sólo en dos sitios (Cepe y Cayo Norte). Solo unos años después, esta especie había sido vista en múltiples sitios a lo largo de la costa venezolana. El objetivo de este trabajo es actualizar el estado del pez león (en términos de abundancia y distribución) y medir la variación espacial de esta especie en múltiples sitios costeros y oceánicos de Venezuela. Para ello, se realizaron censos visuales en 36 sitios ubicados en 7 localidades y en múltiples hábitats de arrecifes entre 5 y 12 m a lo largo de la costa venezolana y algunas de sus islas. Además, desarrollamos modelos basados en datos ambientales y en las características de los hábitats bentónicos para predecir la ocurrencia del pez león en Venezuela. Los resultados indican que después de diez años, esta especie ha incrementado su rango de distribución, tal como se encontró en muchos de los sitios estudiados

(10/36). Además, el análisis retrospectivo de los datos muestra que la especie se ha extendido en 41 sitios desde su primer informe en 2009. Actualmente, la mayor variabilidad en la abundancia ocurre entre sitios dentro de localidades (Pseudo-F = 2,31; df = 29 p = 0,001, CV = 36.5%), y entre transectos (CV = 63.5%). Nuestros resultados demuestran que el pez león se ha establecido con éxito y se ha vuelto conspicuo a lo largo de la costa venezolana, sin embargo, dentro de cada sitio su distribución parece ser irregular, al menos en hábitats de arrecifes de coral poco profundos e intermedios.

Keywords: *Pterois volitans*, Venezuela, abundance, distribution

A COMPARISON OF PHOTOTAXIC BEHAVIOR IN PHOTOSYNTHETIC AND NON-PHOTOSYNTHETIC SACOGLOSSAN SEA SLUGS (**Student**)

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Sacoglossan sea slugs are a group of herbivorous marine gastropods. Several species of sacoglossan engage in kleptoplasty, the process of sequestering chloroplasts stolen from algae inside of the slug's own cells in order to photosynthesize. Because they gain energy from sunlight through photosynthesis it is expected that photosynthetic slug species will spend more time in direct light than non-photosynthetic species. To test this, phototaxic experiments were conducted on two species of long term photosynthetic sacoglossans, including one Caribbean species, and four species of non-photosynthetic Caribbean sacoglossans. The photosynthetic species were significantly more likely to spend time in the light, suggesting that photosynthesis provides a strong incentive for light exposure despite potential risks of predation. On the contrary, non-photosynthetic species either prefer shade or do not exhibit strong phototaxic behavior. Examining differences between these two groups of slugs provides valuable insight into the impact that the evolutionary novelty of kleptoplasty has on the ecology and behavior of these animals.

Keywords: Photosynthetic, Phototaxy, Sacoglossan, Kleptoplasty

POPULATION CONNECTIVITY OF THE COMMON OCTOPUS (OCTOPUS VULGARIS) IN PUERTO RICO AND MANAGEMENT IMPLICATIONS (**Student**)

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Octopus is one of the most consumed invertebrates in the world. With the decline of fish fisheries in recent years, the capture of this cephalopod taxon has been increasing worldwide, causing population declines in most octopus species. Octopus spp. are majestic, smart animals and are the major invertebrate predators of reefs, however we have limited information about their population biology in Puerto Rico, despite the heavy fishing pressure. The Department of Natural Resources of Puerto Rico records data on octopus catches on the island, however, these data do not specify the species of octopus that is caught. At this moment this fishery is not regulated in the island, however it is one of the most sought invertebrates after the lobster and the conch. This study aims to determine the genetic connectivity of populations of common octopus (Octopus vulgaris) in Puerto Rico for management purposes. In addition, we will be identifying the species of octopus that are being fished and sold on markets around the island for consumption. The data obtained during this study will open further avenues of research that could help the resource managers design a sustainable plan for this fishery in the future.

Keywords: Connectivity, fishery, cephalopod, Puerto Rico

Session*: Reef restoration and resilience*

RESTAURANDO *ACROPORA CERVICORNIS* USANDO VARIAS ESTRUCTURAS DE JARDINES DE CORAL EN EL MONUMENTO NATURAL MARINO ARCHIPIÉLAGO CAYOS COCHINOS

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Los arrecifes de coral en el Monumento Natural Marino Archipiélago Cayos Cochinos son uno de los elementos de conservación prioritarios para el manejo (USAID/HCRF 2014) debido a la fragilidad de estos ecosistemas, así como a los bienes y servicios que brindan en el Area Marina Protegida (AMP). Han sido estudiados desde 1995 a la actualidad, entre los primeros estudios se observó que las especies Acroporidos (A. *cervicornis* y *A. palmata)* son de las especies de corales esclerantinidos más representativos, que fueron afectados significativamente debido al periodo prolongado de estrés térmico

del agua que conllevo a un blanqueamiento masivo en 1995 (Guzmán 1998), actualmente continúan siendo una de las especies de mayor importancia debido a la reducción gradual de su abundancia (HRI 2018). Razón por la que se instalaron en noviembre de 2018, 7 jardines de coral de la especie *A. cervicornis* en el sitio denominado Cayo Gallo con el objetivo de contribuir en la restauración de la población de esta especie, de los cuales 5 de estos tienen formas de marcos de metal colocados en el fondo de arena y 2 cuerdas suspendidas por boyas a medio cuerpo. Se colocaron un total de 214 fragmentos de coral con una extensión lineal de 32 m de tejido vivo, de los cuales 186 fragmentos se instalaron en los marcos de metal y 28 fragmentos en las cuerdas suspendidas. El sitio seleccionado para la instalación de los jardines de coral se denomina Cayo Gallo ubicado al NE de Cayo con el mismo nombre, el cual es un parche arrecifal con una batimetría promedio 5.8 m de profundidad, con fondo arenoso y pasto marino *Tallassia sp.* bastante disperso, la corriente predominante es de Este a Oeste. SLos fragmentos fueron colectados en el sitio denominado Punta Pelícano 4 en la misma fecha, ubicado al NO del Cayo Mayor, tiene una batimetría promedio de 6 m de profundidad (ubicado en la cresta arrecifal), con fondo de arrecife de coral, dominado por especies de coral M. faveolata, M. cavernosa y especies de octocorales.

Keywords: Arrecifes de Coral, Objetos de Conservación, Area Marina Protegida, estrés térmico, blanqueamiento, jardines de coral

CULTURE AND PROPAGATION OF STONY CORALS FOR REEF RESTORATION IN CUBA

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Coral reefs throughout the world and mainly in the Caribbean area have suffered an important process of degradation by significantly reduction of their live coral cover. Among the alternatives to counteract this situation is the restoration through fragments of coral colonies cultivated in nurseries for their later planting in degraded sites. In Cuba, experience in this type of restoration is scarce, with occasional small-scale experiences. With the objective of create the bases aimed to the intensive culture of stony corals for restore reef sites in Cuba, two nurseries composed of 20 PVC structures were installed. The first nursery was for the culture of Acropora cervicornis in 2017, the second for A. palmata in 2018. In the west extreme of Cuba, the Guanahacabibes National Park was chosen for its favorable environmental conditions and low anthropization. In that zone, the information obtained through visual surveys and previous evaluations will allow to choose deteriorated sites as areas to be restored. The evaluations were obtained from the estimation of the live cover of the substrate and the complexity of the reef, in addition to the health diagnosis of the fish communities. The next step will be the planting of fragments depending on the growth of the corals in the nurseries, establishing a monitoring program to follow up the survival and growth of the planted specimens. During this year, research and monitoring of the spawning of both species will begin, both from colonies in the natural environment and in the farms. We intend to begin the

experimentation in the capture of gametes, their fertilization, larval development and settlement in artificial substrates in the laboratory, for their subsequent planting in the sites to be restored.

Los arrecifes de coral a lo largo del mundo y fundamentalmente en el área del Caribe han sufrido un importante proceso de degradación al disminuir significativamente su cobertura de coral vivo. Entre las alternativas para contrarrestar esta situación se encuentra la restauración mediante fragmentos de colonias de coral cultivados en granjas para su posterior siembra en sitios degradados. En Cuba la experiencia en este tipo de restauración es escasa, contando con experiencias puntuales a pequeña escala. Con el objetivo de crear las bases dirigidas al cultivo intensivo de corales pétreos para restaurar sitios de arrecifes en Cuba se instalaron dos granjas compuestas por 20 estructuras de PVC cada una. Una granja para el cultivo de Acropora cervicornis en el año 2017 y la otra para A. palmata en el 2018. Se escogió el Parque Nacional Guanahacabibes, en el extremo occidental de Cuba, por sus condiciones ambientales favorables y baja antropización. En el área del parque nacional se escogerán sitios deteriorados como zonas a restaurar a partir de información obtenida mediante reconocimientos visuales y evaluaciones previas. Las evaluaciones se obtuvieron a partir del estimado de la cobertura viva del sustrato y la complejidad del arrecife, además del diagnóstico de salud de las comunidades de peces. El siguiente paso será la siembra de fragmentos en dependencia del crecimiento de los corales en las granjas, estableciendo un programa de monitoreo para el seguimiento de la supervivencia y crecimiento de los ejemplares plantados. Durante el presente año se comenzará la investigación y el monitoreo del desove de ambas especies, tanto de colonias en el medio natural como en las granjas. Se pretende comenzar la experimentación en la captura de gametos, su fecundación, desarrollo larval y asentamiento en sustratos artificiales en laboratorio, para su posterior siembra en los sitios a restaurar.

Keywords: coral reef, reef restoration, coral culture, coral nurseries

"LIONFISH PTEROIS VOLITANS / MILES (TELEOSTEI: SCORPAENIDAE) TOURNAMENTS IN CUBA, AN OPTION FOR THE CONTROL AND HANDLING OF THIS SPECIES"

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The Lionfish (Pterois volitans / miles) is the first species (s) of Indo-Pacific reef fish that invades the western Atlantic, constituting one of the fastest marine fish invasions in history. The objective of this work was to evaluate the results of the four international lionfish tournaments held in the Guanahacabibes peninsula, Cuba. The tournaments were held between October 2015 and September 2018, between 6 and 20 m deep, at several diving dive sites of the C.I. "María la Gorda", belonging to the Guanahacabibes National Park, Pinar del Río, Cuba. The catches were made during daytime with Hawaiian harpoons. A total of 594 fish have been caught among the four tournaments, where it can be seen that, after the second tournament, the catches have decreased despite the increase in the number of fishermen, which

shows the effectiveness of fishing in previous years in the same area. Massive extractions are used to perform biological studies of the species for greater knowledge about it. Also recipes are prepared based on lionfish where they are tasted and in this way its consumption is promoted by the population. As part of the tournament an educational task is carried out with the inhabitants of the surrounding communities to raise awareness about the problem of this biological invasion. These tournaments are part of the national strategy designed for the reduction of the lionfish in the face of the threat it represents for the balance of the Cuban reefs.

El Pez león (Pterois volitans/miles) es la primera especie (s) de pez arrecifal del Indo-Pacífico que invade el Atlántico occidental, constituyendo una de las invasiones de peces marinos más rápida de la historia. El objetivo de este trabajo fue evaluar los resultados de los cuatro torneos internacionales de pez león realizados en la península de Guanahacabibes, Cuba. Los torneos se realizaron entre Octubre del 2015 y Septiembre del 2018, entre los 6 y 20 m de profundidad, en varios puntos de buceo de buceo del C.I. "María la Gorda", perteneciente al Parque Nacional Guanahacabibes, Pinar del Río, Cuba. Las capturas se realizaron en horario diurno con arpones hawaianos. Se han capturado en total 594 peces entre los cuatro torneos, donde se aprecia que a partir del segundo torneo han disminuido las capturas a pesar del aumento de los pescadores, lo que evidencia la eficacia de la pesca de años anteriores en la misma área. Las extracciones masivas se aprovechan para realizar estudios biológicos de la especie para un mayor conocimiento sobre la misma. También se elaboran recetas a base de pez león donde son degustadas y de esta manera se promueve su consumo por parte de la población. Como parte del torneo se realiza una labor educativa con los pobladores de las comunidades aledañas para concientizar sobre el problema de esta invasión biológica. Estos torneos forman parte de la estrategia nacional diseñada para la reducción del pez león ante la amenaza que representa para el equilibrio de los arrecifes cubanos.

Keywords: Lionfish, Fishing, tournament, Cuba.

THE NATURE CONSERVANCY'S CORAL STRATEGY IN THE CARIBBEAN

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With nearly 8,000 square miles of coral reefs, over 1,400 species of fish and marine mammals, and over 40 million people dependent upon these natural resources, the Caribbean is a global priority for conservation. The Nature Conservancy (TNC) and partners aim to conserve, restore and monitor coral reefs throughout the Insular Caribbean and to mobilize regional and global action by proactively sharing science and expertise. To accomplish rapid coordination and deployment of TNC's comprehensive coral strategy, Coral Innovation Hubs are being established in The Bahamas, the Dominican Republic and the U.S. Virgin Islands. TNC's Caribbean coral strategy, focuses on pioneering emerging technologies, while promoting collaboration and knowledge sharing, ensuring local partners can scale up restoration

initiatives to levels relevant to today's rate of coral degradation. With a three-pronged approach that includes coral conservation, restoration and monitoring, TNC and partners are joining forces to ensure that coral reefs survive and thrive for generations to come. Under the conservation pillar TNC is working to remove underlying drivers of reef degradation through local and regional efforts that promote marine protection and management, sustainable fishing and coastal resilience; under the monitoring pillar TNC is working to deploy cutting-edge monitoring systems, such as revolutionary aerial mapping technologies, to inform coral conservation strategy and marine spatial planning, influence policymaking and quantify the effectiveness of coral protection and restoration efforts; and under the restoration pillar TNC is working on the development and dissemination of innovative, scalable technologies for coral restoration, including micro-fragmentation and sexual reproduction, that maximize coral diversity.

Keywords: Aerial mapping, micro-fragmentation, coral sexual reproduction.

SPATIOTEMPORAL PATTERNS OF PARTIAL MORTALITY IN THE THREATENED CORAL ACROPORA CERVICORNIS

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The loss of tissue can affect the ability of corals to survive, grow and reproduce. Therefore, understanding how coral populations respond demographically to the partial mortality of colonies is essential to adequately assess the persistence perspective of the population under unfavorable environmental conditions. However, the number of studies focused on understanding the dynamics of tissue loss is scarce. The objective of this study was to describe the spatial and temporal patterns of partial mortality in the coral Acropora cervicornis in two reefs located in northeastern Puerto Rico. One hundred and fifty colonies were marked at each location and followed from 2011 to 2013 and again in 2017. It was found that the loss of tissue not only varies considerably in time and space but that the partial mortality does not depend on the initial size of the colonies. Projections of population models indicated that partial mortality could also have a negative impact at the population level. For example, a 25% increase in the number of colonies with more than 20% tissue loss would accelerate the time when 75% of the population would be lost by 3-4 years. In our presentation, we will discuss the importance of our results for the conservation of A. cervicornis, one of the most threatened species in the Caribbean.

La pérdida de tejido puede afectar la capacidad de los corales de sobrevivir, crecer y de reproducirse. Por lo tanto, comprender cómo las poblaciones de corales responden demográficamente a la mortalidad parcial de las colonias es esencial para evaluar adecuadamente la perspectiva de persistencia de la población en condiciones ambientales desfavorables. Sin embargo, el número de estudios enfocados en comprender la dinámica de la pérdida de tejido son escasos. Nuestro trabajo fue llevado a cabo con el objetivo de describir los patrones espaciales y temporales de mortalidad parcial en el coral Acropora cervicornis en Puerto Rico. Un total de 300 colonias fueron marcadas en dos localidades y evaluadas en los años 2011, 2012, 2013 y 2017. Se encontró que la pérdida de tejido no solo varía considerablemente en tiempo y espacio, si no que la mortalidad parcial no depende del tamaño inicial de las colonias. Proyecciones de modelos poblacionales indicaron que la mortalidad parcial también

podría tener un impacto negativo a nivel de población. Por ejemplo, un aumento del 25% en el número de colonias con> 20% de pérdida de tejido aceleraría el tiempo en que el 75% de la población se pierde por 3-4 años. En nuestra presentación discutiremos la importancia de nuestros resultados para la conservación de A. cervicornis, una de las especies más amenazada del Caribe.

EX-SITU PROPAGATION OF CORAL MICRO-FRAGMENTS IN JAMAICA –(PRELIMINARY) LESSONS LEARNED

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Coral restoration has become a tool of choice used by reef managers to combat reef degradation resulting from myriad coral reef stressors ranging from local ship groundings to the increasing impacts of climate change. Restoration techniques suitable for fast growing, branching species (e.g., *Acropora* spp.) are well documented. Protocols applicable to massive, slow growing species are not as well developed. This research uses corals deemed resilient by virtue of their survival of local bleaching events and disease outbreaks. The process of micro-fragmenting massive corals, takes advantage of the subsequent accelerated growth rate of small (<1cm^2) pieces of coral and their potential to merge rapidly into comparatively large corals (~10-15 cm dia.) in a relatively short (~8 to 10 month) time period. This procedure compares favorably with the much longer (>24-36 month) time periods needed for larger, single fragments of massive/boulder corals, to reach the same size and requires smaller amounts of donor coral material than is generally harvested. In this pilot study, we endeavoured to grow micro-fragments of local massive species (such as *Siderastrea, Orbicella* and *DIploria* spp.) in ex-situ conditions. Survival and growth rates of micro-fragments mounted on six different types of hard substrates (cement, glass, PVC, coral rubble, terra-cotta tile and BioRock^{TM}) under controlled temperature and water flow rates, were monitored. Two sets of micro-fragmentation of donor corals were carried out. Of the 207 micro-fragments initially created, 61% of the fragments were alive and healthy after 8 months. A second set of 151 micro-fragments had a 95% survival rate after 3 months. Survival was affected by the mean temperature and flow rate of the water moving through the raceway as well as the presence/absence of sea-mites and ciliates in the water supply.

Key Words: Coral restoration, resilient, micro-fragment, massive coral species, ex-situ

ON THE BRINK OF EXTINCTION: STAGHORN CORAL

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Staghorn coral (Acropora cervicornis) are well recognized worldwide by their cylindrical branches reaching 5-25 m lengths. Since 2006, however, they have been protected under the Endangered Species Act, and are in on the brink of extinction. Some states (e.g. Florida) are spending millions of dollars in culturing and replanting these corals, however, transplants appear to suffer the same fate (i.e. bleaching) caused by climate change. A novel technique to culture coral involves electrical impulses but no studies have examined their heat stress tolerance. I propose to test how A. cervicornis responds to thermal stress comparing coral cultured using (1) electrical impulses, (2) current husbandry techniques, and (3) natural populations. This study will reveal (1) whether newer and more novel methods produce a more resistant staghorn coral better adapted to heat stress, and (2) whether such coral is a viable candidate for helping to replant and restore coral reefs.

THE RACE BETWEEN DESPAIR AND HOPE: A SUCCESSFUL STORY OF CORAL REEF RESTORATION AND NATURAL RECOVERY FOLLOWING TWO MAJOR HURRICANES IN PUERTO RICO

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Hurricanes play a fundamental role in shaping coral reef physical structure and biodiversity. Increasing threats by a myriad of localized human factors and sea surface warming trends have largely contributed to coral reef decline. Therefore, many of its ecological functions, as well as tourism-based revenues and local community livelihoods, are under increasing threats. Such altered coral reefs have become de facto novel ecosystems, with limited natural recovery ability, representing a vital management challenge, and often polarizing conservation and restoration scientists between dispair and hope. In September 2017, two category five hurricanes, Irma and Marรญa, impacted the coral reefs of Culebra Island, Puerto Rico, causing unprecedented devastation of coral reef assemblages across some locations. However, SAM's "Hope for the Reef" Program reemerged during 2018 with the support of multiple community-based volunteers and restored partnerships to reconstruct coral nurseries and launching a novel multi-species restoration effort. Several coral species are currently being propagated, including: endangered A. cervicornis, A. palmata, Orbicella annularis, and Dendrogyra cylindrus. Coral triage and replanting to

impacted reefs have included colonies of 14 species. It has also included transplanting of long-spine urchins, Diadema antillarum, to enhance local herbivory activity. Also, recent long-term monitoring studies have shown an unprecedented sexual larval recruitment of A. palmata and of A. cervicornis, suggesting a significant widespread Acroporid coral natural recovery event. This highlights the importance of integrating coral reef conservation and restoration to enhance coral reef connectivity, its ecological resilience and services. But future success of these efforts in Puerto Rico will require a stronger integration of conservation and restoration, and a wider support from multiple stakeholders beyond community-based volunteers, including private business, istitutions and the hospitality and tourism sectors. Specific needs and recommendations are discussed.

