

Rutgers University
CCMI Tropical Marine Conservation Internship

OVERVIEW & SYLLABUS

Faculty

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Contact Information while you are abroad

Little Cayman Research Centre
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Little Cayman Research Centre telephone: 345 948-1094
Field Station Address: 425 North Coast Road, Little Cayman, Cayman Islands KY3 2501
Emergency Contact: Peter Quilliam, mobile: 345 321-8732

Dates: 26 May – 15 June, 2017

Course Credits: 4 Credits (Rutgers University)

Brief Description:

This course will focus on the practice and theory of coral reef conservation and ecology. Interns will engage in the ongoing evaluation of marine protected areas as well as assist with the collection and analysis of ecologic and oceanographic data in relating to global climate change, marine invasions/non-native species, and population restoration.

Programme Student Learning Objectives:

At the end of this course students should be able to:

1. Describe the important physical and biological features, processes and ecological interactions of a tropical marine system.
2. Know the principles of conservation and how marine protected areas function to conserve habitats and species.
3. Explain long-term trends of coral reefs and key reef species.
4. Understand and differentiate between natural and anthropogenic impacts in context with global change and local stressors including ocean acidification, invasive species, major storms, pollution and coastal development.
5. Communicate how conservation and marine protection impacts broader social, cultural and economic concerns.

Programme Fee:

The course fee paid to Rutgers covers the following:

- Tuition (4 credits),
- Travel health insurance
- Dormitory-style accommodations at the Little Cayman Research Centre
- 3 buffet-style meals a day at the Little Cayman Research Centre
- On-island airport/research station transfers
- All field trips
- SCUBA tanks, air fills, and weights/belt

The course fee paid to Rutgers does NOT cover:

- Roundtrip airfare to/from Little Cayman
- Diver's Alert Network (see DAN.org) travel insurance (Preferred Plan or higher level plan required)
- Snorkel gear
- SCUBA gear (BCD, regulators). You may rent gear at the research centre.

Policies and Requirements

Attendance: Interns are required to arrive on time and stay for the duration of every field trip, lecture, discussion, and activity.

CCMI Policies are provided upon arrival at the research station. All safety and personal behavior policies are strictly enforced. See CCMI Code of Conduct.

Rutgers University Study Abroad policies are provided through the website and RU programme directors. Participants in RU Study Abroad are required to adhere to the university academic and activity policies.

Programme Description

The tropical marine conservation internship is an opportunity to gain field experience by being actively involved in the practice of marine conservation at the Little Cayman Research Centre. Through a series of field trips and field training activities, interns develop an excellent practical insight into coral reef conservation issues. The program begins with an introduction to the ecology of the coral reef ecosystem where interns explore the diversity of associated habitats including seagrass beds, mangroves, and coastal zones. Interns will learn the ecological roles of key species within the Little Cayman reef system. Interns prepare for marine conservation projects by learning principles of resilience and resistance, essential theories of marine protection and management, and by reviewing case studies. The Tropical Marine Conservation Intern will examine how conservation biologists and other scientists design and evaluate the effectiveness of marine management and protected areas, manage the impacts of invasive species, and develop tools to provide important data on population dynamics of essential species. Interns become involved in one of the ongoing marine conservation projects at the field station and develop a project poster

for presentation at the end of the internship. As part of the CCMI's overall 'Science and Society' initiative, project outputs will include a public outreach component within the local community such as presentations on results for multiple audiences (children, tourists, and island residents) as well as development of activities and education modules.

Current Research Projects at CCMI include:

- The Lionfish project which examines the effectiveness of culling in reducing this non-native species and movement patterns of the species around Little Cayman. Interns may be involved in dissections, stomach content analyses, catch-per-unit-effort calculations, spatial and temporal comparisons of lionfish demographics, reproductive strategy, and behavior of lionfish on Little Cayman. Interns will assist with weekly fish dissections and acoustic tracking surveys.
- The Coral Restoration project works to improve conservation of threatened coral species. Interns can assist with the construction, deployment, and maintenance of restoration structures as well as documenting survival, health and growth of corals within the nursery and corals outplanted. Work may also include measuring growth rates and monitoring species interactions using video within study plots.
- The EDGE (Evolutionarily Distinct and Globally Endangered) project examines the spatial ecology of critically endangered coral species. Interns learn to identify the endangered corals in the Caribbean and will conduct surveys assessing coral resilience using underwater photographs, and a Coral Point Count program (CPCE and CoralNet).
- The Long term Assessment and Monitoring Program (LAMP) involves an annual survey of ten sites that have been classified as low, medium and high resilience reefs. Interns may help collect data and learn to manage large datasets on the overall coral, sponge, fish, and algae populations; Interns may conduct spatial and temporal coral recruitment studies and assess sea urchin populations. A new project examining the importance and management of herbivorous fish and Cayman reef health will also be starting this spring.