Los huracanes desempeñan un papel fundamental en la configuración de la estructura física y la biodiversidad de los arrecifes de coral. Las amenazas crecientes por una gran cantidad de factores humanos localizados y las tendencias del calentamiento de la superficie del mar han contribuido en gran medida a la degradación de los arrecifes de coral. Como consecuencia, éstos han perdido significativamente el porcentaje de cobertura de coral vivo, su estructura espacial, su papel para amortiguar la energía de las olas, su función como hábitat esencial de los peces y su valor socioeconómico. Por lo tanto, los ingresos basados en el turismo y los medios de vida de las comunidades locales están bajo amenazas crecientes. Estos arrecifes de coral alterados se han convertido en ecosistemas noveles de facto, con una capacidad de recuperación natural limitada, lo que representa un desafío de gestión vital y, a menudo, polarizan a los científicos de conservación y restauración entre la desesperación y la esperanza. En septiembre de 2017, dos huracanes de categoría cinco, Irma y María, impactaron los arrecifes de coral de la isla Culebra, Puerto Rico, causando una devastación sin precedentes en algunos lugares. Esto incluyó la destrucción casi total de los viveros de coral operados por la Sociedad Ambiente Marino (SAM). Más de 7,000 corales se perdieron en los viveros, y más de 70,000 colonias de corales Cuervo de Cuervo en peligro de extinción, *Acropora cervicornis*, se perdieron de los arrecifes restaurados. Sin embargo, el programa "Esperanza para el Arrecife" de SAM volvió a surgir en 2018 con el apoyo de múltiples voluntarios de la comunidad y el apoyo de instituciones privadas y agencias gubernamentales para reconstruir los viveros de coral y lanzar un novedoso esfuerzo de restauración multiespecífica. Actualmente se están propagando varias especies de corales, entre ellas: *A. cervicornis*, *A. palmata*, *Orbicella annularis* y *Dendrogyra cylindrus*. La restauración de emergencia de corales y la replantación en arrecifes impactados han incluido colonias de 14 especies. También ha incluido el trasplante de erizos de espina larga, Diadema antillarum, para mejorar la actividad herbívora local. Además, estudios recientes de monitoreo a largo plazo han mostrado un reclutamiento larvario sexual sin precedentes de A. palmata y de A. cervicornis, lo que sugiere un evento amplio de recuperación natural de corales Acropóridos. Esto destaca la importancia de integrar la conservación y restauración de los arrecifes de coral para mejorar su conectividad, su capacidad de recuperación ecológica y sus servicios. Pero el éxito futuro de estos esfuerzos en Puerto Rico requerirá una mayor integración de la conservación y la restauración, y un apoyo más amplio de múltiples partes interesadas más allá de los voluntarios comunitarios, incluidas las empresas privadas, las instituciones y el sector de la industria hotelera y del turismo. Se discuten necesidades específicas y recomendaciones.

Keywords: Acropora cervicornis, Acropora palmata, coral farming, coral reef restoration, Dendrogyra cylindrus, recovery

SCLERACTINIAN CORALS, OCTOCORALS AND HYDROCORALS ASSOCIATED WITH MANGROVE ROOTS IN LA PARGUERA NATURE RESERVE, PUERTO RICO (**Student**)

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Coral reefs are experiencing worldwide losses because of climate change, disease outbreaks, and other anthropogenic-driven stressors. The increasing rates of coral mortality have driven the scientific community to explore habitat alternatives where coral species can survive and reproduce. Coastal red mangrove (Rhizophora mangle) communities provide one of few alternative marine habitats in which coral colonies have been shown to survive attached to the complex, underwater root system, or over the substrate below. The goal of this study, the first of its kind in Puerto Rico, was to assess the diversity, abundance and size range of coral, octocoral and hydrocoral species growing on mangrove roots in the La Parguera Natural Reserve (LPNR). The diversity and abundance of each group was assessed in coastal and island fringing mangrove systems along 10.32 km and across different wave-energy exposures (exposed, semi-exposed and protected), turbidity and water circulation conditions in LPNR. All colonies of corals and hydrocorals were identified to species level, counted and measured (< 5, 5-10 and > 10 cm in longitude) octocorals were identified to species and counted but not measured. Preliminary results indicate that R. mangle roots around LPNR are a suitable habitat for octocorals, hydrocorals and scleractinian corals. A total of 17 scleractinian coral, 3 octocoral and 3 hydrocoral species were found growing on the roots. Overall, the most abundant species was Undaria agaricites, followed by Porites spp. The exposed habitats showed higher diversity, abundance and large sized colonies. This is similar to reports from the US Virgin Islands and other localities, and an encouraging result, showing that, mangrove roots are a suitable substrate and these habitats might represent a potential refuge from anthropogenic and climate change impacts.

Los arrecifes de coral están experimentando pérdidas en todo el mundo debido al cambio climático, los brotes de enfermedades y otros factores estresantes provocados por actividades antropogénicas. Las creciente tasas de mortalidad coralina han llevado a la comunidad científica a explorar alternativas de hábitat donde las colonias de coral puedan sobrevivir y reproducirse. Las comunidades costeras de mangle rojo (Rhizophora mangle) ofrecen uno de los pocos hábitats marinos alternativos en los que se ha demostrado que las colonias de coral sobreviven unidas al complejo sistema de raíces subacuáticas o en el sustrato debajo de estas. El objetivo de este estudio, el primero de su tipo en Puerto Rico, fue evaluar la diversidad, abundancia y tamaños de especies de corales, octocorales e hidrocorales en las raíces de los manglares a lo largo de 10.32 km dentro de la Reserva Natural La Parguera (RNLP), Puerto Rico. Se estudió la diversidad, abundancia y tamaños de las colonias de coral e hidrocorales, y abundancias de octocorales, en áreas de manglar (costa e islas) expuestas a diferentes niveles de energía de oleaje (expuestos, semi-expuestos y protegidos), turbidez y la circulación del agua en RNLP. Todas las colonias de corales e hidrocorales fueron identificados hasta nivel de especie, se contaron y se clasificaron cualitativamente en tres clases de tamaño (<5, 5-10 y> 10 cm). Resultados preliminares indican que las raíces de R. mangle alrededor de RNLP proveen un hábitat adecuado para corales escleractinios, hidrocorales y octocorales. Un total de 17 especies de corales escleractinios fueron encontrados creciendo sobre las raíces. En general, Undaria agaricites fue la especie más abundante seguida por Porites ssp. Los hábitats expuestos mostraron una mayor diversidad, abundancia y colonias

de mayor tamaño. Esto es similar a los informes de las Islas Vírgenes de los Estados Unidos y otras localidades, un resultado alentador que muestra que las raíces de mangle son un sustrato adecuado y que estos hábitats podrían representar un refugio potencial contra los impactos antropogénicos y del cambio climático.

Keywords: R. mangle, diversity, corals, refuge.

BREEDING BABY UNICORNS: ASSISTED REPRODUCTION OF PILLAR CORAL IN FLORIDA

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The pillar coral population of the Florida Reef Tract has been well surveyed for its demographic and genetic population structure. Genetic analyses show great distances between distinct genets. When clonal ramets are excluded, size demographics are skewed towards large colonies with few to no juveniles. As such, it is highly likely that the species is reproductively extinct within the region. Six years of assisted reproduction in laboratory and field-based spawn collections have provided new information about the reproductive biology of the species and also yielded information on rearing strategies. Widespread hermaphroditism within genets, within ramets over multiple years, and even between regions of the same ramet have been documented. Variation in field spawning times during 2018 suggest potential for complete reproductive failure over an annual cycle. And delayed time of spawning in the lab suggests different cues for fragments removed from the field. Successful fertilization of field and laboratory-spawned gametes can be high, but settlement remains a bottleneck. Future efforts, including cryogenic sperm freezing, will continue to refine assisted reproductive efforts in order to build genetic diversity for eventual outplanting.

Keywords: Pillar coral, Dendrogyra cylindrus, spawning, population structure

DIADEMA ANTILLARUM GRAZING EFFECTS ON ALGAL/BENTHIC COVER AND DIVERSITY IN LA PARGUERA, SOUTHWESTERN PUERTO RICO.

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A modest recovery of the black long-spined sea urchin, Diadema antillarum, has been reported for a few Caribbean locations. D. antillarum has been proposed to be a keystone herbivore that exerts important

controls on benthic assemblages. Most of the evidence supporting this keystone model, however, has been inferred from observational studies; whereas manipulative studies that test hypotheses derived from this keystone model are scarse. Consequently, a manipulative experiment was conducted to test the effect of D. antillarum densities and rugosity (substrate heterogeneity) on the algal/benthic cover (as a proxy of grazing rate) and diversity. The field experiment consisted of fencing coral heads where different densities (1, 5 and 10 individuals per m2) of D. antillarum were placed per experimental unit. Inside these experimental units, three, 10cmx10cm quadrats were permanently and randomly placed to estimate the algal/benthic cover and diversity for six months. Preliminary, non-quantitative observations have shown a decrease in algal cover associated with D. antillarum densities, but not rugosity. On the other hand, no effects of the factors considered in this experiment (i.e. rugosity and densities) have been detected on coral recruitment. It is expected that after the conclusion of this experiment, we will be able to estimate the optimal density of D. antillarum needed on a coral reef area to create positive feedbacks in the south-west part of Puerto Rico. With the information produced, D. antillarum restoration could be constituted as a plausible biocontrol mechanism to reduce algal cover and potentially increase coral recruitment substrate.

Una recuperación modesta del erizo negro de espinas largas, Diadema antilarum se ha reportado para varias localizaciones en el Caribe. D. antillarum se ha propuesto como un herbívoro clave que ejerce controles importantes de ensamblajes bentónicos. Sin embargo, la mayoría de la evidencia apoyando este modelo de herbivoría clave ha sido inferido de estudios observacionales mientras que los estudios manipulativos que ponen a prueba este modelo son escasos. Por consiguiente, un experimento manipulativo fue realizado para medir el efecto de las densidades de D. antillarum y rugosidad (heterogeneidad de sustratos) en la cobertura algal/bentónica (como un proxy de la tasa de pastoreo) y diversidad. El experimento de campo consistió en cercar cabezas de corales donde diferentes densidades (1, 5 y 10 por m2) de D. antillarum fueron encerradas por unidad experimental. Dentro de las unidades experimentales, tres cuadrantes 10x10cm fueron instaladas permanente y aleatoriamente para estimar la cobertura algal/bentónica durante seis meses. Observaciones preliminares, no cuantitativas han mostrado una reducción en cobertura algal asociada a las densidades de D. antillarum, pero no con la rugosidad. Por otra parte no se han detectado efectos de otros factores (rugosidad y densidades) considerados en el experimento en reclutamiento de corales. Se espera que, al terminar el experimento, podremos estimar la densidad optima de D. antillarum necesaria para crear retroalimentación positiva en áreas de arrecifes de coral en la parte suroeste de Puerto Rico. Con esta información, la restauración de D. antillarum podría ser establecida como un mecanismo de control biológico plausible para reducir cobertura algal y potencialmente aumentar sustrato para reclutamiento de coral.

Keywords: Diadema antillarum, keystone, herbivory, rugosity, manipulative experiment

RECOVERY OF THREATENED ORBICELLA ANNULARIS CORALS FROM PARROTFISH PREDATION WITHIN AND OUTSIDE OF A CARIBBEAN MARINE RESERVE (**Student**)

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Parrotfishes (Scaridae) reduce coral-algae competition by grazing algae. Increasing parrotfish biomass to promote coral resilience is a priority for marine managers; however, heavy fishing pressure in parts of the Caribbean can compromise their top-down control of algae. While parrotfishes are primarily herbivores, some occasionally feed on corals (corallivory). Parrotfishes prey upon multiple coral species, but preferentially target threatened Orbicella annularis. Little is known about the impact of corallivory on O. annularis tissue loss. The objective of this research was to quantify O. annularis healing rates from parrotfish scars in St. Croix, US Virgin Islands. In July 2018, we tagged colonies with recent bite scars at four sites: two in the Buck Island marine reserve and two outside the reserve. We used photo monitoring to track scars on colonies every 2-7 days over one month and analyzed photos in ImageJ to calculate changes in scar surface area. We modeled scar healing rates using linear mixed-effects regression with several predictors. The best predictive model based on AICc selection contained the following variables: initial scar surface area, coral colony surface area, scar density, colony depth, and location in or outside of the reserve (marginal R2=0.685). The most significant predictors within the model were initial scar and colony surface area. Controlling for other effects, healing rates were significantly slower when the initial scar area was larger, and significantly faster when the bite occurred in a larger colony. Ultimately, we will integrate these data with research on how parrotfish biomass and benthic community assemblages alter the intensity of parrotfish predation on O. annularis to determine ecological drivers of corallivory and its long-term impact on coral cover of this threatened species.

Peces loros (Scaridae) reduce la competencia entre el coral y las alga cuando comen algas. El aumento de la biomasa del pez loro para promover resiliencia del coral es una prioridad para administradores marinos; pero presión de la pesca en partes del Caribe puede comprometer su control descendente de algas. Algunas especies se alimentan ocasionalmente de corales y prefieren Orbicella annularis, una especie amenazada. El objetivo de esta investigación fue cuantificar las tasas de curación de O. annularis a partir de las cicatrices creadas por el pez loro en St. Croix, Islas Vírgenes. En julio de 2018, etiquetamos colonias con recientes cicatrices de mordeduras en dos sitios dentro y dos sitios fuera de la reserva marina de la isla Buck. Utilizamos escaneos fotográficos en colonias cada 2-7 días durante un mes y analizamos las fotos en ImageJ para calcular cambios en el área de la superficie. Modelamos las tasas de cicatrización utilizando regresión lineal de efectos mixtos con varios predictores. El mejor modelo por selección AICc incorpora el área inicial de la cicatriz, el área de la superficie del coral, la densidad cicatrices y si estaba dentro de la reserva marina (R2 marginal = 0,685). Las mejores variables fueron el área de la cicatriz inicial y el área de la superficie del coral. Al controlar otros efectos, las tasas de curación fueron significativamente más lentas cuando el área inicial de la cicatriz era más grande y significativamente más rápida cuando se produjo la mordedura en una colonia más grande. Últimamente, integraremos estos datos con la investigación sobre cómo la biomasa del pez loro y la comunidad béntica alteran la intensidad de depredación de O. annularis para determinar su impacto a largo plazo.

Keywords: Parrotfish, Corallivory, Recovery, Coral healing.

ROLE OF EPIGENETIC MODIFICATIONS MEDIATING CORAL ACCLIMATORY RESPONSES DURING POST-HURRICANE MARIA RESTORATION EFFORTS IN CULEBRA, PUERTO RICO (**Student**)

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Despite being widely implemented, coral reef restoration strategies are hampered by the low survival rates displayed by outplanted fragments. Given the extremely rapid pace of global change and its harmful effects degrading coral reef ecosystems, it is likely that “optimal” climatic conditions favoring coral recruitment and outplanting success are already gone (or soon will be) across oceans worldwide, making site selection a challenging task. Consequently, alternative strategies consisting in enhancing coral resilience to the future effects of global change (e.g., coral pre-conditioning and assisted evolution) appear very promising. In this work we evaluated how epigenetic mechanisms (heritable modifications in gene expression that do not involve changes in the DNA sequence) participate in the onset of coral pre-conditioned and/or resilient phenotypes, endowing corals with enhanced capabilities to survive post-outplanting. Accordingly, a total of 200 fragments from the stony coral Acropora cervicornis were rescued from four locations in the island of Culebra, affected by the 2017 hurricanes Irma and Maria. Fragments were stabilized for 5 months in tree-like nurseries located in two reefs with different outplanting success histories and reciprocal outplanting experiments were subsequently performed between locations and monitored for one year. Parameters including demographic performance, physiological responses, symbiont dynamics, and DNA methylation changes were analyzed prior (nursery stage) and after outplanting. After 5 months of monitoring, the results obtained indicate high post-transplant survival levels (>90%) and positive growth of most fragments. Physiological and epigenetic analysis hint a dependency on the genotype and the pre-acclimatization to reef conditions. Although preliminary, our results indicate that these mechanisms could constitute useful tools to improve coral management practices and resilience.

A pesar de ser ampliamente aplicadas, las estrategias de restauración de corales adolecen por la baja tasa de supervivencia de los fragmentos luego de sembrados. Producto del rápido avance de los efectos del cambio climático (sensu latu) y sus negativos efectos sobre los ecosistemas de arrecifes de coral, es muy probable que las condiciones “optimas” que favorecen el reclutamiento y el éxito post-siembra ya no existan (o pronto dejaran de existir) en la mayor parte del mundo, dificultando la selección de sitios para la restauración. Consecuentemente, estrategias alternativas buscando incrementar la resiliencia de los fragmentos a los efectos del cambio climático (v.g. precondicionamiento y evolución asistida) parecen muy prometedoras. En este trabajo, evaluamos cómo mecanismos epigenéticos (modificaciones heredables en la expresión génica sin involucrar cambios en la secuencia de DNA) participan en el establecimiento de fenotipos resilientes y/o precondicionados, incrementando la capacidad de los corales para sobrevivir luego de ser sembrados en el arrecife. En correspondencia, doscientos fragmentos del coral Acropora cervicornis fueron rescatados, luego de los huracanes Irma y Maria en 2017, de cuatro arrecifes alrededor de la Isla Culebra, Puerto Rico. Los fragmentos fueron estabilizados en fincas colgantes localizadas en dos arrecifes con diferentes éxitos post-siembra y posteriormente sembrados recíprocamente en ambos arrecifes. Antes (en las fincas) y después de la siembra, fueron

evaluados parámetros demográficos, fisiológicos epigenéticos (metilación de DNA) e indicadores del estado simbiótico. Luego de cinco meses de seguimiento post-siembra, nuestros resultados indican altos niveles de supervivencia (>90%) y crecimiento positivo en la mayoría de los fragmentos. Los análisis preliminares de las respuestas fisiológica y epigenética evidencian una dependencia del genotipo de coral y el estado de aclimatación. Aunque preliminares, nuestros resultados indican que estos mecanismos podrían constituir herramientas útiles para mejorar prácticas de manejo e incrementar la resiliencia de los arrecifes restaurados.

Keywords: coral preconditioning, restauration, staghorn coral, epigenetics

GROWTH AND MORTALITY DYNAMICS OF ACROPORA CERVICORNIS AND A. PROLIFERA IN SOUTHWEST PUERTO RICO

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After their Caribbean-wide, disease-induced mass mortality in the early 1980's, natural population recovery of acroporids in the Caribbean has been slow. Significant recovery has been reported for only a few localities, mostly because recurrent disease outbreaks, bleaching, storm damage, local environmental deterioration, predation, and low sexual recruitment and survivorship affecting the expected, quick recovery of these weedy species. In this study, the recovery status of three populations of A. cervicornis and two of A. prolifera in three shallow reef areas (Media Luna, Mario and San Cristobal) off La Parguera Natural Reserve (LPNR), was assessed using growth and mortality dynamics and changes in their associated algae and fish/invertebrate communities. Five branches were tagged on 29, healthy-looking A. cervicornis and 18 A. prolifera colonies in the three areas. Branch linear extension was measured monthly, together with observations of disease, algae accumulation and predation impact. A. cervicornis had a higher monthly mean linear growth [3.1 ± 0.44 cm/month (= 37.2 cm/y)] compared to A. prolifera [2.6 ± 0.41 cm/month (= 31.2 cm/y)]. Linear growth was significantly higher during Winter-Spring compared to Summer-Fall for both taxa (3.5 ± 0.58 vs. 0.53 ± 0.15 cm/month in A. cervicornis, and 2.43 ± 0.71 vs. 0.27 ± 0.20 cm/month in A. prolifera). Algal accumulation occurred only in A. cervicornis and was significantly higher during the Spring-Summer compared to Fall-Winter (6.1 ± 0.91 cm/month and 3.8 ± 0.29 cm/month SE respectively) (PERMANOVA, df=2, MS=10.2, p=0.37). Mortality associated with white band disease, algae smothering and fish/invertebrate predation was higher in A. cervicornis and varied among colonies within sites, across sites and across seasons. Overall, results indicate good recovery for both taxa across sites until Hurricane Maria, when Mario was significantly more impacted than the other two. Magnitude and direction of the "recovery" seems to be site and species specific.

La recuperación natural de las poblaciones de acroporidos en el Caribe ha sido lenta luego de las mortalidades masivas por enfermedad a principio de los 1980's. Recuperaciones significativas se han

observado en pocas localidades debido a la recurrencia de enfemedad, mortalidad por depredación, blanqueamiento, tormentas, deterioro de las condiciones ambientales locales, y un bajo éxito reproductivo (reclutamiento y sobrevivencia de juveniles). En este estudio, el estatus de tres poblaciones en recuperación de Acropora cervicornis y dos del híbrido A. prolifera en tres arrecifes someros de la Reserva Natural de la Parguera (RNLP), se caracterizó usando datos de la dinámica anual de crecimiento lineal, mortalidad y cambios en la cobertura de algas y comunidades asociadas de peces e invertebrados. Cinco ramas en cada una de 29 colonias saludables de A. cervicornis y 18 de A. prolifera se marcaron y midieron mensualmente por un año para calcular tasas de crecimiento y su variabilidad especial y temporal. Concurrentemente se hicieron observaciones de mortalidad por enfermedades, sobrecrecimiento de algas y depredación por peces damisela e invertebrados. Además se caracterizó la comunidad de peces e invertebrados asociadas a las colonias. Crecimiento linear fue más rápido durante el invierno/primavera comparado con el verano-otoño en ambas taxa (3.5 ± 0.58 vs. 0.53 ± 0.15 cm/month in A. cervicornis, and 2.43 ± 0.71 vs. 0.27 ± 0.20 cm/month in A. prolifera) (PERMANOVA, df=2, MS=10.2, p=0.37). A. cervicornis creció más rápidamente [3.1 ± 0.44 cm/month (= 37.2 cm/y)] que A. prolifera [2.6 ± 0.41 cm/month (= 31.2 cm/y)]. A. cervicornis sufrió mayor mortalidad que A. prolifera y esta varia entre colonias, localidades y estaciones. Resultados indican un buen crecimiento recuperación continua de las poblaciones hasta septiembre de 2017, cuando el Huracán María impacto significativament las poblaciones de Mario. La magnitud y “dirección” de la recuperacion parece ser especifica para cada sitio y cada taxon.

Keywords: Acroporids, recovery status, growth and mortality rates, Puerto Rico

IMPACTO DE LA VEDA TEMPORAL EN LA DENSIDAD DEL PEZ LORO EN LA PARTE ESTE DE REPÚBLICA DOMINICANA

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La sobrepesca de peces loro, considerados como los herbívoros más eficaces en el Caribe, ha contribuido en gran parte al cambio de fase que actualmente presentan la mayoría de los arrecifes de coral en República Dominicana. Ante esto, El Ministerio de Medio Ambiente y Recursos Naturales, estableció una veda temporal (01/jul/2017 – 30/jun/2019) de captura y comercialización de las especies de pez loro, como parte de su estrategia para recuperar y conservar la salud de los ecosistemas coralinos. El presente estudio, evalúa el grado de eficiencia de la veda sobre la densidad poblacional de peces loro en tres localidades con diferente régimen de protección. Mediante censos visuales se estimó la abundancia de peces loro para después obtener su densidad en las localidades de Punta Cana (zona protegida), Bayahibe (zona con protección parcial), y Bávaro (zona sin protección). Después de 1 año 5 meses de veda, Punta Cana muestra una densidad promedio de 0.30±0.04 ind*m^2; y el mayor porcentaje

de incremento en su densidad (25%). Mientas que Bayahibe registra la mayor densidad promedio de peces loro (0.75±0.06 ind*m^2) con un porcentaje de incremento del 5%. Finalmente, la densidad promedio de peces loro en Bávaro permanece estable (0.57±0.05 ind*m^2). Estos resultados suponen una mayor efectividad en zonas protegidas, destacando la importancia de implementar estrategias de conservación alternas a la veda, como por ejemplo, la implementación de Áreas Naturales Protegidas o una regulación eficiente de las pesquerías en el país.

Keywords: Republica Dominicana; Pez loro; Densidad; Veda

POSTER ABSTRACTS

Day 2 – Tuesday, May 21st

Session*: Human related issues including fisheries*

USING ENVIRONMENTAL DNA TO STUDY SHARK DIVERSITY IN THE LA PARGUERA NATURAL RESERVE, PUERTO RICO (**Student**)

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Sharks populations worldwide are currently facing one of their biggest existential threats due to targeted and indiscriminate overfishing. Sharks around Puerto Rican waters face the same threats as in many other countries. Several species are targeted by fishermen for the fishing industry. However, there is little to no data on the actual species that are being caught for consumption or as by-catch. Part of the problem is the lack of education that fishermen have with regards to the shark's ecological importance within coral reef and deep reef communities. The second problem that is the lack of information regarding population species status in the area. In Puerto Rico, there are about 35 shark species inhabiting shallow and deeper waters, although, the actual species present is not known. The main goal of this research is to identify and provide a baseline list of the species of sharks present in the La Parguera Natural Reserve. Our research group will be using environmental DNA, a powerful, relatively simple and cost-effective method for working with elusive and mobile species, such as elasmobranchs. Our results will allow us to provide reliable and baseline data to the local and federal agencies that will aid in the conservation and proper management of the species present in the sampled region.

Keywords: eDNA, Selachimorpha, Puerto Rico

IDENTIFICATION OF SPOTTED EAGLE MANTA RAYS IN PUERTO RICO USING ENVIRONMENTAL DNA (**Student**)

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Spotted Eagle rays (Aetobatus spp.) are large marine batoids which are distributed across tropical and warm-temperate waters across the planet. Although once thought to be circumglobally species, recent genetic evidence supports the existence of at least four species: A. flagellum, A. narinari, A. narutobiei,

and A. ocellatus. Aetobatus narinari can be found in the Western Atlantic and the Caribbean Sea. Little to nothing is known about the life history, behavior, feeding habits, reproduction, distribution, abundance, and overall population status of A. narinari in the Caribbean region. Spotted eagle rays around the world face population decline due to a history of being targeted by local regional fisheries. Because of the nondiscriminatory fishing impact, Aetobatus spp. as has been listed as "Near Threatened" in the IUCN Red List in 2006. In Puerto Rico, A. narinari can be observed in different habitats around the island, from inshore and outshore shallow reefs, seagrass beds, mangroves, and mesophotic coral reefs (30-130 m). They are considered a native species but are not officially protected by the Department of Natural and Environmental Resources of Puerto Rico (DNER-PR), despite the fact that it can be commonly bought at local fish markets. Environmental DNA (eDNA) is proven to be a powerful method to record the presence ofspecific species in a region. We will implement this method by taking water and sediment samples from different habitats (cays, shallow and mesophotic reefs, and seagrass) around La Parguera, southwest Puerto Rico to record the presence/absence of A. narinari. This molecular, noninvasive tool will allow us to detect A. narinari without disturbing and endangered a species already threatened. This project will provide much-needed baseline data to understand the biology of the species and potentially help DNER to implement data-driven regulations to protect the population in Puerto Rico.

Keywords: batoids, Spotted Eagle rays, Puerto Rico

EL CASO DE LA RESERVA NATURAL CANAL DE LUIS PEÑA: UN EJEMPLO DE LA IMPORTANCIA DEL TERCER SECTOR EN LOS ESFUERZOS DE CONSERVACION

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The term Socio-ecological Systems (Berkes and Folke, 1998) is used to refer to a systemic concept of "human-being-in-nature". Therefore, it is understood as a complex and adaptive system in which cultural, political, social, economic, ecological, technological components, among others, are interacting (Resilience Alliance, 2010). This implies that the focus of the management of ecosystems and natural resources does not focus on the components of the system but on their relationships, interactions and feedback (Farhad, 2012). In the case of the marine protected area known as the Natural Reserve of the Canal de Luis Peña, on the island of Culebra, PR, there were positive ecological and therefore socioeconomic consequences when there were interactions between public, private and third sector entities. Historically the area was affected by continuous bombardment from the United States Navy. In 1999, the area was declared a Natural Reserve at the insistence of local private sectors. Since then, scientific studies have been conducted in the area led at first by the University of Puerto Rico. Coupled with the efforts of non-profit organizations such as Sociedad Ambiente Marino (SAM) and their volunteers have brought positive changes in the physical environment of the area, attracting a greater diversity of species and increasing the biomass of the species. The results obtained in this protected area show how

the joint efforts have provoked first ecological, cultural, tourist and finally economic resurgence in the region.

El término Sistemas Socio-ecologico (Berkes y Folke, 1998) se utiliza para referirnos a un concepto sistémico del “ser humano-en-la naturaleza”. Por tanto se entiende como un sistema complejo y adaptativo en el que componentes culturales, políticos, sociales, económicos, ecológicos, tecnológicos, entre otros están interactuando (Resilience Alliance, 2010). Esto implica que el enfoque de la gestión de los ecosistemas y recursos naturales, no se centra en los componentes del sistema sino en sus relaciones, interacciones y retroalimentaciones (Farhad, 2012). En el caso del área marina protegida conocida como Reserva Natural del Canal de Luis Peña, en la isla de Culebra, PR, hubo consecuencias ecológicas y por ende socioeconómicas positivas cuando hubo interacciones entre entidades públicas, privadas y del tercer sector. Históricamente la zona fue afectada por continuos bombardeos de la Marina de Estados Unidos. En el año 1999 la zona fue declarada Reserva Natural a insistencias de sectores privados locales. Desde ese entonces se han realizado estudios científicos en la zona liderados en un principio por la Universidad de Puerto Rico. Aunados con los esfuerzos de entidades sin fines de lucro como la Sociedad Ambiente Marino (SAM) y sus voluntarios han provocado cambios positivos en el entorno físico de la zona logrando atraer mayor diversidad de especies y aumentando la biomasa de las especies. Los resultados obtenidos en esta área protegida demuestran como los trabajos en conjunto han provocado un resurgir primeramente ecológico, cultural, turístico y finalmente económico en la región.

Keywords: socioecological system, economy, conservation, third sector

USAGE AND DISPOSAL PATTERNS OF VISITORS TO THE UWI PORT ROYAL MARINE LABORATORY, JAMAICA

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Marine litter is a worldwide problem compromising the various ecological goods and services that coastal and marine habitats provide. In 2018, the Jamaican Government announced a move to ban single-use plastic bags, straws and Styrofoam. In addition to legislation and policy change to reduce marine litter, education and outreach have the potential to build awareness and influence behavior change. The Port Royal Marine Laboratory (PRML), The University of the West Indies, Jamaica, conducts an outreach programme for the general public focusing on students aged 4-18 years. The PRML educational programme seeks to increase environmental awareness of plastics and Styrofoam, including educational tours in and around the nearby Kingston Harbour to demonstrate the current challenges of waste disposal to the mangrove habitats. A study has been conducted to determine patterns in the usage and disposal of plastics and Styrofoam, and assess whether the PRML’s educational tours can sensitize people to the

marine litter problem. Surveys were conducted with visitors pre- and post- educational visit. Participants encompassed students aged 6-18 years old, teachers, and the general public. Data on parish of origin and socio-economic backgrounds provided insights into island wide usage patterns and highlight limitations to environmentally-friendly practices. Surveys revealed poor waste disposal and their reliance on plastics and Styrofoam. Poor practices included disposal of garbage in gullies/storm drains, rivers, road networks, and by burning. Poor practices were related to: (1) infrequent collections of household waste by authorized agencies in local communities; (2) individual disregard for environmental quality, and (3) a lack of environmental awareness on the consequences of improperly disposed waste. Results highlight the importance of sensitization in order to influence behavioral change to marine litter, information that will be used to inform future engagement with the local communities in the Port Royal-Palisadoes Protected Area.

Keywords: Styrofoam, plastic, marine litter, public education, disposal patterns, Jamaica, Port

Royal Marine Laboratory

FROM START TO SETTLEMENT, STARTING A MARINE ORNAMENTAL HATCHERY IN THE DOMINICAN REPUBLIC

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Marine ornamental aquaculture's purpose is to increase the availability of captive cultured marine species in the aquarium industry in order to reduce the impacts of wild collection on fish populations and the coral reefs where they live. Here we present several aspects of starting a marine ornamental fish hatchery in the Dominican Republic. Designing and building closed aquarium systems for broodstock, larval rearing, and growout. The target species for collection were *Gramma loreto*, and *Elacatinus* sp. After collecting more than 50 fish with the aid of clove oil, these fish were put through a quarantine system and treated with medications as needed. Once their 30-day quarantine was completed, they were moved to broodstock tanks, where conditioning began. This conditioning included photoperiod manipulation, temperature, and dietary needs. Pairs were formed with a 90% success rate with *G. loreto* forming trios, and *Elacatinus* sp. forming pairs. Local fishermen were employed to assist in the feedings to offer alternative income opportunities to combat the wild collection of species that are collected without regulations. Courting was recorded in both species within the first month of pairing. *Elacatinus* pairs started spawning within the first 90 days of pairing with the first spawn being recorded within 30 days. During spawning, embryo development was documented, with trials being run on temperature effects on development. After hatching, the larvae were given an array of different live feeds including copepods, rotifers, artemia, and a few species of microalgae. The larvae went through different life processes, the loss of their egg yolk, inflation of swim bladder, flexion, development of pelvic fins, metamorphosis, and

settlement. Success rate of these trials were more than 50% survivorship. The next phase of this project will move towards the restoration of vulnerable pelagic species.

Keywords: Aquaculture, Fish, Larvae, Dominican Republic, Plankton, Collection

FROM COLLECTION TO REPRODUCTION, WORKING WITH *ELACATINUS* SP. IN THE DOMINICAN REPUBLIC

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Gobies of the genus *Elacatinus* play a key role on reef habitats. These gobies engage in a type of symbiosis with other marine creatures by offering them a cleaning service. They will consume ectoparasites off of the other fish's bodies. Thus removing unwanted pests from the host, and gaining their main source of food. This has made species of *Elacatinus* extremely desirable in the aquarium trade with more than a dozen species of the genus being collected. In the Dominican Republic there are six species of *Elacatinus*. 30 *Elacatinus* were collected with the assistance of a 10% clove oil mixture from reef habitat. These fish were quarantining and treated with Cupramine at a concentration between .25ppm-.5ppm. Once their 30-day quarantine was completed they were moved to broodstock tanks. Pairs were formed with a 90% success rate. After the success of pairing, different techniques were used to condition the broodstock which included; photoperiod manipulation, temperature, and dietary needs. During spawning, egg incubation and development was documented. 12 pairs of *Elacatinus sp.* produced over 12 spawns. The survival rate of these spawns is upwards of 50%. The eggs were removed from the pair prior to estimated hatch date, and different techniques were employed to hatch the embryos. After hatching, the larvae were given an array of different zooplankton including copepods, rotifers, and artemia. Feeding trials were run for results of cultured vs. wild zooplankton. These zooplankton had all been enriched prior to feeding by species of phytoplankton. During the rearing the larvae go through different life processes, the loss of their egg yolk, inflation of swim bladder, flexion, development of pelvic fins, metamorphosis, and settlement.

Keywords: Aquaculture, Fish, Larvae, Dominican Republic, Elacatinus, Collection

PRELIMINARY EVALUATION OF THE CORAL REEFS OF LAS TERRENAS (SAMANÁ PROVINCE), EL MORRO NATIONAL PARK AND BUEN HOMBRE (MONTECRISTI PROVINCE), DOMINICAN REPUBLIC (**Student**)

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In order to evaluate the current status of the coral reefs in the Dominican Republic, assessments were carried out in 3 locations on the Atlantic coast of the country as the initial phase of the process: Las Terrenas (Samaná province), El Morro National Park and Buen Hombre (Montecristi province). One or two sites were chosen at random in each locality and the "Protocol for Monitoring Coral Reefs in Dominican Coastal Areas", elaborated by MARENA in the framework of the BCyT Project, was used for the collection of data. A guide line of 100 m with 4 transects of 20 m (separated each by 5 m) was established in each site and data on benthic cover, density of parrotfish and other herbivore fish, groupers and other carnivorous fish and *Diadema antillarum* urchins were registered *in situ*. It was found that the coral reefs in Las Terrenas have an average live hard coral cover of 17.5% and in Montecristi of 21.1%, while the algae cover was 26.6% and 15.5%, respectively. In Las Terrenas and Montecristi, the average density of *D. antillarum* was 0.06 ind/m^2 and 0.09 ind/m^2, parrot fish density was 0.03 ind/m^2 and 0.11 ind/m^2, grouper fish density was 0.01 ind/m^2 and 0.01 ind/m^2; respectively. In general, the reefs of Montecristi were found in a better conservation state than those of Las Terrenas. These data are not statistically representative of all the reefs of Montecristi and Samaná; however, they will serve as a baseline for future studies to detect changes over time.

Con el propósito de conocer el estado actual de los arrecifes de coral en la República Dominicana, se realizaron evaluaciones en 3 localidades de la costa Atlántica del país como fase inicial de este proceso: Las Terrenas (provincia Samaná), Buen Hombre y el Parque Nacional El Morro (provincia Montecristi). Para la colecta de datos, se eligieron de 1-2 estaciones al azar en cada localidad y se utilizó el "Protocolo para el Monitoreo de Arrecifes de Coral en Áreas Costeras Dominicanas" elaborado por MARENA en el marco del Proyecto BCyT. En cada estación, se estableció una línea guía de 100 m con 4 transectos de 20 m, separados cada uno por 5 m, donde se tomaron datos *in situ* de cobertura bentónica, densidad de peces loros y otros herbívoros, peces meros y otros carnívoros y de erizos *Diadema antillarum*. Se encontró que los arrecifes de coral en Las Terrenas tienen una cobertura promedio de 17.5% de coral duro vivo y en Montecristi de 21.1%, mientras que la cobertura de algas fue de 26.6% y 15.5%, respectivamente. En Las Terrenas y Montecristi, la densidad promedio de erizos *D. antillarum* fue de 0.06 ind/m^2 y 0.09 ind/m^2, de peces loro de 0.03ind/m^2 y 0.11 ind/m^2, de peces mero de 0.01 ind/m^2 y 0.01 ind/m^2, respectivamente. En general, los arrecifes de Montecristi presentan mejor estado de conservación que los de Las Terrenas. Estos datos no son estadísticamente representativos de todos los arrecifes de Montecristi y Samaná; sin embargo, servirán como línea base para detectar cambios a través del tiempo.

Keywords: Coral reef, monitoring, benthic cover, fish density, *Diadema antillarum*

SEA TURTLE RESEARCH AND CONSERVATION STRATEGIES: 60 YEARS OF THE SEA TURTLE CONSERVANCY PROGRAM AT TORTUGUERO, COSTA RICA

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Tortuguero is located on the Caribbean of Costa Rica. For the past 60 years the Sea Turtle Conservancy (STC) has been working on this beach protecting and collecting data from nesting females, helping to increase the knowledge we have about this species and identifying the threats they face. Each season, from the month of June until October, the estimated numbers of Green sea turtle (Chelonia mydas) nesting females fluctuate between 20.000 and 180.000. Due to the abundance of Green turtles, Tortuguero is categorized as the most important nesting site for that species in the Caribbean, and the second most important in the world. In the same way, it is an important area for nesting Leatherback (Dermochelys coriacea) and Hawksbill (Eretmochelys imbricata) sea turtle populations. The main objective of the work conducted by the STC is to research and conserve sea turtle nesting areas so they can fulfill their ecological role. This is possible through different strategies, such as: (1) monitoring and study of nesting turtles; (2) working with the Costa Rican Government and the community of Tortuguero; (3) training young scientists, conservationists and others to ensure the continuation of the efforts for the protection of turtles in Tortuguero and elsewhere; and (4) educating the public about sea turtles and threats that affect their survival. The survival of the sea turtle populations in Tortuguero will require many years of continued protection; to accomplish this, it is necessary to acknowledge the achievements obtained and continuously review problems in our research and conservation programs and identifying areas of improvement.

Tortuguero está localizado en el Caribe de Costa Rica. Por los últimos 60 años la Sea Turtle Conservancy (STC) ha estado trabajando en esta playa protegiendo y colectando datos de las hembras anidadoras, ayudando a incrementar el conocimiento que se tiene de esas especies e identificando las amenazas que ellas enfrentan. Cada temporada, desde el mes de junio hasta octubre, el número estimado de hembras anidadoras de tortuga verde (Chelonia mydas) fluctúa entre los 20.000 y 180.000. Debido a la abundancia de tortugas verdes, Tortuguero es categorizada como el sitio de anidación más importante para esa especie en el Caribe y el segundo más importantes en el mundo. Del mismo modo, es una zona importante para la anidación de las poblaciones de tortugas baula (Dermochelys coriacea) y carey (Eretmochelys imbricata). El objetivo principal del trabajo que lleva a cabo la STC es la investigación y conservación de las áreas de anidación de tortugas marinas, para que éstas puedan cumplir sus roles ecológicos. Esto es posible a través de diferentes estrategias, como: (1) monitoreando y estudiando las tortugas anidadoras; (2) trabajando con el gobierno costarricense y la comunidad de Tortuguero; (3) entrenando a jóvenes científicos, conservacionistas y otros para asegurar la continuidad de los esfuerzos de protección de las tortugas en Tortuguero y en cualquier otra parte del mundo; y (4) educando al público sobre las tortugas marinas y las amenazas que afectan su supervivencia. La supervivencia de las poblaciones de tortugas marinas en Tortuguero requerirá de muchos años de protección; y para alcanzar esto, es necesario reconocer los logros obtenidos y revisar continuamente los problemas en nuestros programas de investigación y conservación, e identificar las áreas de mejora.