Activities that all Interns will be involved in include:

- Field trips to marine protected areas and replenishment zones
- Training in field methods
- Attend lectures and discussions.
- Lab and field work with research staff
- Assist with island community projects including turtle nest surveys, invasive iguana walks and beach cleanups
- Data analysis
- Developing a joint research poster and abstract that is publishable and that could be presented at a national or international conference.
- Presenting field data and analysis to the field station community of scientists, staff and local stakeholders.

General Field Schedule

Breakfast:	7:00 – 7:45am
Lunch:	12:30 – 1:30pm
Dinner:	6:00 – 7:00pm
Morning Session:	8:30am - 12:30pm
Afternoon Session:	2:00 - 4:00pm
Free Time:	4:00 – 6:00pm
Evening Session:	7:00 – 9:00pm

Course Structure

Interns participate in field trips, collect and compile data on a daily basis. Lectures, workshops and discussions generally take place in the afternoon or evening. The program begins with an overview of marine ecology, conservation, and field methods. Interns work in teams and support other projects, which allows the groups to collect large data sets that contribute to research at the field station. Intern teams will organize and analyze data to be summarized in a final research poster that will be presented at the end of the internship. Note: The internship offers 4 college credits which requires significant contact hours within a less-than-three-week period. You will be working each day, including weekends, and are required to participate in ALL sessions, activities, and functions related to the Rutgers Study Abroad Internship.

OPPORTUNITY FOR AN EXTENDED INTERNSHIP

One intern will be selected to stay an additional one to two months as an intern for the research station ongoing research projects and programs. This intern will be chosen by five core staff members based on **ALL** of the below course criteria. Prior to the internship you will notify us if you wish to be considered for the extended internship and for how long you can stay. The selected intern will be provided room and board and will be compensated for their airfare change fee up to \$200.

Evaluation/Grading

Programme Components:

- Pre-trip assignments – reading and summaries
- Presentation on pre-trip reading topic (of your choice)
- Daily participation in all lectures, lab activities, field trips and discussions
- Identification Test and Knowledge quiz on Field Methods
- Field Journals & Blog
- Project Proposal
- Group projects and final research poster presentation.

Grading/Evaluation:

1. Pre-Trip Reading & Assignments	100 pts
2. Pre-Trip Reading Topic Presentation	125pts
3. Class/Field/Lab Workshops	175pts
4. Field and Class Participation	100
5. Field Journal and Blog	150pts
6. Project Proposal	100 pts
7. Project Final Poster and Presentations	200 pts
8. <u>Station Etiquette</u>	<u>50 pts</u>
TOTAL	1000 pts

Grading is on a straight scale:

A	925 points and higher
B+	875 to 924 points
B	825 to 874 points
C+	775 to 824 points
C	725 to 774 points
D+	675 to 724 points
D	600 to 674 points
F	599 points and lower

IMPORTANT NOTE

All assignments submitted electronically must be named in the following format....

LastName_FirstNAME_AssignmentName

Examples

Doe_Jane_FieldMethodsReview.doc

Smith_John_CriticalReview.doc

5 POINTS will be deducted for improperly named files. The important point is the format. The “assignment name” just needs to be clear. This makes my life a lot easier when grading and saving assignments. I should not have to rename your file. You should always use a similar format when sending anything via email (CVs, cover letters...)

PREPARING FOR THE TRIP ASSIGNMENTS

1. Pre-Trip Presentation

Interns will prepare a 5 minute presentation on the topic of your choice. A list of potential topics is provided below or you may suggest your own. Each topic can be selected by only one intern (first come, first served basis). Submit your topic for approval to the Dr. Allison Candelmo at acandelmo@reefresearch.org no later than **May 1, 2017**.