Keywords: Caribbean, Chelonia mydas, conservation, sea turtles, Tortuguero

EFFECTS OF THE HURRICANE MARIA IN HAMLET COMMUNITIES (HYPOPLECTRUS SPP., SERRANIDAE) IN PUERTO RICO (**Student**)

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Hypoplectrus spp. are hermaphroditic, carnivorous, and highly territorial fishes of the family Serranidae, primarily distributed around the western Atlantic. We studied 10 reefs located in the La Parguera Natural Reserve in Puerto Rico to record differences in Hypoplectrus spp. communities after the passage of Hurricane Maria. Our results were compared to surveys performed in the years 2000 and 2017 (before the storm). A non-metric multidimensional analysis revealed a “boomerang pattern” ranging from high diversity in 2000 to low diversity in 2017 and back to higher diversity levels in 2018. Hypoplectrus spp. son peces hermafroditas, carnívoros y altamente territoriales de la familia Serranidae, distribuidos principalmente alrededor del Atlántico occidental. Estudiamos 10 arrecifes ubicados en la Reserva Natural La Parguera en Puerto Rico para registrar las diferencias en las comunidades de Hypoplectrus spp. después del paso del Huracán Maria. Nuestros resultados se compararon con los censos realizados en los años 2000 y 2017 (antes de la tormenta). Un análisis multidimensional no métrico reveló un "patrón boomerang" que va desde una alta diversidad en 2000 a una baja diversidad en 2017 y de regreso a niveles de diversidad más altos en 2018.

Keywords: La Parguera Natural Reserve; Puerto Rico; Diversity; Hypoplectrus spp.

WISER USE: CONSERVING BIODIVERSITY WITH COASTAL BLUE CARBON IN THE CARIBBEAN (**Student**)

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Coastal wetlands play a significant role in sequestering carbon dioxide (CO2) worldwide. This highlights the potential for economic mechanisms, such as a blue carbon market, to incentivize and reward the conservation of threatened systems. The Ramsar secretariat’s 2017 decision to join the International Partnership for Blue Carbon has opened a window of opportunity for Ramsar sites to consider the benefits of blue carbon management strategies in their protected areas. Although the carbon sequestration potential for coastal wetlands has garnered much attention in North America and Asia, relatively little work has been conducted to date in Latin America and the Caribbean. The diversity of coastal wetland types in this region provides a glimpse of the complexity of implementing a global, or even regional, blue carbon market. Given the distribution and number of critical wetlands and their importance in the region,

the convention could play a vital integrating role in developing such a market. Balancing the biodiversity monitoring and management objectives of Ramsar sites with this novel financing mechanism poses significant challenges. Identifying sites where these disparate uses are socially and environmentally compatible with the convention objectives may further provide a much-needed push to global decision makers to adopt a more structured approach to financing blue carbon and coastal wetland conservation.

Los humedales costeros desempeñan una contribución significativa en la captura biológica de dióxido de carbono mundialmente. Esto destaca una oportunidad para mecanismos financieros, como un mercado de carbono azul, para fomentar y generar fondos para la conservación de sistemas amenazados. La decisión de la secretaría de la Convención Ramsar en el 2017 de unirse a la Asociación Internacional para el Carbono Azul ha creado la posibilidad de que los sitios Ramsar consideren los beneficios de estrategias para gestionar el carbono azul en sus áreas protegidas. Aunque el potencial de la captura biológica de carbono en humedales costeros ha sido investigado más profundamente en Norteamérica y Asia, se conoce relativamente poco del tema en Latinoamérica y el Caribe. La diversidad de tipos de humedales costeros en esta región además complica nuestra capacidad de implementar un mercado de carbon azul, sea global o regional. Dada la distribución y número de humedales críticas y su importancia en la región, la Convención podrá desempeñar un papel vital para desarrollar tal mercado. Balanceando el monitoreo de la biodiversidad y los objetivos de manejo de sitios Ramsar con esta nuevo financiacion plantea retos considerables. Identificar sitios donde estos usos distintos sean compatibles socialmente y ecológicamente con los objetivos de la Convención podrá impulsar a los decisores globales a adoptar un enfoque más estructurado al financiamiento de carbono azul y la conservación de los humedales costeros.

Keywords: Ramsar, coastal wetlands, blue carbon, management

USING UNDERWATER LASER AND VIDEO TECHNIQUES TO MONITOR NASSAU GROUPER SPAWNING AGGREGATIONS (SPAGS) IN BELIZE

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Nassau Grouper (Epinephelus striatus) inhabits mainly the outer reef crest and is rarely seen in shallow water. This species can grow up to a 100 cm and can weigh more than 22.75kg. These groupers are harvested within Belize's coastal waters due to their high value in both recreational and commercial fisheries. In Belize, extraction of this species is controlled through regulations that restrict harvest size between 51 to 76 cm and a closed season from December 1st to March 31st. Belize enacted further conservation for this critically endangered species through the designation of thirteen fully protected Spawning Aggregation (SPAG) sites, seven of which are for Nassau groupers. Mauger Caye, the northernmost point in the Turneffe Atoll Marine Reserve (TAMR) is one of the few remaining active

Nassau grouper SPAGS. This site has been monitored annually since 2013 using visual surveys to estimate abundance and observe spawning behavior. In 2017, laser sizing using a video-based system was introduced to determine fish size. Laser sizing techniques have been shown to provide more accurate readings than visual estimates. Fish abundance at the SPAG site ranged from 390 in 2013 to 497 in 2015. Preliminary results for 2019 show abundance of 114, which is a marked decrease in numbers. The mean size of fish recorded at the SPAG sites was 67.4 cm (n=124), indicating that fish aggregating at the site were sexually mature. This combined approach of visual surveys and laser sizing is a very effective tool for monitoring these highly variable sites. Five years of data show that while the fish aggregating are sexually mature, their numbers show a concerning decline despite management measures in place.

Keywords: Nassau grouper, SPAGs, laser sizing, Turneffe, critically endangered

PLASTIC SINKS OR SOURCES: CHARACTERIZING CYCLING OF PLASTIC ON MANGROVE SHORELINES IN BISCAYNE BAY, FL (**Student**)

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The invention and subsequent mass production of plastic has left massive amounts of plastic in our oceans as 'marine debris'. Meanwhile, debris continues to wash up in coastal ecosystems. Some of the debris remains on the surface, and in estuaries and mangrove swamps, plastics are also buried in sediments. Over time, these plastics degrade into their insidious, microscopic form known as microplastics (considered <5mm in size). A growing body of literature has been dedicated to the study of how microplastics fragment and are transported throughout the marine environment, but fluxes of plastic debris in and out of estuarine sediments are less understood. The uncertainty regarding this issue highlights the lack of long-term data on marine debris in mangrove forests and prevents land managers from effectively addressing plastic pollution. To understand the mechanisms for debris retention in mangrove forests of Biscayne Bay, surficial meso- (5mm-2.5cm) and macroplastics (>2.5cm) and vegetation will be surveyed along transects perpendicular to shore. Debris will be counted by size class and type. I expect smaller plastics to be found further inland compared to larger plastics that become entangled in the prop roots of fringe mangroves. For analysis of buried plastic, fragments will be extracted via flotation to separate particles of different densities from aged soil cores. A subsample of fragments will be characterized with spectroscopy and analyzed for degrees of degradation. The depth and condition of buried plastics will be a proxy for time since burial based on the local sediment deposition rate. It is expected that larger, newer fragments will be near the surface versus smaller, older fragments buried deeper in the soil profile over time. Finally, collaboration with other local researchers and volunteer clean-up groups to develop standardized data collection methods will facilitate long-term datasets on the deposition of marine debris in the mangroves.

La invención y la posterior producción masiva de plástico han dejado grandes cantidades de plástico en nuestros océanos como "desechos marinos". Mientras tanto, los desechos continúan lavándose en los ecosistemas costeros. Algunos de los escombros permanecen en la superficie, y en los estuarios y manglares, los plásticos también están enterrados en los sedimentos. Con el tiempo, estos plásticos se degradan en su forma insidiosa y microscópica conocida como microplásticos (considerados de tamaño de < 5mm). Un cuerpo creciente de la literatura se ha dedicado al estudio de cómo los microplásticos fragmentan y se transportan a través del ambiente marino, pero los flujos de los desechos plásticos dentro y fuera de los sedimentos estuarinos son menos entendidos. La incertidumbre con respecto a esta cuestión subraya la falta de datos a largo plazo sobre los desechos marinos en los bosques de manglar y evita que los gestores de tierras aborden eficazmente la contaminación plástica. Comprender los mecanismos de retención de escombros en los bosques de manglares de la Bahía Vizcaína, meso (5mm-2,5 cm) y macroplásticos (> 2,5 cm) y vegetación se encuestará a lo largo de transectos perpendiculares a la orilla. Los desechos se contarán por clase y tipo de tamaño. Espero que los plásticos más pequeños se encuentren más en el interior en comparación con los plásticos más grandes que se enredan en las raíces de los manglares marginales. Para el análisis de plástico enterrado, los fragmentos se extraerán a través de flotación para separar partículas de diferentes densidades de núcleos de suelo envejecidos. Una submuestra de fragmentos se caracterizará con espectroscopía y analizada para grados de degradación. La profundidad y la condición de los plásticos enterrados será un proxy para el tiempo desde el entierro basado en la tasa de deposición de sedimentos local. Se espera que los fragmentos más grandes y más nuevos estén cerca de la superficie versus fragmentos más pequeños y más viejos enterrados más profundamente en el perfil del suelo con el tiempo. Finalmente, la colaboración con otros investigadores locales y grupos de limpieza voluntarios para desarrollar métodos estandarizados de recolección de datos facilitará los datasets a largo plazo sobre la deposición de desechos marinos en los manglares.

Keywords: Marine debris, plastic, mangrove, sediment, citizen science, Biscayne Bay

USAID'S HISTORICAL SUPPORT FOR MARINE PROTECTED AREAS IN THE REGION AND COMMON CHALLENGES

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The Samaná Bay area is a main fishing hotspot in the Dominican Republic most famously known for its shrimp catch. To reduce impacts from the intensive shrimp harvesting in Samaná, USAID has been working with the San Lorenzo Fishing Cooperative on a pilot activity testing low impact shrimp fishing gear known as the *suripera net*. After much testing and tinkering, this fishing community is convinced that the instrument can catch bigger live shrimp with little to no by catch. However, the lack of fisheries governance in Samaná Bay has allowed others to continue to use more destructive, sometimes illegal

fishing gear, such as the *licuadora* (trawl nets) Samaná Bay currently represents a classic "tragedy of the commons" situation, despite all the efforts to mitigate this. Whether it's whale watching, shrimp fishing, coral reefs, mangroves, and nearby hillsides, the area's natural resources are, for the most part, being over utilized and mismanaged, for short term economic gain. In the last year, fishers report a significant lower catch of most marine species fished in the bay indicating the depletion of the resource.

La Bahía de Samaná es uno de los puntos de mayor actividad de pesca en el país proporcionando su captura para el consumo nacional, más conocido por su captura de camarón. Entre otras actividades, a través del Programa Caribeño para la Conservación de la Biodiversidad Marina (CMBP, por sus siglas en inglés), USAID ha estado trabajando con la Cooperativa de pescadores de la Bahía de San Lorenzo en una actividad piloto probando equipos sostenibles para la pesca de camarón. Después de mucho probar y manipular el nuevo equipo, esta comunidad de pescadores está convencida de que el instrumento puede capturar camarones vivos más grandes, además de una captura incidental de mejor calidad. Sin embargo, la falta de gobernabilidad en la Bahía de Samaná permite que otros no incluidos en nuestro programa piloto utilicen tecnologías más destructivas e incluso ilegales. La Bahía de Samana representa actualmente una situación clásica de "tragedia de los bienes comunes", a pesar de todos los esfuerzos para mitigar esto. Ya sea que se trate de ballenas, camarones, arrecifes de coral, manglares y/o pastos marinos cercanas, la mayoría de los recursos naturales están siendo sobre utilizados y mal manejados, para obtener ganancias económicas a corto plazo. En el último año, los pescadores informaron una captura significativamente menor de la mayoría de las especies marinas que se pesca en la bahía, lo que indica el agotamiento del recurso.

Keywords: Biodiversity, human pressures, fisheries, marine health, conservation and protection, area governance

CIENCIA, EDUCACIÓN Y DIVULGACIÓN PARA EL DESARROLLO SOSTENIBLE…55 AÑOS DE EXPERIENCIA EN EL ACUARIO NACIONAL DE CUBA

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Scientific research, dissemination and Environmental Education in terms of sustainable development are fundamental missions of the National Aquarium of Cuba. Framing in a complex system of objectives that ranges from the instruction and education that the visitor receives in his tour of the institution, to the research work outside the local limits of the center.
Given that the prioritized lines of institutional work are marine biological diversity, Ecology, Aquariology, management of organisms and Environmental Education, the present work aims to publicize the main results of the scientific and educational work of the National Aquarium of Cuba for more of five decades that have allowed us to generalize the experience achieved.

Las investigaciones científicas, la divulgación y la Educación Ambiental en función del desarrollo sostenible constituyen misiones fundamentales del Acuario Nacional de Cuba. Enmarcándose en un complejo sistema de objetivos que abarca desde la instrucción y educación que recibe el visitante en su recorrido por la institución, hasta los trabajos de investigaciones fuera de los límites locales del centro. Teniendo que las líneas priorizadas del trabajo institucional son la diversidad biológica marina, la Ecología, la Acuariología, manejo de organismos y Educación Ambiental el presente trabajo tiene como objetivo dar a conocer los principales resultados del trabajo científico y educativo del Acuario Nacional de Cuba por más de cinco décadas que nos han permitido generalizar la experiencia alcanzada.

Keywords: ciencia, educación, desarrollo sostenible, Cuba

FINANCIAL MECHANISM FOR THE CONSERVATION OF CORAL REEFS IN THE DOMINICAN REPUBLIC

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Financial mechanisms have become an innovative and attractive option to promote that beneficiaries of ecosystem services, contribute with a payment, compensation and/ or contract, for the use of them. With these resources, actions can be developed for the protection and restoration of ecosystems. This triangular project aims to conserve coral reefs through the implementation of a financial mechanism for environmental conservation. The German government provides support through the Federal Ministry of Economic Cooperation and Development (BMZ). Based on the exchange of experiences, knowledge sharing and technical assistance by State actors, as well as by the Costa Rican civil society jointly with the German cooperation, the objective is pursued through the following lines of action:

• Identification and valuation of ecosystem services and awareness rising to the private sector: The ecosystem services of coral reefs are identified, and their value is defined. Based on this information, a communication strategy is developed and implemented in order to convince beneficiaries, especially the private sector, to invest in a financial mechanism for the conservation of these services. Costa Rica contributes with its experience in the valuation of ecosystem services carried out in protected coastal areas of the country and advises the process in the Dominican Republic.

• Organizational development of financial mechanism management: Supported by Costa Rican experts, the management structure of the financial mechanism in the Dominican Republic is developed for the conservation of coral reefs and the identification of the ecosystem services.

• Pilot Projects: Projects are being developed to pilot the financial mechanism in *Bayahibe, Punta Cana* and *Samaná, in* the Dominican Republic. In each locality, the ecosystem services of its coral reefs are analyzed and a catalogue of measures for their conservation will be created.

Los mecanismos financieros se han convertido en una opción innovadora y atractiva para promover que beneficiarios de servicios ecosistémicos, contribuyan con un pago, compensación y/o contrato, por el uso de ellos. Con estos recursos se desarrollan acciones para la protección o restauración de estos ecosistemas. Este proyecto triangular tiene como objetivo la conservación de los arrecifes de coral a través de la implementación de un mecanismo financiero de conservación ambiental. El gobierno alemán brinda apoyo a través del Ministerio Federal de Cooperación Económica y Desarrollo (BMZ). A partir del intercambio de experiencias (Knowledge Sharing) y asesoría técnica de actores estatales, así como de la sociedad civil de Costa Rica junto a la Cooperación Alemana, se busca lograr el objetivo mediante las siguientes líneas de acción:

• Identificación y valoración de los servicios ecosistémicos y sensibilización del sector privado: Se identifican los servicios ecosistémicos de los arrecifes y se define su valor. Con base en esta información se desarrolla e implementa una estrategia de comunicación con el fin de convencer a los beneficiarios, sobre todo del sector privado, que inviertan en un mecanismo financiero para la conservación de estos servicios. Costa Rica aporta su experiencia en valoración de servicios ecosistémicos realizada en áreas marino costeras protegidas del país y asesora el proceso en República Dominicana.

• Desarrollo organizacional de los gestores del mecanismo financiero: Con ayuda de expertos de Costa Rica, se desarrolla la estructura de gestión del mecanismo financiero en República Dominicana para la conservación de los arrecifes de coral y la identificación de los servicios ecosistémicos.

• Proyectos piloto: Se desarrollan proyectos para pilotear el mecanismo financiero en Bayahibe, Punta Cana y Samaná, en la República Dominicana. En cada sitio se hace el análisis de los servicios ecosistémicos de sus arrecifes y se crea un catálogo de medidas para su conservación.

Keywords: Public Private Partnerships, financial mechanisms, ecosystem services, triangular cooperation, ecosystem valuation

ALLIANCES OF CITIZEN SCIENCE BASED ON THE COMMUNITY: AN EFFICIENT STRATEGY FOR THE MANAGEMENT AND CONSERVATION OF COASTAL RESOURCES.

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Tropical coastal resources have shown signs of degradation and a declining ability to naturally recover from disturbance. Multiple human factors, including the increasing demand and misuse of natural resources, have contributed to this trend. In September 2017, after two category five Hurricanes (Irma and María) caused unprecedented destruction of coral reefs surrounding Culebra Island, Puerto Rico. The result: extensive coral fragmentation, colony dislodgement, and in the decimation of shallow coral reef grounds. Community-based Coral Aquaculture and Reef Rehabilitation Program led by Non-

Governmental Organization Sociedad Ambiente Marino (SAM), has been a critical tool in Culebra Island to support the ecological recovery of formerly bombarded grounds during historical military training. As a result, a substantial increase in socio-economic benefits associated to nature-based tourism in Culebra due to the dramatic increase in visitors and water recreationists to restored coral reef sites, which has largely contributed to increase coastal resilience, the local fragile economy and community livelihoods. Sharing scientific information with base communities empower citizens with the necessary hands on knowledge to support a variety of management strategies, including coral farming, reef restoration, wetland and coastal reforestation; contributing to restore ecosystems functions and resilience through ecosystem-based, sustainable, participatory management strategies. SAM maintains a growing National, Regional and International network of collaborative interagency level support; from Puerto Rico's State and Municipal agencies, as well as Federal institutions, NGOs, Philanthropists and private organizations. It also maintains strong collaborative efforts with the academia, including several Universities. The wide symbiosis of ecological knowledge and social participation through SAM has resulted in over 200 presentations in multiple national and international meetings, generating more than 30 publications in peer-reviewed scientific journals. The concern about declining coastal resources plus the interest, love and passion for the sea shared by volunteer citizens scientist are great sources of motivation to protect their backyards.

Los recursos costeros tropicales han mostrado signos de degradación y una capacidad decreciente para recuperarse naturalmente de las perturbaciones. Múltiples factores humanos, incluyendo la creciente demanda y el mal uso de los recursos naturales, han contribuido a esta tendencia. En septiembre de 2017, después de dos huracanes de categoría cinco (Irma y María) causaron una destrucción sin precedentes de los arrecifes de coral que rodean la isla Culebra, Puerto Rico. El resultado: extensa fragmentación de coral, desalojo de colonias y en la aniquilación de los arrecifes de coral poco profundos. El programa comunitario de acuicultura de coral y rehabilitación de arrecifes, liderado por la Organización no gubernamental Sociedad Ambiente Marino (SAM), ha sido una herramienta fundamental en la isla de Culebra para apoyar la recuperación ecológica de los terrenos anteriormente bombardeados durante el entrenamiento militar histórico. Como resultado, un aumento sustancial en los beneficios socioeconómicos asociados con el turismo de naturaleza en Culebra debido al aumento dramático en los visitantes y en las actividades recreativas acuáticas a los sitios de arrecifes de coral restaurados, que ha contribuido en gran medida a aumentar la resiliencia costera, la frágil economía local y la calidad de vida de la comunidad. El intercambio de información científica con las comunidades de base capacita a los ciudadanos con el conocimiento manos necesario para apoyar una variedad de estrategias de manejo, incluyendo el cultivo de corales, la restauración de arrecifes, los humedales y la reforestación costera; contribuyendo a restaurar las funciones y la capacidad de recuperación de los ecosistemas a través de estrategias de gestión participativa y sostenible basadas en el ecosistema. SAM mantiene una creciente red nacional, regional e internacional de apoyo colaborativo a nivel interinstitucional; de las agencias estatales y municipales de Puerto Rico, así como de instituciones federales, ONG, filántropos y organizaciones privadas. También mantiene fuertes esfuerzos de colaboración con la academia, incluidas varias Universidades. La amplia simbiosis del conocimiento ecológico y la participación social a través de SAM ha resultado en más de 200 presentaciones en múltiples reuniones nacionales e internacionales, generando más de 30 publicaciones en revistas científicas revisadas por pares. La preocupación por la disminución de los recursos costeros más el interés, el amor y la pasión por el mar que comparten los ciudadanos científicos voluntarios son una gran fuente de motivación para proteger a sus patios traseros.

Keywords: Alliances, Community-Based, Citizens Science, Strategy for Management, Conservation, Coastal Resources

THE BEHAVIOR OF TWO SYMPATRIC CARIBBEAN CLEANER GOBIES (ELACATINUS PROCHILOS AND ELACATINUS EVELYNAE) ON CORAL AND SPONGE SUBSTRATES

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The Caribbean cleaner gobies Elacatinus prochilos and E. evelynae exhibit different livelihoods on corals and sponges. On corals, they live in small groups and engage in fish cleaning activity, whereas on sponges they live in larger groups characterized by dominance hierarchies and feed mainly on sponge-gleaned material. In Barbados, both species can overlap in microhabitat use, prompting questions about co-existence mechanisms for such ecologically similar species. This study dwells into such questions by identifying and quantifying behaviors of co-occurring E. prochilos and E. evelynae on both corals and sponges. Twenty individuals (ten living on corals and ten living on sponges) were selected haphazardly from each species on a shallow Barbadian patch reef in which both microhabitats were closely interspersed and abundant. Each individual was video-recorded over 25 minutes and its behaviors identified and timed. Overall, 34 behaviors were identified and grouped into four broad categories: moving, perching, foraging and interacting. Irrespective of species, sponge-dwellers moved more than coral-dwellers. They also displayed higher foraging rates, possibly to compensate for the higher movement rates. Individuals of both species were capable of cleaning and nibbling on both microhabitats, indicating plasticity in foraging behavior. However, how many individuals engaged in cleaning versus nibbling varied along a continuum. On corals, 90% and 60% of E. evelynae cleaned and nibbled, respectively, and 30% and 60% of E. prochilos cleaned and nibbled, respectively. On sponges, 20% and 90% of E. evelynae cleaned and nibbled, respectively, whereas 10% and 100% of E. prochilos cleaned and nibbled, respectively. Interactions between individuals largely consisted of aggressive behavior, with E. prochilos living on sponges being the most aggressive group. However, we found no evidence that behavioral variability among gobies was density-dependent. This study is the first behavioral comparison between co-occurring E. prochilos and E. evelynae on both coral and sponge substrates.

Keywords: Behavioral comparisons between Elacatinus species on corals and sponges

"EYES ON AND UNDER THE WATER." THE IMPORTANCE OF CITIZEN SCIENCE FOR MARINE RESEARCHERS IN THE FLORIDA KEYS

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As marine ecosystems face ever increasing threats from local and regional sources of pollution, as well as global climate change and ocean acidification, there is an increasing concern that human activities may cause, or exacerbate, episodic marine events. To determine the origin and impact of changes in

the overall health of the marine ecosystem, information about the frequency, distribution, extent, duration, and mechanism of episodic events must be obtained. The key to early detection of these marine events is to utilize individuals from the community who are frequently on the water, typically have a considerable knowledge of the area, and at least a basic understanding of when things are not as they should be. Community-based reporting networks such as Mote Marine Laboratory's Community-based Observations of Coastal Ecosystems and Assessment Network (C-OCEAN), established in 1997, and the Florida Keys BleachWatch Program, established in 2004, provide scientists and resource managers within the Florida Keys National Marine Sanctuary and surrounding areas with a better understanding of the spatial and temporal variability of emerging marine episodic events and whether the causes can be addressed by local management action or if they are due to the broader environmental impacts. After dissemination to the research community and resource managers, observations and relevant data associated to recent events are posted on the project website, utilized in public outreach and provide feedback to volunteers, which in turn promotes continued interest and participation by the community. As with any community-based program, there are difficulties in maintaining the frequency and reliability of reports, but through proper coordination the community can play an important role in detecting and documenting emerging marine events, while also increasing public awareness regarding episodic marine events, and empowering the public to get involved with protecting and preserving the local marine environment.

DOMINICAN REEF NETWORK (RAD), A CORAL REEF CONSERVATION ALLIANCE

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The Dominican Reef Network (RAD) is a coral reef conservation alliance emerged in 2016, after launching the report "State of the Coral Reefs in the Dominican Republic". This report revealed the level of degradation of coral reefs in the country and the need to act in collaboration to ensure the future of this ecosystem. RAD, today with 19 members, play as an example to other countries in the Caribbean, regarding national cooperation for coral reef conservation, management, restoration and monitoring. RAD ensures active participation of the Government, private sector, academia and local communities to define actions to be achieved to ensure the sustainable management of coral reef ecosystems. RAD works in 4 strategic lines: conservation, management, restoration and education. In 2019, RAD launched a nation-wide educational program: "Reef of the Future" in collaboration with CEBSE and The Nature Conservancy. The Reef of the Future program goal is to transfer knowledge to 3,000 students (ages 6 to 18) about the different values of coral reefs for the coastal-marine environment and communities in Dominican Republic, and how, keeping them safe, is key for their livelihood. The program goals are the following: (1) Give the teenagers and professors a space to share sensibility and reflection on harmonious relationship with nature; (2) Make empathy on teenagers with coral reefs and their associated species;

(3) Contribute to the formation of responsible citizens with the environment and help them to contribute to the sustainable development of the Dominican Republic; (4) Build capacity and knowledge among teachers and students about coral reef ecosystems, the benefits they provide to humans and marine species, the threats they are facing and what needs to be done to reduce or eliminate harmful impacts from human activities.

La Red Arrecifal Dominicana (RAD) es una alianza interinstitucional que surge en 2016, tras conocer los resultados del informe “Estado de los Arrecifes de Coral de la República Dominicana" que dio indicios sobre el nivel de degradación de los arrecifes. Desde entonces junto a sus 19 miembros la RAD es un ejemplo para la región Caribe de cooperación multilateral que promueve la participación del Gobierno, el sector privado, la academia y las comunidades en la definición de acciones de conservación que permitan lograr un manejo sostenible de estos importantes ecosistemas. La RAD trabaja en 4 líneas estratégicas: conservación, gestión, restauración y educación. En 2019, RAD lanzó un programa educativo a nivel nacional: "Reef of the Future" en colaboración con CEBSE y The Nature Conservancy. La meta del programa es transferir el conocimiento a 3,000 estudiantes (de 6 a 18 años) sobre los diferentes valores de los arrecifes de coral para el medio ambiente marino y las comunidades en República Dominicana, y cómo protegerlos es clave para su bienestar. Los objetivos del programa son los siguientes: (1) Brindar a los jóvenes y profesores un espacio para compartir la sensibilidad y la reflexión sobre la relación armoniosa con la naturaleza; (2) Hacer empatía entre los estudiantes con los arrecifes de coral y sus especies asociadas; (3) Contribuir a la formación de ciudadanos responsables con el medio ambiente que aporten al desarrollo sostenible de la República Dominicana; (4) Desarrollar la capacidad y el conocimiento entre maestros y estudiantes sobre los ecosistemas de arrecifes de coral, los beneficios que brindan a los seres humanos, las amenazas que enfrentan y lo que debe hacerse para reducir o eliminar los impactos dañinos de las actividades humanas.

Keywords: Cooperation, conservation alliance, coral reef, education, knowledge

Session*: Reef monitoring – AGRRA: Science to Action*

PREDICTING THE SPATIAL DISTRIBUTION OF BENTHIC CORAL COMMUNITIES IN VENEZUELA: A VALUABLE TOOL FOR MANAGEMENT (**Student**)

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The importance of coral reefs for human societies is unequivocal for they provide a series of ecosystem goods and services at local and global scales. Unfortunately, coral reefs are in crisis because they are declining rapidly, particularly in the Caribbean region. Monitoring programs are extremely valuable not only to understand the dynamics of these ecosystems but to make predictions from models capable of foreseeing the distribution of communities that share similar features using descriptive variables related to the natural physical oceanographic environment and human activities (e.g. distance to cities, distance

to harbors, etc). This paper aimed to: (1) classify and identify coral and benthic communities based on specific similarities along the Venezuelan coast, (2) to characterize the physical environment where these communities are located using satellite data, (3) to find out the set of environmental predictors that better explain the occurrence of these communities and (4) to produce a model (i.e., classification tree) that allows to predict the type of coral community expected to be found along the Venezuelan coast and Island territories. We found a total of 10 coral ecosystem "types" in Venezuela. The spatial distribution of these ecosystems was explained with a 90% precision by: (1) sea surface temperature, (2) salinity, (3) Chlorophyll A and (4) Remote Reflectance. Our results suggest that upwelling processes have a primary role to determine the spatial distribution of coral communities in Venezuela. We provide the first predictive model for coral communities in Venezuela and this could be a promising management tool for coral reef conservation.

La importancia de los arrecifes de coral es inequívoca dado que ellos proveen a las sociedades humanas una serie de bienes y servicios ecosistemicos a escala local y global. Desafortunadamente los arrecifes de coral están en crisis, dado que están presentado un declive acelerado, en especial en la región del Caribe. Los programas de seguimiento son extremadamente importantes no solo para entender la dinámica de estos ecosistemas sino para generar modelos predictivos que permitan pronosticar la distribución de comunidades con características similares utilizando variables predictivas relacionadas con el ambiente oceanográfico natural y con actividades humanas (e.g. distancia a ciudades y a puertos). Este trabajo tuvo por objetivo: (1) clasificar e identificar comunidades bentónicas y coralinas con características similares a lo largo de la costa Venezolana, (2) caracterizar el ambiente físico donde estas comunidades se encuentran utilizando datos satelitales, (3) encontrar el grupo de variables ambientales que mejor explican esta distribución y (4) producir un modelo predictivo (i.e., árbol de regresión) que permita pronosticar el tipo de comunidad coralina esperada en Venezuela. Encontramos un total de 10 comunidades coralinas "tipo" en Venezuela. La distribución espacial de estos ecosistemas fue explicada con un 90% de precisión por cuatro variables: (1) temperatura superficial del océano, (2) salinidad, (3) Clorofila A y (4) reflectancia remota. Nuestros resultados sugieren que los procesos asociados a la surgencia costera tienen un papel central en la distribución espacial de las comunidades coralinas en Venezuela. Proveemos el primer modelo predictivo de las comunidades coralinas en Venezuela y esto puede ser una herramienta de manejo prometedora para la conservación de estos ecosistemas.

Keywords: coral community, predictive model, spatial distribution

CORAL REEF FISH COMMUNITIES ASSESSMENT AT MORROCOY NATIONAL PARK AND CUARE WILDLIFE REFUGE, VENEZUELA

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There are several protected marine areas in Venezuela; nevertheless, in practice these areas have few restrictions on resource use and access to human populations. Morrocoy National Park (MNP) and Cuare Wildlife Refuge (CWR) are coastal marine protected areas in northwestern Venezuela. MNP is also one of the main touristic attractions along the Venezuelan coastline. We conducted a rapid fish assessment in MNP and CWR to evaluate fish community status at strata reef with the highest abundance of *Orbicella* spp. Fish community structure was evaluated using a modified Atlantic and Gulf Rapid Reef Assessment (AGRRA) protocol during a week in July 2018 at seven sites in MNP and two sites in CWR. Members of the Pomacentridae, Labridae (Scarinae, parrotfishes) and Haemulidae were the most abundant fishes; however, there were differences in dominance among the other groups, especially in the mainly in Labridae (Labrinae, wrasses), Acanthuridae and Chaetodontidae. The CWR reefs had higher richness (38 species) and density (up to 700 ind. 100m-2) of fishes, in comparison to five sites in the MNP that are popular for visitors (up to 210 ind. $100m^{-2}$) (PERMANOVA, $F = 2.31$, $p = 0.003$). At the same time, there were differences among areas inside MNP (PERMANOVA, pair-wise test, $t < 1.74$, $p < 0.02$). Two sites distant from the coastline had higher values for abundance, diversity and abundance of key fish species (largest parrotfish and commercially important generalized carnivorous snappers, grunts and jacks), and SIMPER analysis showed greater similarities among their reef fish communities. Our results have a similar pattern to those found for the AGRRA coral and benthos indicators in 2018, indicating that anthropogenic activities probably are a major, indirect cause of the differences found among sites in these coastal, coral reef fish communities.

En Venezuela, existen numerosas áreas marinas protegidas, sin embargo, pocas cumplen las restricciones de uso de sus recursos y acceso a las poblaciones humanas. El Parque Nacional Morrocoy (PNM) y El Refugio de Fauna Silvestre Cuare (RFC) son áreas marinas protegidas localizadas en la región nor-oriental de Venezuela pero a su vez son una de las mayores atracciones turísticas de la costa venezolana. Con la finalidad de evaluar el estatus comunitario de los peces arrecifales de PNM y RFC, se realizó una evaluación rápida de peces en la zona del arrecife que presenta mayor densidad de colonias y cobertura viva de *Orbicella* spp. Para ello, utilizamos el protocolo *Atlantic and Gulf Rapid Reef Assessment* (AGRRA) en siete sitios del PNM y en dos sitios del CWR durante una semana en Julio de 2018. En todos los sitios, las familias más abundantes fueron las Pomacentridae, Labridae (Scarinae, peces loro) y Haemulidae, aunque se encontraron diferencias en la dominancia entre los otros grupos de peces, principalmente en los Labridae (Labrinae), Acanthuridae y Chaetodontidae. Entre el PNM y el RFC se encontraron diferencias en la estructura comunitaria (PERMANOVA, pair-wise test, $t < 1.74$, $p < 0.02$), donde los arrecifes de RFC presentaron la mayor riqueza (38 especies) y la mayor densidad de peces (hasta 700 ind. 100 m-2) mientras que cinco sitios de los más populares por visitantes dentro del

PNM mostraron baja riqueza (19 – 30 especies) y densidad de peces (hasta 210 ind . $100m^{-2}$). A su vez, hubo diferencias entre sitios dentro del PNM (PERMANOVA, pair-wise test, $t < 1.74$, $p < 0.02$), donde dos de los sitios estudiados y más alejados de la costa presentaron mayores valores de los principales indicadores evaluados: abundancia, diversidad y abundancia de especies claves (grandes peces loros y carnívoros generalizados comercialmente importantes, tales como pargos, meros y jureles). Similitudes entre las comunidades de dichos arrecifes fueron mostradas por medio un análisis SIMPER. Estos resultados tienen patrones similares a los indicadores de salud de los corales y organismos bentónicos reportados, lo cual probablemente indica que las actividades antropogénicas son las causas principales en la diferenciación de las comunidades arrecifales del PNM y el RFC.

Key words: reef fishes, AGRRA, marine protected area, Venezuela.AGRRA: SYNERGISM WITH

THE CARIBBEAN MARINE BIODIVERSITY PROGRAM

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The USAID-funded Caribbean Marine Biodiversity Program (CMBP), implemented by The Nature Conservancy and a consortium of local NGOs (CCAM, FoProBiM, CEBSE, SusGren), is aimed at creating and effectively managing marine conserved areas while establishing and promoting sustainable fisheries. In 2015, AGRRA partnered with CMBP to collect ecological (benthos, fish, coral) data at 10-12 sites associated with each of its high-priority locations in Jamaica, Haiti, Dominican Republic, St. Vincent and the Grenadines, and Grenada. A Reef Condition Index was developed to summarize important ecological information that can be relatively easily collected by non-specialists and understood by policy makers. Coral reef scorecards were then generated by TNC for each seascape in 2018, and shared with local governments and other resource managers, further informing adaptive management responses (e.g., placement of restricted fishing zones in NE Haiti's new Three Bays Protected Area). We provided training in reef ecology and survey techniques between 2016 and 2017 to wardens, fisheries officers, NGO employees, university students and dive industry personnel in a total of eight nations. Repeat surveys of the benthos and fish were conducted at 9-12 sites for each of the five areas in 2019. The resulting, short-term (2.5-3 year) follow-up reports are aiding CMBP's efforts to understand the efficacy of programme interventions on the condition of key, high-biodiversity reef seascapes and to recommend actions for further improvement of their respective marine resources.

Keywords: Caribbean, reef condition summaries, adaptive management responses

ON THE IMPORTANCE OF SPATIAL SCALES ON CORAL ALPHA AND BETA DIVERSITY: A CASE STUDY FROM VENEZUELAN CORAL REEFS (**Student**)

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Estimating the spatial variability across scales is a core tenet of ecological science for it is imperative to understand the processes that shape communities. This paper aims to estimate the variability of benthic and coral community structure at different spatial scales in order to determine which scales explain the greatest variability of α and β-diversity. For this, a fully nested design including locations, reef sites and transects were sampled across the Venezuelan territory. Following a slight modification of the standardized protocol of the GCRMN, four 30m-long transects were placed at each site and 15 photoquadrats were taken for each transect (90x80cm) to determine the structure of the benthic and coral community. The analysis of the photoquadrats was done using PhotoQuad with 25 random points on each square. We found a greater variability in the structure of the benthic and coral community between sites within locality (Pseudo-F = 7.2679, p-value = 0.001, CV = 23.23% and Pseudo-F = 9.98; value = 0.001, CV = 20.27%, respectively). The Canonical Analysis of Principal Coordinates (CAP) showed that latitude (Ccor = 0.73, SqrCcor = 0.53, P = 0.016) and longitude (Ccor = 0.79, SqrCcor = 0.62, P = 0.005) were both good predictors of the benthic and coral community structure in Venezuela. PermDisp analysis showed that largest changes in beta diversity of corals occurred within transects (F = 8.35, df1= 131, df2 = 1067, p = 0.001). Our results suggest that processes operating at spatial scales of hundreds of meter and tens of kilometers instead of larger scale processes might have a critical importance in shaping the benthic and coral community structure in Venezuela. This result highlights the importance of creating management actions adapted to local scales.

Estimar la variabilidad espacial a diferentes escalas es un principio básico de la ecología, ya que es imperativo comprender los procesos que moldean las comunidades. Este estudio tiene como objetivo estimar la variabilidad de la estructura de comunidades bentónicas y coralinas en diferentes escalas espaciales para determinar cuáles explican la mayor variabilidad de la α y β diversidad. Para esto, se realizó un muestreo con un diseño totalmente anidado que incluye localidades, sitios de arrecifes y transectos en todo el territorio venezolano. Siguiendo un protocolo modificado del GCRMN, se colocaron cuatro transectos de 30 m con 15 fotocuadratas (90x80cm) en cada sitio, para determinar la estructura de la comunidad bentónica y coralina. El análisis de las fotocuadratas se realizó con 25 puntos aleatorios en cada una. Encontramos la mayor variabilidad en la estructura de la comunidad bentónica y coralina entre sitios dentro de una misma localidad (Pseudo-F = 7.2679, valor de p = 0.001, CV = 23.23% y Pseudo-F = 9.98; valor = 0.001, CV = 20.27%, respectivamente). El análisis canónico de coordenadas principales mostró que la latitud (Ccor = 0.73, SqrCcor = 0.53, P = 0.016) y la longitud (Ccor = 0.79, SqrCcor = 0.62, P = 0.005) fueron buenos predictores de la estructura de la comunidad béntonica y coralina en Venezuela. El análisis PermDisp mostró que los mayores cambios en la β -diversidad de corales ocurrieron dentro de los transectos (F = 8.35, df1 = 131, df2 = 1067, p = 0.001). Nuestros resultados sugieren que procesos que operan a escalas espaciales de cientos de metros y decenas de

kilómetros podrían tener una importancia crítica en la configuración de la estructura de la comunidad bentónica y coralina en Venezuela. Este resultado destaca la importancia de crear acciones de gestión adaptadas a las escalas locales.

Keywords: diversity, coral communities, spatial scales, beta-diversity, Venezuela

TRANSECTS, QUADRATS OR POINTS: WHAT IS THE BEST COMBINATION TO GET A MORE PRECISE DESCRIPTION OF A CORAL COMMUNITY?

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Large scale monitoring projects establish standardized protocols in order to capture information that can be comparable regardless of the spatial scales, the number of researchers involved, or other factors. Typically, sampling effort is chosen based on power analysis, however this implies reducing multivariate data to a single dimension. Herein we present an assessment of the multivariate precision for a series of coral community surveys conducted in multiple locations of Venezuela between 2017 and 2018. Our results show that the achieved precision using a combination of four 30m-long transects with 15 photoquadrats and 25 sampled points is highly variable among sites. We chose the 12 sites with the highest interquantile range of the multivariate standard error and tested the effect of repeating the sampling using a larger number of transects, quadrats, points per quadrat and their respective combinations. Using a linear regression on box-cox-transformed data, we found that the number of transects is the most important variable to consider to improve multivariate precision for the characterization of a coral assemblage ($b = -1.898$; $t = -23.144$; $p = 2x10\text{-}16$, $R2 = 0.99$). Thus, our results indicate that using a standard number of sampling units is not necessarily the best strategy to design coral reef monitoring programs.