Topic Selection due May 1, 2017

Presentation topics (or suggest your own):

- ❖ Coral Reef Resource and Ecosystem Management
 - Marine Protected Areas
 - Species vs Ecosystem Management
 - Common Pool Resource Management
 - Reef regeneration, restoration
 - Reef resilience
 - Seagrass or Mangrove habitats
- ❖ Threats to Coral Reefs
 - Natural hazards
 - Overfishing and impacts on coral reefs
 - Ocean acidification
 - Lionfish & invasive species
 - Coral diseases (exclude bleaching)
 - EDGE Species (current status, conservation plans)
 - Climate Change
 - Coral Bleaching
 - Nutrient enrichment and coastal development
- ❖ Coral Reef Processes
 - Herbivory on coral reefs
 - Grouper spawning & aggregation
 - Ocean circulation, upwelling, tidal influences on coral reefs
- ❖ Geology of coral reefs
 - Paleoclimate and high resolution records from coral skeletons
 - Sea level
 - Sedimentation and island accretion and erosion
 - Coral Reef evolution, modern and ancient biodiversity

1. PRE-TRIP TOPIC PRESENTATION due May 26, 2017

Come to Little Cayman with your presentation ready to go!

Your presentation should include references to at least three scientific articles from published journals (not the internet, newspaper, or non-scientific magazines). **Note:** These three articles do NOT have to come from the reading list provided at the end of this syllabus (you may do your own literature search).

You should create a power point for your presentation. The presentation should have the following components:

1. Title Page with your name and topic,
2. Introduction to topic,
3. **Concise** summary of your literature findings (Do not include an outline slide on each paper, summarize it into a presentation)
4. The most important thing(s) you learned while doing the research,
5. Conclusion
6. Reference slide

If you choose to include video clips or animations from the web, please limit these to less than 1 minute in length. Your actual speaking time should still be 5 minutes. Presentation length should be 5 minutes (minimum 4, maximum 7). 5 Points will be deducted for every minute above or below these limits.

2. Pre-trip Reading Assignments due May 23, 2017

A. Field Methods Manual & Review Questions – 50 points

Pre-trip reading includes the ‘**Methods for Ecological Monitoring of Coral Reefs**’ and answering the review questions. (See “Field Methods Review Questions” in the assignments folder). Submit the review questions electronically via email. This assignment is designed to introduce you to the common terminology, methods, and project design considerations in the field of coral reef conservation. The ‘Methods’ text will prepare you for more advanced reading in the scientific literature.

B. Scientific Articles – Read 7 articles and Write 3 Critical Reviews - 75 points

READ

The four articles in you assignments folder are mandatory reading.

Schutte et al. 2010; Hughes et al. 2007; Mumby et al. 2009; Edmunds et al. 2001

Choose **three** additional articles from the list below or your own literature search. You may also use any/all of these articles for your Topic Presentation.

Two of the additional articles you choose must be primary research (some of the papers below are review papers). <http://apus.libanswers.com/faq/2324>

CRITICAL REVIEW

Write a **one page** critical review essay on **THREE** of the Primary Research articles you have read. (See “Critical Review” handout assignment).

One of these reviews must be on the mandatory paper....

Edmunds PJ, Carpenter RC (2001) Proc Natl Acad Sci 98:5067-5071

The other two are your choice but must be on a primary research article.

You should be prepared to discuss the content of **all articles** you have read.

Email me the **3** essays and a list of the **3 additional papers** you have read by **May 23, 2017 all as one word document**

Research Station Assignments/Grading

3. Class/Field/Lab Workshops

Interns will participate in a number of class and field workshops, including coral reef species (coral, fish, algae) ID, coral nursery, lionfish dissection, fish behavior and ecotourism which will involve grades for small quizzes or assignments and the participation of each intern during these workshops.

4. Field and Class Participation

We anticipate full participation and engagement from interns throughout the course. Attendance is mandatory for all classroom, lab and field activities. Please be on time and prepared. It is important to be prepared before you arrive in the field so that you are ready to contribute with good skills so that you can make thoughtful contributions throughout the course. We also expect all interns to assist in the set up for field work, loading and unloading trucks and boats during field days and putting research equipment away at the end of the day. Points will be deducted throughout the course for lack of participation and assistance, lateness, use of phone, browsing on computer during lectures.

5. FIELD JOURNAL AND BLOG : Due 1 week after the end of the Internship (June 23, 2017)

The purpose of a **FIELD Journal** – To document the internship experience, record the data that you and your team collect, and create an archive for your future reference. Your field log should include maps, drawings, diagrams, photographs, videos, notes, questions, methods and data, items for future work, descriptions of unknowns to be looked up later, etc. You can record notes in a book but it should all be transferred to a word or pdf file to hand in. You can scan pictures/drawings, etc. using an App on your phone or just photos. See “Field Journal and Blog Guidelines” in Assignments folder for further details.