Los proyectos de monitorización a gran escala establecen protocolos estandarizados para poder capturar información que sea comparable sin importar las escalas espaciales, el número de investigadores involucrados, u otros factores. Típicamente el esfuerzo de muestreo es elegido con base en análisis de potencia, sin embargo esto implica reducir los datos multivariados a una sola dimensión. En este trabajo presentamos una evaluación de la precisión multivariada en múltiples localidades de Venezuela entre 2017 y 2018. Nuestros resultados indican que la precisión alcanzada usando una combinación de cuatro transectas de 30m con 15 fotocuadratas y 25 puntos muestreados es altamente variable entre los sitios. Elegimos los 12 sitios con mayor rango intercuantil asociado al error estándar multivariado y probamos el efecto de repetir el muestreo usando un número mayor de transectas, cuadratas, y puntos por cuadrata y sus respectivas combinaciones. Usando una regresión lineal sobre los datos con una transformación Box-Cox, encontramos que el número de transectas es la variable más importante a considerar para mejorar la precisión multivariada durante la caracterización

del ensamblaje coralino (b = -1.898; t = -23.144; p = 2x10-16, R2 = 0.99). Por lo tanto, nuestros resultados indican que usar un número estándar de unidades muestreales no es necesariamente la mejor estrategia para diseñar programas de monitorización en arrecifes coralinos.

Keywords: coral communities, multivariate precision, monitoring programs, sampling effort

Session*: Historical Ecology & Mangrove and Seagrass Ecosystems*

DIFFERENTIAL IMPACTS OF HURRICANE MARIA IN ACROPORA CERVICORNIS THICKETS OFF LA PARGUERA NATURAL RESERVE ACROSS SMALL SPATIAL SCALES (< 3 KM) (**Student**)

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The staghorn coral *Acropora cervicornis* is an important Caribbean foundation species providing structural complexity and essential fish habitats. Given abrupt population declines since the early 1980s due to a variety of stressors and lack of Caribbean-wide recovery, the species is now listed as threatened under the United States Endangered Species Act (ESA). Our study goals were to (1) estimate backreef occupancy of *Acropora cervicornis* in cays off La Parguera Natural Reserve (LPNR) and (2) characterize benthic assemblages within *A cervicornis* thickets. Six backreef areas were mapped in GIS off LPNR, with a total area = 46,357 m^2 and an average backreef occupancy of 14% ± 5%. Point-intercept and band transect methods were used along permanent transects at two backreef areas, Mario (M) (n=10) and San Cristobal (SC) (n=13), to assess spatial and temporal variation in benthic community cover percentage, and damselfish and urchin abundances. Changes in benthic composition between years (2016, 2018) and sites (M, SC) were tested with the PERMANOVA routine, showing that the Year x Site interaction was significant (P = 0.001). A SIMPER analysis was performed to identify benthic categories contributions to temporal dissimilarities. Temporal dissimilarities were lower at SC than in M ($\bar{x}$ 33.11% vs 53.29%), with *A. cervicornis* contributing less to temporal dissimilarities in SC than in M ($\bar{x}$ 10.41% vs. l6.89%). At SC, *A. cervicornis* had a higher live cover in 2018 than in 2016 ($\bar{x}$ 65% ± 10% vs. 50.13% ± 16.76%; P = 0.001), while at M had a lower live cover in 2018 than in 2016 ($\bar{x}$ 11% ± 11% vs. 45.21% ± 22.39%; P = 0.001). Data from CariCOOS SWAN wave energy model is being gathered to explore the potential role of cyclone wave energy exposure in *A. cervicornis* thicket development and its implications to coral restoration planning.

El coral cuerno de ciervo (Acropora cervicornis) ha sido una importante especie fundadora en ambientes de lagunas arrecifales, agregando tridimensionalidad a los hábitats esenciales de peces. Sin embargo, esta especie ahora está clasificada como vulnerable según la Ley de Especies en Peligro de Extinción de los Estados Unidos (ESA, por sus siglas en inglés) debido a las reducciones significativas y la falta de recuperación en los arrecifes del Caribe desde fines de los años ochenta. Los principales objetivos de este estudio son (1) estimar la ocupación de las poblaciones silvestres de Acropora en los cayos de la Reserva Natural La Parguera (RNLP) y (2) caracterizar los ensamblajes bénticos dentro de las áreas

de matorral de Acropora. Las áreas de lagunas arrecifales con matorrales de Acropora cervicornis se mapearon con GIS en seis cayos de RNLP (área total = 46,357m^2, ocupación promedio de lagunas arrecifales = 14% ± 5%). Los cayos con mayor ocupación, Mario y San Cristóbal (~ 18% y 20%, respectivamente), fueron seleccionados para establecer transectos de banda permanentes de longitud variable (8 - 57 m). Durante el verano de 2016 y 2018, el porcentaje de cobertura de sustrato se estimó utilizando el método de intercepción de línea. Se observaron abundancias de damiselas y erizos de mar a 1 m a la izquierda de cada transecto (N = 23). Los cambios en la composición bentónica entre años y cayos se probaron con la rutina PERMANOVA. Los resultados sugirieron que los cambios entre años dependían del sitio (Interacción de Año x Sitio P = 0.001). Se realizó un análisis SIMPER para identificar las contribuciones de las categorías de sustratos a las disimilitudes temporales. Las disimilitudes temporales en San Cristóbal fueron 33.11%, con Acropora contribuyendo con 10.41%. Sin embargo, Mario mostró 53.29%, con Acropora contribuyendo con 16.89%. En general, la cobertura de damiselas y algas (turf + macro) mostró una correlación positiva, mientras que los erizos de mar y las algas (macro) mostraron una correlación negativa. Los datos resaltan los impactos diferenciales del huracán María [2017] en escalas espaciales pequeñas (<3 km), posiblemente relacionadas con la exposición a las olas. Se están recopilando datos de energía de olas modelados para respaldar nuestros resultados. Con fines de monitoreo, se debe explorar el papel de la abundancia de damiselas y erizos de mar en la recuperación de Acropora cervicornis.

Keywords: Acropora cervicornis, hurricane impact, coral cover, population recuperation ; Scleractinians, La Parguera Natural Reserve, Hurricane Maria, Acropora cervicornis, Population

ASSESSING INVERTEBRATE HABITAT PREFERENCE IN A SHALLOW TROPICAL COASTAL BAY (**Student**)

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In shallow coastal systems, submerged aquatic vegetation are fundamental contributors to habitat complexity. Biscayne Bay's shallow coastal system is characterized by seagrasses and red macroalgal mats, which are the dominant habitats available for invertebrate epifauna. The structural complexity of seagrasses differs from macroalgae: while seagrasses have flat vertical form, macroalgae can form three-dimensional architecture. Previous studies suggest a combination of macrophyte architecture and environmental factors dictate epifaunal habitat preference. This research tests if habitat preference among epifauna between benthic seagrass and red macroalgal mats exists in a shallow coastal area in Biscayne Bay. Macroalgal mats and benthic seagrass were collected in five replicates from Deering Estate in October and December 2017 and March 2018. Results showed that total epifaunal abundances were higher in red macroalgal habitat (X = 304.90, 324.09) than seagrass (X = 42.44, 23.90) ($p < 0.001$). Species richness was also higher in red algal mats (X = 6.05, 1.39) than benthic seagrass (X = 4.55, 1.15) ($p < 0.001$). However, preference of habitat was taxa specific with some species selecting for

seagrass and other for red algal mats (X2 = 8271.2, p < 0.001). Polychaetes showed clear habitat preference, while s isopods and tanaids had preference only in a particular site. Other, rarer taxa such as caridean shrimp and starfish, showed no habitat preference. While habitat preference may occur among invertebrate epifauna between macrophyte types, other factors associated with seasonality or small-scale environmental variability can also influence epifaunal distribution. The variability in habitat preference shown by invertebrate epifauna demonstrates that both seagrasses and macroalgae are important contributors to maintaining invertebrate diversity within the coastal community.

Keywords: Red macroalgae, seagrass, epifauna, habitat preferences, community ecology

SYRINGODIUM FILIFORME SEAGRASS REPRODUCTIVE SEASONALITY IN A TROPICAL CARIBBEAN REEF LAGOON

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Seagrass meadows are a key ecosystem in the Caribbean. Seagrass monitoring efforts have been developed on the Caribbean coast of Costa Rica since the mid-1990's, with the Caribbean Coastal Marine Productivity Program (CARICOMP) site for seagrass monitoring at Cahuita National Park, on the southern Caribbean coast. Many studies have been carried out at this location, mainly focused on the dominant seagrass species Thalassia testudinum, including its sexual reproductive seasonality. Sexual reproduction in seagrasses is synchronized to maximize pollination due to limited pollen dispersal and to minimize pollen wastage or flower herbivory. This synchronization in sexual reproduction is driven by environmental cues. Here, the reproductive state and frequency, and shoot length for Syringodium filiforme were measured non-destructively at 1- 4 month intervals between May 2010 and May 2012 at Cahuita National Park. Water turbidity, temperature and salinity were measured in situ. The seasonal reproductive period for S. filiforme at this location occurred between February and May. In contrast, seagrass shoot length did not vary within the sampling period. The reproductive peak of S. filiforme coincided with the known seasonal reproductive period for this species in the Caribbean and with the reproductive period of T. testudinum at this site. The reproductive period coincided with the first of two dry seasons at the study site, when solar radiation, hours of sunlight, and temperature are highest and precipitation, runoff and tidal range are lowest. More detailed studies on pollination, dispersal mechanisms, and genetic diversity are now warranted to further understand the sexual reproduction mechanisms of this seagrass species.

Las praderas de pastos marinos son un ecosistema clave en el Caribe. Esfuerzos de monitoreo de pastos marinos se han desarrollado en la costa Caribe de Costa Rica desde mediados de la década de 1990, con el sitio de monitoreo de pastos marinos del Caribbean Coastal Marine Productivity Program (CARICOMP) en el Parque Nacional Cahuita, en la zona del Caribe sur. Muchos estudios se han llevado

a cabo en este sitio, principalmente enfocados en la especie de pasto marino dominante Thalassia testudinum, incluyendo la estacionalidad en su reproducción sexual. La reproducción sexual en pastos marinos está sincronizada para maximizar la polinización debido a una dispersión de polen limitada y para minimizar el desperdicio de polen o la herbivoría de flores. Esta sincronización en reproducción sexual está influenciada por condiciones ambientales. Aquí, el estado reproductivo y frecuencia, y la longitud del haz de Syringodium filiforme se midieron no destructivamente en intervalos de 1-4 meses entre mayo 2010 y mayo 2012 en el Parque Nacional Cahuita. La turbidez del agua, temperatura y salinidad se midieron in situ. El período reproductivo estacional para S. filiforme en este sitio ocurrió entre febrero y mayo. En contraste, la longitud del haz no varió durante el período de muestreo. El pico reproductivo de S. filiforme coincidió con el período reproductivo estacional para esta especie en el Caribe y con el período reproductivo de T. testudinum en este sitio. El período reproductivo coincidió con la primera de dos temporadas secas en el sitio de estudio, cuando la radiación solar, horas de luz y temperatura son las más altas y la precipitación, escorrentía y rango de marea son menores. Estudios más detallados sobre polinización, mecanismos de dispersión y diversidad genética son ahora necesitados para entender mejor los mecanismos de reproducción sexual de esta especie de pasto marino.

Keywords: Phenology, flowers, seeds, dispersal mechanisms, sexual reproduction

PRELIMINARY EVALUATION OF THE SEAGRASS BEDS OF LAS TERRENAS (SAMANÁ PROVINCE) AND EL MORRO NATIONAL PARK (MONTECRISTI PROVINCE), DOMINICAN REPUBLIC (**Student**)

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In order to evaluate the current status of the seagrass beds in the Dominican Republic, assessments were carried out in 2 locations on the Atlantic coast of the country, as the initial phase of this process: Las Terrenas, Samaná province and El Morro National Park, Montecristi province. Three-four sites were chosen at random in each locality and the “Protocol for Monitoring Seagrasses in Coastal Dominican Areas”, elaborated by MARENA in the framework of the BCyT Project, was used for the data collection. Three 50 m transects were established parallel to the coast and 10 quadrats of 1 m2 were placed in each transect, in which data on shoot density, relative cover (%), average height, epiphytes, present morpho-functional macroalgae groups and associated fauna were registered in situ. It was found that the seagrasses of Las Terrenas are build up of the species Thalassia testudinum (average cover of 48.51%), Syringodium filiforme (11.97%), Halodule wrightii (0.15%) and Halophila decipiens (0.001%); while in El Morro National Park they are constituted by the species T. testudinum (62.11%) and S. filiforme (0.06%). A higher shoot density and average height were recorded in Las Terrenas. Fruits of T. testudinum were found in both locations, yet flowers were only observed in Las Terrenas. In both El Morro National Park and Las Terrenas, the most abundant morpho-functional macroalgae group was calcareous algae, mostly

represented by the genus Halimeda; followed by the fibrous group, represented mainly by algae of the genera Udotea and Penicillus. Fish, echinoderms, crustaceans, mollusks, cnidarians and sponges were present in both sites, with the particularity that the presence of annelids was recorded only in Las Terrenas. These data are not statistically representative for the seagrasses of Montecristi and Samaná; however, they will be taken as a baseline to detect changes in the future through periodic monitoring.

Con el propósito de conocer el estado actual de las praderas de fanerógamas marinas en la República Dominicana, se realizaron evaluaciones en 2 localidades de la costa Atlántica del país como fase inicial de este proceso: Las Terrenas, provincia Samaná y el Parque Nacional El Morro, provincia Montecristi. Para la colecta de datos, se eligieron 3-4 estaciones al azar en cada localidad y se utilizó el "Protocolo para el Monitoreo de Praderas Marinas en Áreas Costeras Dominicanas", elaborado por MARENA en el marco del Proyecto BCyT. Se establecieron tres transectos de 50 m paralelos a la costa, en los que se colocaron 10 cuadrantes de 1 m2; se tomaron datos in situ de la densidad de vástagos, cobertura relativa (%), altura promedio, epífitos, grupos morfo-funcionales de macroalgas presentes y fauna asociada. Se encontró que las praderas marinas de Las Terrenas están conformadas por las especies Thalassia testudinum (cobertura promedio de 48.51%), Syringodium filiforme (11.97%), Halodule wrightii (0.15%) y Halophila decipiens (0.001%), mientras que en el Parque Nacional El Morro están constituidas por las especies T. testudinum (62.11%) y S. filiforme (0.06%). Se registró una mayor densidad de vástagos y altura promedio en Las Terrenas. En ambas localidades se encontraron frutos de T. testudinum, pero sólo en Las Terrenas se observaron algunas con presencia de flores. Tanto en Parque Nacional El Morro como en Las Terrenas, las macroalgas más abundantes fueron las calcáreas, mayormente representadas por el género Halimeda; seguido por el grupo de las fibrosas, representado mayormente por algas de los géneros Udotea y Penicillus. En ambos sitios se reportó la presencia de peces, equinodermos, crustáceos, moluscos, cnidarios y poríferos, con la particularidad de que en Las Terrenas se registró la presencia de anélidos. Estos datos no son estadísticamente representativos para las praderas marinas de Montecristi y Samaná; sin embargo, servirán como línea base para detectar cambios en el futuro a través de monitoreos periódicos.

Keywords: Seagrasses, monitoring, coverage, shoot density

POPULATION STATUS OF THE LONG-SPINED SEA URCHIN DIADEMA ANTILLARUM PHILIPPI IN LA PARGUERA, PUERTO RICO, 30 YEARS AFTER THE MASS MORTALITY

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The historical demise of Caribbean populations of the long-spined, black sea urchin Diadema antillarum Philippi in the early 1980's has been well documented. The disease-induced mass mortality of this keystone herbivore helped the phase shift of many Caribbean reefs from coral-dominated to algal-dominated communities. The last detailed study to assess population recovery in La Parguera, Puerto

Rico was completed in 2001, when results indicated slow to modest recovery, albeit densities remained far below pre-mass mortality levels. The present study provides an updated status of the recovery and population size structure of D. antillarum in the same localities surveyed and using the same methods. Population densities and size structure were examined along three depth habitats (1-5; 6-11; >12m) in the same localities. Habitat complexity and urchin sizes were recorded to assess distribution preferences and population dynamics of the area. No significant differences in population densities between reef zones (inner shelf and mid-shelf) were observed (df=1, Pseudo-F=0.64, p>0.05). Significantly higher densities were found on shallow habitats, compared to intermediate and deep (df=2, Pseudo-F=8.68, p=0.01) indicating a preference for high algae covered habitats. Habitat complexity had the greatest effect on population densities at all levels (site, zone and depth) with more rugose environments containing significantly higher densities and wider size class distributions. Populations were dominated by medium to large (5-8 cm in test diameter) individuals and size-frequency distributions indicated that smaller juveniles were virtually absent. Comparison between survey years revealed that D. antillarum populations have decreased since last estimated and populations are constrained to shallower, more complex and productive habitats, where competition might be occurring. Lack of recovery and low juvenile densities since 2001 possibly indicate recruitment-limited populations due to low recruitment and/or survival of juveniles.

La desaparición histórica principios de la década de 1980 de las poblaciones caribeñas del erizo negro Diadema antillarum Philippi ha sido bien documentada. La desaparición de este importante herbívoro ayudó al cambio de fase arrecifal, de comunidades dominadas por corales a dominadas por algas. El estudio de la recuperación de poblaciónes del erizo en La Reserva Natural de La Parguera (RNLP), Puerto Rico en 2001, indicó una recuperación lenta pero moderada, con densidades muy por debajo de los niveles pre-mortalidad. El presente estudio evalúa las poblaciones en las mismas localidades de 2001, usando los mismos métodos, para comparar resultados y determinar estado de recuperaración luego de 30 años. Las densidades y la estructura de tamaño y la complejidad estructural del hábitat se midieron a lo largo de cinco transectas de banda (10x2m) en cada una de tres profundidades (1-5, 7-11, >12m) en cada localidad. No se observaron diferencias significativas en las densidades promedio de erizos entre las zonas de arrecifes (plataforma interior y plataforma media) (df=1, Pseudo-F=0.64, p>0.05). Se encontraron densidades significativamente mas altas en las áreas someras comparadas con intermedias y profundas (df=2, Pseudo-F=8.68, p=0.01). La complejidad del hábitat tuvo el mayor efecto en las densidades en todos los niveles (sitio, zona y profundidad), con densidades significativamente más altas en habitats mas complejos. Las poblaciones estaban dominadas por individuos medianos y grandes (5-8 cm de diámetro), y las distribuciones de frecuencia de tamaño muestra que los juveniles más pequeños estaban prácticamente ausentes. Esto indica que las poblaciones parecen estar limitadas por el bajo reclutamiento y/o sobrevivencia de juveniles. En general, las densidades poblacionales han disminuido un poco en comparación con el 2001, posiblemente por competencia y migración a otras áreas, lo cual sugiere que va a tomar mucho mas tiempo para las densidades alcancen las densidades de pre-mortalidad.

Keywords: Diadema antillarum, mass mortality, population recovery status, Puerto Rico

Session*: Novel Techniques in Remote Sensing and Reef Science*

HYPERSPECTRAL CHARACTERIZATION OF CORAL REEF-FORMING SPECIES OF COZUMEL ISLAND, MEXICO

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The monitoring of coral reefs requires the use of novel techniques to assess colony condition in a fast, non-destructive manner. In here, we use the spectral signatures of reef-forming corals to explore for differences related to the species identity, colony size, and depth. SCUBA diving was used to characterize the spectral signatures of *Montastrea cavernosa, Orbicella faveolata, Orbicella annularis* and *Siderastrea siderea* colonies in three reefs of the Cozumel Reefs National Park. A GER 1500 spectroradiometer with underwater housing and LED lights was utilized. Measurements were calibrated with a Spectralon reflectance panel. The mean and standard deviation of the reflectance for each of the colonies was calculated. Considering the spectral range from 430 nm to 700 nm, it was observed that the reflectance obtained in colonies of the species *M. cavernosa, O. faveolata* and *O. annularis* exhibit a triple-peaked pattern in the 579 nm, 605 nm and 650 nm. In the case of the *S. siderea*, the reflectance generally had a maximum plateau between 600 nm and 650 nm. Preliminary analysis shows that *S. siderea* shows significant differences ($p<0.05$) with the other species. Furthermore, it seems that there are significant differences in the reflectance between the colonies of each species, per sampling site. It was also found that the spectral behavior of the species in the three depths does not show significant differences. The species *S. siderea* presents a spectral behavior different from the other species, exhibiting a "blue" spectral reflectance mode. The species *M. cavernosa*, *O. faveolata* and *O. annularis*, exhibit a "brown" spectral reflectance mode. There is variability in the reflectance between colonies of the same species. Finally, the effect of diameter and height on the spectral response of coral colonies of these species is being explored.

El monitoreo de los arrecifes de coral requiere el uso de nuevas técnicas para evaluar el estado de las colonias de una manera rápida y no destructiva. Aquí, utilizamos las firmas espectrales de los corales formadores de arrecifes para explorar las diferencias relacionadas con la identidad de la especie, el tamaño de la colonia y la profundidad. Mediante buceo SCUBA se caracterizaron las firmas espectrales de las colonias de *Montastrea cavernosa, Orbicella faveolata, Orbicella annularis* y *Siderastrea siderea* en tres arrecifes del Parque Nacional de Arrecifes de Cozumel. Se utilizó un espectrorradiómetro GER 1500 con carcasa subacuática y luces LED. Las mediciones se calibraron con un panel de reflectancia Spectralon. Se calculó la media y la desviación estándar de la reflectancia para cada una de las colonias. Teniendo en cuenta el rango espectral de 430 nm a 700 nm, se observó que la reflectancia obtenida en colonias de la especie *M. cavernosa, O. faveolata* y *O. annularis* exhiben un patrón de triple pico en los 579 nm, 605 nm y 650 nm. En el caso de *S. siderea*, la reflectancia generalmente tuvo una meseta máxima entre 600 nm y 650 nm. El análisis preliminar muestra que *S. siderea* muestra diferencias significativas ($p <0.05$) con las otras especies. Además, parece ser que hay diferencias significativas de la reflectancia entre las colonias de cada especie, por sitio de muestreo. El comportamiento espectral de las especies en las tres profundidades no muestra diferencias significativas. La especie *S. siderea*

presenta un comportamiento espectral diferente a las demás especies, exhibiendo un modo de reflectancia espectral “azul”. Las especies *M. cavernosa, O. faveolata* y *O. annularis*, exhiben un modo de reflectancia espectral “marrón”. Existe variabilidad en la reflectancia entre las colonias de la misma especie. Finalmente, se está explorando el efecto del diámetro y la altura sobre la respuesta espectral de colonias coralinas de estas especies.

Keywords: reflectancia, firma espectral, hermatípico, pigmentos fotosintéticos; reflectance, spectral signature, hermatypic, photosynthetic pigments.

Session*: Climate Change and Other Stressors*

DETOXIFICATION IN HEALTHY CORALS, DISEASE AND ZOOXANTHELLAE DURING AND AFTER STRESS BY TO XENOBIOTICS

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Caribbean Yellow Band Disease (CYBD) compromises detoxification mechanisms in corals. However, little is known about the ability of diseased corals to recover after being exposed to xenobiotics. We aimed to evaluate and compare a series of detoxification responses in healthy and disease corals during and after exposure to Benzo (a) Pyrene (BaP). For this, we conducted a bioassay consisting of three fixed and orthogonal factors: (1) treatment (with and without the xenobiotic), (2) host status (healthy and YBD tissues) and (3) time (during, 2 weeks and 4 weeks after exposure). The activity of CAT, GST, NADPH c-reductase was evaluated in the coral tissues and the zooxanthellae. We found an interaction between treatment, status of the host and time in the activity of each of the enzymes measured in the tissue (CAT: Pseudo-F = 2.9133, df = 4, p = 0.033, GST: Pseudo- F = 2.5638, df = 4, p = 0.04 and NADPH c-reductase: Pseudo-F = 4.1646, df = 4, p = 0.004;). This result indicates that the response to treatment depends on the time and the status of the coral host. In the zooxanthellae, we found an effect in the activity of CAT associated with the status of the host (Pseudo-F = 5.661, df = 4, p = 0.02), being 52% greater in zooxanthellae associated with diseased tissues compared to their healthy counterpart (t = 2.37, df = 4, p = 0.02). Our results show that CYBD increases CAT activity compared to healthy corals. The activity of GST also resulted significant for the second order interaction (GST: Pseudo-F = 2.6443, df = 4, p = 0.044), being 52% lower in zooxanthellae associated to diseased tissue compared to healthy corals. Our results clearly indicate that CYBD compromises mechanism of detoxification and hampers their ability to recovery after xenobiotic exposure.

La enfermedad de banda amarilla del Caribe (CYBD_Siglas en inglés) compromete los mecanismos de detoxificación en los corales. Sin embargo, poco se sabe acerca de la capacidad de los corales enfermos para recuperarse después de haber sido expuestos a xenobióticos. Evaluamos y comparamos una serie de respuestas de detoxificación en corales sanos y con enfermedad durante y después de la exposición a Benzo (a) Pireno (BaP). Para esto, realizamos un bioensayo que constó de tres factores fijos y

ortogonales: (1) tratamiento (con y sin el xenobiótico), (2) estado del hospedero (sanos y YBD) y (3) tiempo (2 semanas y 4 semanas después de la exposición). La actividad de CAT, GST, NADPH c-reductasa se evaluó en los tejidos de coral y las zooxantelas. Encontramos una interacción entre el tratamiento, el estado del hospedero y el tiempo en la actividad de cada una de las enzimas medidas en el tejido (CAT: Pseudo-F = 2.9133, df = 4, p = 0.033, GST: Pseudo-F = 2.5638, df = 4, p = 0.04 y NADPH c-reductasa: Pseudo-F = 4.1646, df = 4, p = 0.004;), Indicando que la respuesta al tratamiento depende del tiempo y el estado del hospedero. En las zooxantelas, encontramos un efecto en la actividad de CAT asociada con el estado del hospedero (Pseudo-F = 5.661, df = 4, p = 0.02), siendo 52% mayor en las zooxantelas asociadas con tejidos enfermos (t = 2,37, df = 4, p = 0,02). Nuestros resultados muestran que CYBD aumenta la actividad de CAT en corales enfermos. La actividad de GST también resultó significativa para la interacción de segundo orden (GST: Pseudo-F = 2.6443, df = 4, p = 0.044), siendo 52% más baja en zooxantelas asociada a tejido enfermo. Nuestros resultados indican claramente que la CYBD compromete el mecanismo de detoxificación y obstaculiza su capacidad de recuperación después de la exposición a xenobióticos.

Keywords: Coral reef, Caribbean Yellow Band Disease, enzymatic activity, detoxification routs, recovery.

VENEZUELAN CORAL REEFS: A HEALTH ASSESSMENT USING THE REEF HEALTH INDEX WITH COMPLEMENTARY VARIABLES

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The implantation and development of new methods aimed to assess the health status of coral reefs is a tenet core for the conservation science of these systems. For years, coral reefs communities have been described in Venezuela; however, no efforts to classify the health status of these systems have been accomplished. Part of the problem is that reefs have being always classified in terms of live coral cover, while other variables clearly linked with healthy reefs have been neglected. In this paper, we aimed to assess the health status of 36 reef sites encompassing seven different geographical locations in Venezuela using a multivariate approach. For this, we used a modification of the Reef Health Index (RHI) proposed by The Nature Conservancy (TNC, 2016). In addition to all variables composing the RHI (i.e., biomass of commercial and forager fish, life coral and macroalgal cover), our index also included rugosity and turf algal height; because these two variables are currently seen as important proxies of reef health. Our results show that most of the reef sites located in five out of the seven locations so far included in the analysis can be classified as “Very Good” and/or “Fair”; being Los Roques National Park (Boca de Cote and La Venada), Morrocoy National Park (Cayo Norte, Cayo del Medio, Cayo Sur and Sombrero) and Ocumare the ones with the highest RHI values. “Fair” sites were most likely located in Chichiriviche and Los Frailes. Only a few sites within Mochima National Park and Cubagua were rated as “Poor” and/or “Critical”. Our results provide evidence supporting that most reefs in Venezuela are above the standards

of many Caribbean countries and offer a valuable tool for managers and policy makers interested to implement future conservation actions in Venezuela.

La implementación y el desarrollo de nuevos métodos destinados a evaluar el estado de salud de los arrecifes de coral es un elemento fundamental para la conservación de estos sistemas. Durante años, las comunidades de arrecifes de coral han sido descritas en Venezuela; sin embargo, no se han realizado esfuerzos para clasificar el estado de salud de estos sistemas. Parte del problema es que los arrecifes se han clasificado siempre en términos de cobertura de coral vivo, mientras que otras variables claramente relacionadas con arrecifes saludables se han descuidado. En este documento, intentamos evaluar el estado de salud de 36 sitios de arrecifes que abarcan siete ubicaciones geográficas diferentes en Venezuela utilizando un enfoque multivariado. Para ello, utilizamos una modificación del Índice de salud de arrecifes (RHI) propuesto por The Nature Conservancy (TNC, 2016). Además de todas las variables que componen el RHI (es decir, la biomasa de peces comerciales y de forraje, y cobertura de coral y macroalgas), nuestro índice también incluyó la rugosidad y la altura del turf; Debido a que estas dos variables se consideran actualmente como importantes indicadores de la salud de los arrecifes. Nuestros resultados muestran que la mayoría de los sitios de arrecifes ubicados en cinco de los siete lugares incluidos hasta ahora en el análisis se pueden clasificar como "Very Good" y / o "Good"; siendo el Parque Nacional Los Roques (Boca de Cote y La Venada), el Parque Nacional Morrocoy (Cayo Norte, Cayo del Medio, Cayo Sur y Sombrero) y Ocumare los que tienen los valores más altos de RHI. Los sitios "Fair" se encentran en Chichiriviche y Los Frailes. Solo unos pocos sitios dentro del Parque Nacional Mochima y Cubagua fueron calificados como “Poor” y / o “Critical”. Nuestros resultados proporcionan evidencia que confirma que la mayoría de los arrecifes en Venezuela están por encima de los estándares de muchos países del Caribe y ofrecen una herramienta valiosa para los administradores y responsables de políticas interesados en implementar futuras acciones de conservación en Venezuela.

Keywords: Venezuela, coral reefs, health index, baseline

LACK OF RECOVERY OF LIFE CORAL COVER IN MORROCOY (VENEZUELA): AN APPLICATION OF 3D BENTHIC MODELS TO UNDERSTAND KEY PROCESSES

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Coral reefs are facing rapid degradation due to local anthropogenic factors and climate change. Reef flattening and the concomitant loss of structural complexity are perhaps amongst the most worrisome problems that jeopardize coral reef resilience. Playa Mero (Morrocoy National Park) is a natural laboratory to study damaged coral reefs. Twenty three years ago a sea temperature anomaly killed about

90% of benthic community. After two decades, this reef has failed to recover its former live coral cover (i.e. 30%) which remains below 5% even though different coral species are recruiting. In this paper we asked why coral cover has not recovered yet by monitoring 3D models of the substrate at a scale of 0.25 m2 through 18 months. We hypothesized that structural complexity, benthic community composition and growth rates may affect abundance, survivorship and recruitment of small corals. We found that the abundance of species of small corals varies in space (ANOSIM = 0.537, p = p<0.05) and time (ANOSIM = 0.387, p = p<0.05). A DistLM showed that rugosity, fleshy algae, Agaricia and sand cover were the most important variables to predict up to 76% of the spatial and temporal variation of small corals. The benthic community changed in space (ANOSIM = 0.214, p = 0.005) showing a cyclic pattern (Relate, Rho = 0.204, p = 0.001) for the study period. Only Agaricids, Colpophyllias and Scolymias were observed to recruit whereas major reef builders were seldom recorded. We conclude that lack of recovery in Playa Mero might be the result of lack of recruitment of large reef builders, rapid mortality of a limited number of species that are recruiting and the cyclic arrival of competitors for space that hamper survival of new individual.

Actualmente los arrecifes de coral se están degradando rápidamente debido a la actividad humana y al cambio climático. La pérdida de complejidad estructural es probablemente uno de los problemas que más afecta la resiliencia de los arrecifes de coral. Playa Mero (Parque Nacional Morrocoy) es un laboratorio natural para estudiar arrecifes que han sufrido daños. Hace veintitrés años una anomalía en la temperatura del agua mató alrededor del 90% de la comunidad bentónica. Luego de dos décadas, este arrecife ha fallado en recuperar su cobertura de coral previo (i.e. 30%) siendo actualmente cercana al 5%, a pesar de que hay especies de coral que están reclutando. Nos preguntamos por qué la cobertura de coral no se ha recuperado aún y se monitorearon sustratos del arrecife a escala de 0.25 m2 durante 18 meses con el uso de modelos tridimensionales. Hipotetizamos que la complejidad estructural, la comunidad bentónica y las tasas de crecimiento afectan la abundancia, supervivencia y reclutamiento de los corales de tallas pequeñas. Encontramos que la abundancia de las especies de corales pequeños varía en el espacio (ANOSIM = 0.537, p = p<0.05) y tiempo (ANOSIM = 0.387, p = p<0.05). Un DistLM mostró que la rugosidad, la cobertura de algas carnosas, agaricia y arena predijeron en un 76% la variación espacial y temporal de los corales pequeños. La comunidad bentónica varió en espacio (ANOSIM = 0.214, p = 0.005) mostrando un patrón cíclico (Relate, Rho = 0.204, p = 0.001) para el período estudiado. Soloagaricias, colpophylias y scolymias reclutaron, mientras que los corales constructores de arrecifes fueron poco observados. Nosotros concluimos que la falta de recuperación puede deberse a la falta de reclutamiento de corales constructores de arrecifes, y la rápida mortalidad del limitado número de especies que reclutan y la llegada cíclica de organismos que compiten por espacio e impiden la supervivencia de los nuevos individuos.

Keywords: reef recovery, photogrammetry, structural complexity, recruitment, survivorship, g

FORAM INDEX AND ITS APPLICABILITY IN CORAL REEF MONITORING IN PUERTO RICO

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Coral reefs at Jobos Bay National Estuaries Research Reserve (JBNERR) have been degraded by anthropogenic inputs. A better understanding of reef health is needed to improve stakeholders' decisions and support proper management actions in the reserve. The FORAM Index (FI) can be used as a tool to determine the water quality at the reefs using foraminifers as bioindicators. Four reefs; Cayo Caribe, Cayo Barcas, Cayo Pajaros and Cayo Morrillo, were sampled along transects in the front and back of each reef. Physicochemical parameters and nutrients were measured through the water column. Normal oligotrophic conditions permeate the reefs at JBNERR with FI values 4 which is indicative of conditions conducive for growth. Of all the reefs, the ones on Cayo Caribe have three stations (1, 6, 9) with FI values between 2 and 4 as indicative of conditions of 鈥渘vironment marginal for reef growth and unsuitable for recovery. Cayo Caribe is the easternmost and largest reef of the study area and is proximal to pharmaceutical and carbon processing plant. The predominance of sand-sized sediments and abraded specimens reflects the active hydrodynamic regime coupled with low foraminiferal density values (<61 individuals/g). The FI values are yielding useful information about the current reef conditions and the index is expected to be incorporated as a rapid and cost-effective biomonitoring tool for JBNERR resource managers.

Los arrecifes coralinos del Jobos Bay National Estuarine Research Reserve (JBNERR) estan siendo degradados por efectos antropicos. Los manejadores de reservas naturales necesitan herramientas adecuadas para poder tomar prontas decisiones en cuanto al entendimiento de la salud de los arrecifes. El FORAM Index (FI) puede ser usado como una herramienta para determinar la calidad del agua asociada a los arrecifes coralinos mediante el uso de foraminiferos benthnicos como bioindicadores. Cayo Cayo Caribe, Cayo Barcas, Cayo Pajaros and Cayo Morrillo, fueron muestreados a lo largo de transectos y en cada estacion se tomaron muestras de agua para nutrientes y sedimentos. En general, las condiciones oligotroficas dominan los arrecifes estudiados lo cual el FI obtuvo valores >4 que es indicativo de condiciones conducentes para crecimiento. En Cayo Caribe solamente tres estaciones (1, 6, 9) obtuvieron valores del FI entre 2 y 4 lo cual indica que las condiciones del ambiente son marginales para el desarrollo de los arrecifes e inadecuadas para restablecimiento. Cayo Caribe es el arrecife mas grande de JBNERR y se encuentra cerca de farmaceuticas y de una planta de procesamiento de carbon. La abundancia de sedimentos arenosos en conjunto con foraminiferos bentonicos fragmentados indica condiciones hidrodinamicas de alta energia el cual se reflejan en una densidad poblacional de foraminiferos bentonicos bien baja (< 61 individuos/g). Los valores del FI proveen informacion vital acerca de las condiciones actuales de los arrecifes coralinos y se espera que este indice ecologico sea incorporado en el plan de monitoreo de JBNERR como un bioindicador costo efectivo y de beneficio para los manejadores de la reserva.

Keywords: Reefs, Foraminifera, Biomonitoring

INCIDENCE OF CONGENITAL MALFORMATIONS IN EMBRYOS OF GREEN SEA TURTLE (CHELONIA MYDAS) DURING 19 YEARS AT TORTUGUERO, COSTA RICA

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Sea Turtle Conservancy, Tortuguero, Costa Rica

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The occurrence of malformations, anomalies and asymmetries in vertebrates is indicative of instability during embryonic development, and may be related to the environment and or genetic factors. These events are rare and can cause a negative impact on the fitness of the animal. The present study aims to increase the little information available on this subject in sea turtles, characterizing the presence and frequency of malformations in embryos of the Green sea turtle (Chelonia mydas) at Tortuguero, Costa Rica. For this study, a thorough review of the past 19 years of the extensive database maintained by the Sea Turtle Conservancy (STC) was performed. Every nesting season, nearly 200 nests on the northernmost 8 Km of the beach were marked and monitored; this sample represents 1.5 to 2.0 % of the nests laid every season in the study area. The incidence of malformations with prevalence and intensity index was estimated and the analysis of the data comprised a total of 2.066 nests and 225.657 eggs, registering a mean hatching success of 78.1 % (± 21.6) for these years. A total of 1.054 embryo records were analyzed, identifying 14 types of malformations. General deformity (52.3 %) was the most frequently registered during these years, followed by the lack of pigmentation (26.5 %) and twins (12.2 %). Prevalence (5.8 % on nests and 17 % on the embryos) and intensity (1.6 malformed embryos per nest and 1 malformation per embryo) were low compared with other studies. This report provides the basis for a more detailed study about malformations, especially to specify the occurrence deformities. Similarly, aspects such as genetic characterization of nesting female and correlation with environmental factors could help to have a better understanding of the factors affecting embryonic development and how they influence the occurrence of malformations during the incubation period.

La aparición de malformaciones, anomalías y asimetrías en vertebrados indica inestabilidad durante el desarrollo embrionario, y puede estar relacionado con factores ambientales, genéticos o ambos. Estos eventos son raros y pueden causar un impacto negativo en el fitness del animal. El presente estudio pretende incrementar la poca información existente sobre este tema en tortugas marinas, caracterizando la presencia y frecuencia de malformaciones en embriones de tortuga verde (Chelonia mydas) en Tortuguero, Costa Rica. Se realizó una revisión minuciosa de los últimos 19 años de la extensa base de datos de la Sea Turtle Conservancy (STC). Cada temporada de anidación cerca de 200 nidos en los 8 km más al norte de la playa fueron marcados y monitoreados, representando del 1.5 al 2.0 % del total cada temporada. Fue estimada la incidencia de malformaciones con índices de prevalencia e intensidad; el análisis de los datos comprendió un total de 2.066 nidos y 225.657 huevos, registrando una media de éxito de eclosión de 78.1 % (± 21.6) para esos años. Un total de 1.054 registros de embriones fueron analizados, identificando 14 tipos de malformaciones: malformación general (52.3 %) fue la más frecuentemente registrada, seguido por la falta de pigmentación (26.5 %) y gemelos (12.2 %). El índice de prevalencia (5.8 % en nidos y 17 % en embriones) e intensidad (1.6 embriones malformados por nidos y 1 malformación por nido) fueron bajos comparados con otros estudios. Este reporte provee la base para un estudio más detallado con respecto a las malformaciones, especialmente para especificar la ocurrencia de deformidades. Del mismo modo, aspectos como la caracterización genética de la hembra anidadora y correlación con factores ambientales podrían ayudar a entender mejor los factores

que afectan el desarrollo embrionario y como estos pueden influir en la ocurrencia de malformaciones durante el periodo de incubación.