One online group **Field Blog** will be set up for the internship. Each person will be assigned one day to blog. – See “Field Journal and Blog Guidelines” in assignment folder

6. FIELD PROJECT PROPOSAL: 100 Points (Due June 1)

A 2-page proposal that describes your final field project should be prepared by the end of your first week of the internship. The proposal can be coordinated with your project team or you may work on your own. Each student must provide the professor with their final proposal via email.

The project proposal will include:

- A succinct statement that explains the rationale for the project. It may include your hypothesis or prediction, and must explain the need and justification for the project.
- Describe the field methods with a timeline for the work that will need to be completed.
- Anticipated outcomes and impact of the work
- 5 References minimum

See “Proposal guidelines” in the assignments folder

7. POSTER AND PRESENTATION: 200 Points (Due June 12)

Little Cayman Coral Reef Health

- Throughout the internship we will work as a group to conduct urchin and benthic reef surveys. Urchin populations may be increasing on the reefs of Little Cayman and we will assess densities and compare results based on location, depth, time of day and reef health.
- You will then work in groups to develop a poster and presentation based on the data from the urchin and benthic surveys conducted during the internship and past data. Each group will focus on a different topic of analysis from this project.
- Specific topics for each group will be assigned randomly. These topics may include Urchin density vs Algal abundance; Urchin density at different depths, Urchin densities at different times of day; Urchin density versus herbivorous fish abundance.
- You will receive a group grade out of **100 POINTS** for the Poster (See Rubric).
- For the presentation of the poster you will each present a section and be graded individually on your presentation (**100 POINTS**). Each Person will present for 3 minutes.
- **EXCEL and Statistics**
- For this Assignment you will be required to work in **Excel** and run **basic statistics** on your data. See “Excel and Statistics” in the assignments folder

8. FIELD STATION Etiquette

Interns are involved in every aspect of the running of the field station and assist with kitchen duties and overall cleanliness of their work areas, and are expected to be on time and participating in fellow intern presentations and projects. Full participation in all outreach and residential activities is required. Interns are required to respect the research, living space and quiet areas at the research centre at all times. The Field Operations manager will review Standard Operating Procedures for the Little Cayman Research Centre. Grades will be assigned based on three categories.

Poor Etiquette – 0 points

Ok Etiquette – 25 Points

Excellent Etiquette – 50 Points

PRE-ARRIVAL READING:

REQUIRED

Hill J, Wilkinson C (2004) Methods for ecological monitoring of coral reefs. Australian Institute of Marine Science. 123 pages.

Read the above in conjunction with the Field Methods Review Questions document.

Schutte VGW, Selig ER, Bruno JF (2010) Regional spatio-temporal trends in Caribbean coral reef benthic communities. Mar Ecol Prog Ser 402:115-122.

http://www.int-res.com/articles/meps_oa/m402p115.pdf

Hughes TP, Rodrigues MJ, Bellwood DR, Ceccarelli D, Hoegh-Guldberg O, McCook L, Moltschaniwskyj N, Pratchett MS, Steneck RS, Willis B (2007) Phase shifts, herbivory, and the resilience of coral reefs to climate change. Current Biology 17:360-365.

<https://www.ncbi.nlm.nih.gov/pubmed/17291763>

Mumby PJ, Hedley JD, Zychaluk K, Harborne AR, Blackwell PG (2006) Revisiting the catastrophic die-off of the urchin *Diadema antillarum* on Caribbean coral reefs: Fresh insights on resilience from a simulation model. Ecological Modeling 196:131-148

<https://www.ncbi.nlm.nih.gov/pubmed/11274358>

*****Edmunds PJ, Carpenter RC (2001) Recovery of *Diadema antillarum* reduces macroalgal cover and increases abundance of juvenile corals on a Caribbean reef. Proc Natl Acad Sci USA 98:5067-5071. **CRITICAL REVIEW PAPER****

<http://www.pnas.org/content/98/9/5067.full>

SELECT an additional 3 ELECTIVE ARTICLES (Prepare Review Essay and Critique (See above and attached) of 2 of the articles (Primary Research Articles).

Read 3 articles from the following list or your own literature search prior to arriving in Little Cayman. You will need to use your home library to articles most of these articles. Bring only electronic versions with you to Little Cayman. Be ready to give informal overview of the any of the articles you read).

Those highlighted in green were conducted in the Cayman Islands.

Two other important urchin papers from the initial crash...

Bak RPM, CarpayMJE, Ruyter van Steveninck ED (1984) Densities of the sea urchin *Diadema antillarum* before and after mass mortalities on the coral reefs of Curacao. Mar Ecol Prog Ser 17:105-108.

http://www.dcbd.nl/sites/www.dcbd.nl/files/documents/BAkCarpayRuytervStevDiademabefore-and-after_meps17-1984.pdf

Lessios HA, Robertson DR, Cubit JD (1984) Spread of *Diadema* mass mortality through the Caribbean. Science 226:335-337.

http://stri.si.edu/sites/publications/PDFs/Lessios_Ross%20Science%201984.pdf

Additional urchin or phase shift papers

Hughes TP (1994) Catastrophes, phase shifts, and large-scale degradation of a Caribbean coral reef. *Science* 265:1547-1551.

<http://bio.classes.ucsc.edu/bio160/Bio160readings/Catastrophes,%20Phase%20Shifts.pdf>

Mumby PJ, Hastings A, Edwards HJ (2007) Thresholds and the resilience of Caribbean coral reefs. *Nature* 450: 98-101.

<http://www.nature.com/nature/journal/v450/n7166/full/nature06252.html>

Miller RJ, Adams AJ, Ogden NB, Ogden JC, Ebersole JP (2003) *Diadema antillarum* 17 years after mass mortality: Is recovery beginning on St. Croix? *Coral Reefs* 22:181-187.

<http://link.springer.com/article/10.1007/s00338-003-0301-x>

Lessios HA, Garrido MJ, Kessing BD (2001) Demographic history of *Diadema antillarum*, a keystone herbivore on Caribbean reefs. *Proc Royal Soc B* 268.

<http://rspb.royalsocietypublishing.org/content/268/1483/2347.short>

Sherman E (2015) Can sea urchins beat the heat? Sea urchins, thermal tolerance and climate change. *PeerJ* 3:e1006.

<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4465948/>

Additional Coral Reef Papers

Aiken, J, B Godley, A Broderick, *et al.* "Two hundred years after a commercial marine turtle Fishery: the current status of marine turtles nesting in the Cayman Islands." *Oryx*. 35.2 (2001): 145-151.

Aronson, R.B., MacIntyre, I.G., Wapnick, C.M., O'Neill, M.W., 2004. Phase shifts, alternative states, and the unprecedented convergence of two reef systems. *Ecology* 85, 1876-1891.

Baird AH, Guest JR, Willis BL (2009) Systematic and biogeographical patterns in reproductive biology of scleractinian corals. *AnnuRevEcolEvolSyst* 40:551-571

Baker AC (2003) Flexibility and specificity of coral-algal symbiosis: diversity, ecology and biogeography of *Symbiodinium*. *AnnuRevEcolEvolSyst* 34: 661-689

Barbour, A. B., M. S. Allen, *et al.* (2011). Evaluating the Potential Efficacy of Invasive Lionfish (*Pterois volitans*) Removals. *PloS one* 6

Barry SC, TK Frazer, CA Jacoby (2013) Production and carbonate dynamics of *Halimeda incrassata* (Ellis) Lamoroux altered by *Thalassia testudinum* Banks and Soland ex König. *Journal of Experimental Marine Biology and Ecology* 444: 73-80.

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

Bell, C, J Solomon, J Blumenthal, T Austin, *et al.* "Monitoring and conservation of critically reduced marine turtle nesting populations: lessons from the Cayman Islands." *Animal Conservation*. 10.

Bellwood, D.R., Hoey, A.S., Choat, J.H. (2003) Limited functional redundancy in high diversity systems: resilience and ecosystem function on coral reefs. *Ecology Letters* 6, 281-285.

Bellwood, D.R., Hughes, T.P., Folke, C., Nystrom, M. (2004) Confronting the coral reef crisis. *Nature* 429, 827-833.