Keywords: deformities, embryonic development, sea turtles, Tortuguero

EXPERIMENTAL ESTIMATION OF GROWTH RATES OF THE EXCAVATING SPONGE CLIONA DELITRIX IN BARBADOS (**Student**)

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As coral reefs decline worldwide, concern is increasing over the activity of excavating sponges due to their ability to bioerode reef framework and because their increased abundance has been linked to stressed reef environments. The aggressive excavating sponge Cliona delitrix is particularly common in Barbados. Because C. delitrix can excavate deep into live and dead calcium carbonate substrate, it is difficult to obtain accurate in situ measures of excavation rates and thus assess its contribution to bioerosion. Here, we sought to remediate this by measuring C. delitrix outcrop growth rates and associated excavation rates using standardized experimental limestone blocks deployed at ten sites along the west and south coasts of Barbados. Samples of C. delitrix were grown on these replicate blocks transplanted at each site (5 per site) and monitored over a 13-month period. The lateral growth of the outcrop area was measured each month and the total volume excavated by each outcrop was determined at the end of the study. There was considerable among-site variation in outcrop surface area growth (-15–8cm^2 per block) and in excavated volume (0–110cm^3 per block). These data were consistent with measures of outcrop growth concurrently obtained from the reef benthos at the same sites, with south coast sites consistently exhibiting the highest lateral growth (513cm^2/year). Overall, larger outcrops had also excavated larger limestone volumes: preliminary data indicate the following relationship between sponge outcrop area (X; in cm^2) and excavated volume of limestone substrate (Y, cm^3): $Y = 0.08X - 1.79$ (R^2=0.57, N=34). This is the first attempt to quantify excavation rates by C. delitrix in Barbados, which will help provide a more accurate depiction of the carbonate budget of Barbados' reefs.

Keywords: Cliona delitrix, excavating sponge, bioerosion, growth, Barbados

Welcome Reception:

Mr. Frank Rainieri, CEO and President of Grupo Puntacana has been gracious enough to invite all of us into his house for the 39th AMLC conference Welcome Reception. During the reception, we will have talks by Mr. Rainieri and Dr. Rita Peachey, Executive Director of the AMLC, followed by some drinks and light food. Transportation has been arranged for this event. Buses will be available to take conference participants to and from Mr. Rainieri's house from the Westin Puntacana, the Four Points and Grupo Puntacana Foundation. Shuttles leaving from the Westin will depart from the entrance to the lobby and shuttles from the Four Points will depart from designated areas; please look for the signs. There will only be one bus departure to and from the Foundation so please be ready to go by the scheduled time. Pickup at the foundation will be from at the entrance to the lobby. The table below, indicates departure times for this event. If you were planning on registering the day of the conference, please contact: Victor Galvan at vgalvan@puntacana.com or through the AMLC whatsapp groups. You need to be on a list in order to board the bus; all other registered participants have been registered for the event.

Sunday Night Welcome Reception

From/To	Corales Residency	Four Points	Westin	Grupo Puntacana Foundation
Four Points	7:00PM 8:00PM	-	-	-
Westin	7:00PM 8:00PM	-	-	-
Grupo Puntacana Foundation	7:00PM	-	-	-
Corales Residency	-	9:00PM 9:30PM	9:00PM 9:30PM	9:30PM

Banquet

The conference banquet will be held at the beach front Playa Blanca restaurant and bar from 7PM to 11:00PM on Thursday May 23rd.

The banquet is open to all those attending the meeting. Tickets will be available for sale before and during the meeting up until the end of the day on Thursday May 23rd. The cost is US$50 per person which includes family style entrée, main plate, desert and open bar for the first 3 hours of the event. We sincerely invite everyone to attend this event. During the banquet we will have two special guests speak. Awards for the best talks and posters will be presented at this event. The Playa Blanca restaurant is walking distance from the Westin Puntacana and also accessible by the free shuttle service from the Four Points hotel (please see resort shuttle schedule). For those at the foundation, we have scheduled transportation departing from the entrance to the foundation lobby.

Thursday Night Banquet at Playa Blanca					
From/To	Playa Blanca	Westin	Four Points	Foundation	
Four Points	-	-	-	-	
Westin	-	-	-	-	
Foundation	6:45PM	-	-	-	
Playa Blanca	-	-	-	10:00PM	
				11PM	
For all others - see Resort Shuttle schedule. Westin Guests can walk over along the beach or take the resort shuttle					

Microfragmentation Workshop:

This introductory coral microfragmentation training workshop is available to registered attendees of the AMLC conference. It is being hosted by the Association of Marine Laboratories (AMLC), *Grupo Puntacana Foundation* at its *Center for Marine Innovation* (CIM) and *The Nature Conservancy*. The workshop will consist of a series of techniques from cutting donor colonies, recovery protocols, to water system and raceway tank set-up. Participants will have a chance to fragment and attach donor fragments; a good opportunity to exchange ideas with existing and future micro-fragmentation practitioners. This event will be led by Dr. Dave Vaughan of Plant a Million Corals Foundation. Round trip transportation will be provided from the Four Points to the Westin and from the Westin to the CIM. Please see additional details below.

Date and Time
Wednesday, 22 May 2019 9:00AM to 12:30PM

Location
Westin Puntacana Resort & Club and at the Center for Marine Innovation at Grupo Puntacana Foundation

Reservation and Logistics

Reservations are required. Reservations can be made on site at the AMLC Conference, or by emailing to vgalvan@puntacana.com. The workshop is limited to 25 people. A sign-up sheet will be available until Tuesday afternoon during the AMLC conference.

Cost: Free. Roundtrip transportation will be provided

Agenda
9:00 AM Meet at the Westin Puntacana Resort & Club. *Forty-five minutes inside presentation on the history of micro-fragmentation process*

9:45 AM Transport to the Grupo Puntacana Foundation Center for Marine Innovation.

10:00 AM Walking tour and explanation of water systems, tank and plumbing set-ups, inside labs tour and full process flows.

10:45 AM Hands-on micro-fragmentation cutting demonstration, substrate manufacturing and attachment methods and operational raceway maintenance and management.

11:30 PM Questions, Answer and Discussion Period.

12:15 PM Transportation back to the Westin and Four Points

Wednesday Microfragmentation Workshop Transportation Schedule			
From/To	Westin	Center for Marine Innovation	Four Points
Four Points	8:30AM	-	-
Westin	-	10:00AM	-
Center for Marine Innovation	12:15PM	-	12:30PM

Student Mixer

The Student Mixer will be held on Wednesday May 22 at Punta Cava Bar and Grill located in the center of Puntacana Village starting at 7PM. The student mixer is being sponsored by Blue Vision Adventures for all students to get together and mingle. This is a student only event. Each registered student will get 2 free drink tickets that they can change for beer, water, or soft drinks at the Cava. The venue will also have a happy hour rate for additional purchases. There is no designated transportation for this event. Participants staying at the Westin can just jump on the Resort Shuttle at the schedule departure times. Participants at the Foundation can walk across the street to the designated area and also jump on the Resort shuttle at very specific times (schedule provided in the next section). Foundation guests are encouraged to be at the designated area 5 minutes before the shuttle schedule. The shuttle will not stop if it does not see anyone waiting. Please see schedule for return departures. After scheduled departures, participants will have to find their way back to their lodging areas.

Ground Transportation

There are multiple types of transportations mentioned at the AMLC including:

- Resort Shutter/Free Resort Shuttle
- AMLC Venue Shuttle
- Special Events Shuttle (Welcome Reception, Microfrag workshop and Banquet)
- Taxis/Cabs and
- Public Transportation

This section will help you differentiate between them. Please look for signs throughout the complex for signs that will help you move around.

Resort Shuttles:

The Four Points offers a free hotel shuttle to and from the airport but guests must request this service in advance. There are signs posted at the airport indicating where to go. Forgot to call ahead? Look for the Four Points shuttle telephone signs posted at each terminal.

Westin Puntacana does not offer a free airport shuttle service. Taxis are required to take you to the hotel. Taxis are available after exiting the airport or pick up can be arranged with the hotel prior to arrival or on-site. Expect to pay between US$20-30 to get to the Westin from the airport, the price is for up to 4- 6 people. There are various taxi companies at the airport but the Westin Puntacana official taxi company is Best Day Travel (red and white vans).

Puntacana Resort & Club offers a free hop-on, hop-off shuttle service that runs from approximately 10:30AM to 10:30PM. The shuttle moves within the entire resort on specific times and routes. Cab rides in Punta Cana are generally expensive so take advantage of the free shuttle service. Guests staying at the Westin, Four Points, or one of the other Puntacana Resort & Club hotels have access to this service. AMLC participants are encouraged to depart the conference at the end of each day using this service. Due to the large number of expected participants, shuttles might run full and may experience some delays in reaching your destination. The Foundation guests usually have no problem accessing this service during the day but stops and times can be limited during the day. For the AMLC, we have arranged for specific night stops at the foundation Monday, Tuesday and Wednesday. Here is the resort shuttle schedule as of May 10th.

RESORT SHUTTLE SCHEDULE

Westin Puntacana Resort & Club	Playa Blanca Restaurant	Four Points by Sheraton (Village)	Playa Blanca Restaurant	Westin Puntacana Resort & Club	La Cana Golf & Beach Club	La Yola Restaurant	Indigenous Eyes Ecological Reserve	La Cana Golf & Beach Club
10:00 AM	10:05 AM	10.15 AM	10:25 AM	10:30 AM	10:35 AM	N/A	10:41 AM	10:50 AM
11:00 AM	11.05 AM	11.15 AM	11.25 AM	11.30 AM	11.35 AM	N/A	11.41 AM	11:50 AM
12:00 PM	12.05 PM	12.15 PM	12.25 PM	12.30 PM	12.35 PM	12.45 PM	12.50 PM	1.00 PM
1.15 PM	1.20 PM	1.30 PM	1.40 PM	1.45 PM	1.50 PM	2.00 PM	2.50 PM	2.15 PM
2.30 PM	2.35 PM	2.45 PM	2.55 PM	3.00 PM	3.05 PM	3.15 PM	3.20 PM	3.30 PM
3.45 PM	3.50 PM	4.00 PM	4.10 PM	4.15 PM	4.20 PM	N/A	4.30 PM	4.40 PM
5.00 PM	5.05 PM	5.15 PM	5.25 PM	5.30 PM	5.35 PM	N/A	5.41 PM	5.51 PM
6.00 PM	6.05 PM	6.15 PM	6.20 PM	6.25 PM	N/A	6.35 PM	**6.40 PM**	6.45 PM
6.55 PM	7.00 PM	7.10 PM	7.20 PM	7.25 PM	N/A	7.35 PM	**7.40 PM**	N/A
7.45 PM	7.50 PM	8.00 PM	8.10 PM	8.15 PM	N/A	8.25 PM	**8.30 PM**	N/A
8.35 PM	8.40 PM	8.50 PM	9.00 PM	9.05 PM	N/A	9.15 PM	**9.20 PM**	N/A
9.25 PM	9.30 PM	9.40 PM	9.50 PM	9.55 PM	N/A	10.05 PM	**10.10 PM**	N/A
10.15 PM	10.20 PM	10.30 PM	10.40 PM	10.45 PM	N/A	11.00 PM	**11.05 PM**	N/A
11.10 PM	11.15 PM	11.25 PM	11.35 PM	11.40 PM	N/A	11.50 PM	**N/A**	N/A

AMLC Venue Shuttle

Access to the venue hotel without a car can be restricted due to the cost of taxis and other transportation. The free shuttle service provided by the resort does not start running until 10:00AM. As a result, the AMLC has hired a bus company to pick up participants from the Four Points and Grupo Puntacana Foundation and take them to the venue. Guests at the Puntacana Village, can also walk over to the Four Points and access this service. During lunch, the shuttle will be available in front of the conference center to take interested participants to the Puntacana Village for more meal options. Please note that Foundation guests don't have to leave the conference venue for their lunch.

AMLC Private Transportation Services to the Venue Hotel				
From/To	Westin			
Four Points	Monday 20	Tuesday 21	Thursday 23	Friday 24
	7:00AM	7:00AM	7:00AM	7:00AM
	7:30AM	7:30AM	7:30AM	7:30AM
	8:00AM	8:00AM	8:00AM	8:00AM
	8:30AM	8:30AM	8:30AM	8:30AM
	9:00AM	9:00AM	9:00AM	9:00AM
Westin	Four Points (lunch)			
	12:00PM	12:00PM	12:00PM	12:00PM
	12:45PM	12:45PM	12:45PM	12:45PM
	1:15PM	1:15PM	1:15PM	1:15PM
Grupo Puntacana Foundation	Westin			
	7:45AM	7:45AM	7:45AM	7:45AM
	8:20AM	8:20AM	8:20AM	8:20AM
For Shuttle services after the conference ends for the day, please see resort shuttle. IMPORTANT: resort shuttle is not available for the foundation on Thursday and Friday evenings.				

Special Events Shuttle:

These shuttle services have already been mentioned before and include the Welcome Reception, the Microfragmentation workshop and the Awards Banquet. These are event specific services. See shuttle schedules for those events.

Taxis/Cabs:

Taxis at the airport are clearly marked and are considered safe. Individual taxis are not allowed in the airport for your safety. However, individual taxis can still drop off passengers but do not generally pick up clients. Make sure to agree on a price prior to getting on. Fares for taxis within the Puntacana Resort range between US$20-30 per way for up to 4-6 people. If the cab is asking for more, look for another provider. Note, the price is a based on an area rate (i.e. Puntacana Resort & Cub, CapCana, Bavaro, Ciudad La Palma, etc.)

Prices for external trips to downtown Puntacana, Bavaro, or other locations can range from US$35-50 each way. Ask about a round trip price as these are often cheaper and the cab can wait for you for up to 2 hours for the same price. If you have any doubts, ask the marked volunteers or conference organizers for suggestions and tips. Taxis to Santo Domingo are very expensive and can costs as much as US$190 one-way for 4-6 people.

Public transportation:

There is public transportation within the Punta Cana area but it becomes more complicated to access the further inside the resort you are. The bus service company is called: SITRABAPU. These are either 24 or 48-person bus with A/C, wi-fi, and often TV. This company does not offer bathrooms in their buses. If you are staying near the conference venue, you will not see the 48-person bus. These buses stop any time someone asks to get in or out so they can be slower. For those at Felo Hotel, Veron, Pueblo Bavaro,etc, this will be your best option.

Before getting in one, please ask if they are going to Punta Cana or near the airport

This ensures that you are on the right bus. Once on board, ask them to drop you off at the Four Points where AMLC has hired a bus company to pick-up and take AMLC conference participants to the conference venue. Public transport should not cost more than 30 -40 pesos or about 90 US cents (exchange rate 50.5:1 US$) as of May 10th. Make sure to bring local cash for this. This service starts running at 7AM or earlier and the last bus is at 8PM.

Other:
Punta Cana is a very popular destination, therefore, there are multiple car rental services. Car rental options are available at both airport terminals.

Who Can Help?

Who can help you with “stuff” during the meeting? Who can answer questions about Puntacana Resort and Club and Punta Cana?

During your stay on Punta Cana, the following Grupo Puntacana Foundation staff, students, and interns can be approached at any time in case you need help with something, from internet passwords to driving directions to restaurant advice.

Victor Galvan (vgalvan@puntacana.com) 829-336-8344
Samantha Mercado (smercado@puntacana.com) +1829-257-7731
Noel Heinsohn (nheisohn@puntacana.com)
Enyi Baez (ebaez@puntacana.com)
Antonio Barletta (abarletta@puntacana.com)
Griselda Osoria (grosoria@puntacana.com)
Maribel Sanchez (msanchez@puntacana.com)

They will have matching shirts or look for someone with the Foundation logo

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The AMLC has also establishe whatsapp groups for faster and better communication. Please note that if you have not received any AMLC communications through these groups, contact an AMLC representative. The application can be downloaded directly from the AMLC website: WWW.AMLC-CARIB.ORG.

Frequently Asked Questions (FAQs)

What is the power on Punta Cana?
Punta Cana runs on 120V/50Hz..

What language do they speak in Punta Cana?
Spanish and English. This is a very popular tourist destination and almost everyone speaks English.

Do I need shots when I go to Punta Cana? Is the water safe to drink?
No special vaccinations are needed but consult your medical provider if you have any doubts. Although the water in Puntacana Resort & Club is treated and generally safe to use, we still recommend drinking water from identified sources such as at restaurants, bars, and drinking dispensers. All water served by the restaurants, at coffee breaks or happy hours is safe to drink.

What money is used in Dominican Republic?

The national currency is Dominican Pesos (DOP) but dollars and euros are widely accepted around the Punta Cana area. The official current exchange rate as of May10, 2019 is 50.5 pesos to 1 USD, however, supermarkets, restaurants and others might exchange it at anywhere from 46-49 pesos to the dollar. Credit cards are also readily accepted but avoid using them to purchase gasoline. We recommend that you notify your credit card issuer about your travel arrangements and verify international transaction fees. There is no deed to

exchange large sums of money upon arrival as there are multiple banks and ATMs around the area including the Westin and Puntacana Village.

What kind of driver's license can I use?

It's always best to have an international driver's license. However, depending where you're from, different rental companies have different policies. It's therefore a good idea to inquire beforehand whether your license will be accepted or if you have to get an international driver's license. Licenses from the U.S.A. are commonly accepted. A major credit card might be required to make car rental reservations.

What about immigration "rules" etc.?
Generally, most Caribbean countries do not require an Immigration visa to enter; Haiti, Cuba and Colombia are specifically listed as requiring visas. Please the see the link below for more information on the exact countries. This document comes directly from the immigration website of the Dominican Republic and is subject to change. Please use the same link to determine when you should apply and how long can you expect it to take.

https://www.migracion.gob.do/Content/main_side_banner_01.pdf

Previously, visiting tourist were required to pay a US$10 tourist visa upon arrival but that has change and is now included in your air ticket. Tourists are allowed to stay in country for 30 days without fees or penalties. After 30 days, you are subject to overstay fees that range from US$50 to US$200 or more depending on the number of days overstayed. US visitors do not require visa and can enter with a valid passport and a return ticket.

We recommend that participants be in possession of: (1) valid passport with at least 6 months validity left, (2) a return or outward ticket on arrival, (3) sufficient funds for accommodations and food and (4) necessary documents for returning to the country of origin, or further travel elsewhere.

What about internet during the meeting?

All attendants to the meeting will receive a code during registration that will allow them access to the Conference Room's internet. Please be aware that an estimated 140 people will be logged in to this internet.

Participants staying at the Westin Puntacana will have free wi-fi in the common areas (lobby, pool, etc.) and access to internet in their rooms with some speed restrictions. However, Starwood Preferred Guest (SPG) program participants that qualify can get high speed access free of charge in their rooms. (This is the Marriott's resort and hotels loyalty program).

Participants staying at the Sheraton Four Points will also have access in the common areas and rooms with some speed restrictions. SPG program benefits also apply here.

Participants staying at the Grupo Puntacana Foundation's Center for Sustainability have free access in the first floor of the center and in the common areas only in the second floor.

For participants not staying at the above-mentioned areas, please inquire and confirm with your hotel/AB&B, home stay or similar, for internet access.

*** Additional notes: Internet access is commonly available at local restaurants and shops. ***

What airport should I land at?
The Punta Cana International Airport (Airport code PUJ) is located 5 minutes away from the conference venue and Puntacana Resort & Club. PUJ is the leading airport for travel to the Dominican Republic with direct flights arriving daily from over 28 countries and 96 cities around the world. Transfers to and from the Hotel are readily available.You must present a valid passport to enter the Dominican Republic at any of these airports.

Are there medical services near-by?
Yes, there are currently 4 medical facilities within 25-minute drive from the Puntacana Resort & Club. The closest one is Puntacana Doctors located at the Puntacana Village 5 minutes from the Westin Puntacana. This facility is open for consultations until 5PM depending on the specialty, Mondays thru Fridays and open 24 hours a day for emergencies. Space and doctors are often on call or serving at other locations. Please verify with your medical insurance prior to using these services. The second medical facility is Hospiten, a Spanish medical center located an estimated 10 km from the Westin Puntacana. Medical services here are acceptable but can be costly for non-locals or for those with international insurance. A 3rd option includes the new International Medical Group located an estimated 20km from the Four Points hotel Puntacana Village. This is a new medical group that started operating in the area approximately 1 year ago. The carry multiple specialties and are open 24 hours a day for emergencies. The 4th medical facility is Centro Medico Puntacana located in Bavaro, approximately, 25 km from the Four Points hotel at Punta Cana Village. Visitors often prefer to visit this center because of the increase number of doctors, varied medical services, and treatment.

How safe is Punta Cana?
Punta Cana is one of the safest destinations within the Dominican Republic. As a general rule of thumb for visitors to any destination, be aware of your surroundings and don't wear lavishly items. People are quite athletic so you will often see them walking in the early morning or late afternoon as a sign of safety in the area.

Additional Conference Information:

- Conference shirts are included in your registration. Additional shirts can be purchased for US$8 each but should be reserved in advance.

- In an effort to help reduce waste and help the environment, we ask participants to bring their own reusable water bottle. Although glassware will be available during the conference.
- Conference participants with allergies, please let the AMLC know of any life-threatening allergies.
- We recommend that you purchase travel insurance and if possible, purchase health insurance. Foreign insurances are accepted but can be expensive up front.


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