- Bonaldo RM, Hoey AS, Bellwood DR (2014) The ecosystem roles of parrotfishes on tropical reefs.. *Oceanography and Marine Biology: An Annual Review*, 52: 81-132.
- Brandt ME, McManus JW (2009) Dynamics and impact of the coral disease white plague: insights from a simulation model, *Dis Aquat Org.*, Vol. 87:117-133.
- Brown BE (1997) Coral bleaching: causes and consequences. *Coral Reefs* 16 Suppl: S129-S138.
- Bruno JF, Selig ER, *et al.* (2007) Thermal stress and coral cover as drivers of coral disease outbreaks. *PLoS Biol* 5(6):e124
- Bythell JC, Hillis-Starr ZM, Rogers CS (2000) Local variability but landscape stability in coral reef communities following repeated hurricane impacts. *Mar Ecol Prog Ser* 204: 93-100.
- Camp EF, KE Lohr, SC Barry, PG Bush, CA Jacoby, C Manfrino (2013) Microhabitat associations of late juvenile Nassau groupers (*Epinephelus striatus*) off Little Cayman, BWI. *Bulletin of Marine Science* 89(2): 571-581.
- Carpenter, K.E., Abrar, M., *et al.* (2008) One-third of reef-building corals face elevated extinction risk from climate change and local impacts. *Science* 321, 560-563.
- Carpenter RC, Edmunds PJ (2006) Local and regional scale recovery of *Diadema* promotes recruitment of scleractinian corals. *Ecol Letters* 9: 271-280.
- Christie, P., White, A. T. (2007) Best practices for improved governance of coral reef marine protected areas *CORAL REEFS* 26: 1047-1056
- Coelho VC and Manfrino C. (2007) Coral Community decline at a remote Caribbean Islands: Marine no-take reserves are not enough, *Aqua. Conserv.* 17: 666-685
- Connell JH, Hughes TP, Wallace CC (1997) A 30-year study of coral abundance, recruitment, and disturbance at several scales in space and time. *Ecol Monogr* 67(4): 461-488.
- Cowen RK, Paris CB, Olson, DB, Fortuna JL (2003). The role of long distance dispersal versus local retention in replenishing marine populations. *Gulf and Carib Res*, 14, 129-137
- Darling ES, *et al.* (2012) Evaluating life-history strategies of reef corals from species traits. *Ecology Letters*, 15: 1378-1386
- Day T, Nagel L, van Oppen MJH, Caley MJ (2008). Factors affecting the evolution of bleaching resistance in corals. *American Naturalist*, 171: E72-E88
- Diaz MC, Rutzler K (2001). Sponges: an essential component of Caribbean coral reefs. *Bull Mar Sci*, 69: 535-546
- Diller JL, Frazer TK, Jacoby CA (2014) Coping with the lionfish invasion: evidence that naïve, native predators can learn to help. *Journal of Experimental Marine Biology and Ecology*, 455: 45-49.
- Eakin, C.M., Morgan, J.A., *et.al.*, (2010) Caribbean Corals in Crisis: Record Thermal Stress, Bleaching, and Mortality in 2005, *PLoS One*. 10.1371: e 13969.
- Edmunds, P.J.(2007). Evidence for a decadal-scale decline in the growth rates of juvenile scleractinian corals. *Marine Ecology-Progress Series* 341, 1-13.
- Edmunds, P.J., Elahi, R., 2007. The demographics of a 15-year decline in cover of the Caribbean reef coral *Montastraea annularis*. *Ecological Monographs* 77, 3-18.
- Edwards MA, Frazer TK, Jacoby CA (2014) Age and growth of invasive lionfish (*Pterois* spp.) in the Caribbean Sea, with implications for management. *Bulletin of Marine Science* 90(4): 953-966.
- Fitt WK, Brown BE, Warner ME, Dunne RP (2001). Coral bleaching: interpretation of thermal tolerance limits and thermal thresholds in tropical corals. *Coral Reefs*, 20: 51-65

- Frazer, T.K., Jacoby, C.A., Edwards M., Barry, S., & Manfrino, C, 2012, Coping with lionfish: culling can alleviate detrimental effects, *Reviews in Fisheries Science*, v. 20 no.4, 185-191.
- Friedlander, Alan M., Brown, Eric, Monaco, Mark E. (2007) Defining reef fish habitat utilization patterns in Hawaii: comparisons between marine protected areas and areas open to fishing *Mar Eco ProgSer* 351: 221-223
- Gardner PG, Frazer TK, *et al.* (2015) Reproductive biology of invasive lionfish (*Pterois* spp.) from Little Cayman Island. *Frontiers in Marine Science* Vol 2, Article 7: 1-10.
- Gardner TA, Côté IM, Gill JA, Grant A, Watkinson AR (2003) Long-term region-wide declines in Caribbean corals. *Science* 301: 958–960
- Gardner TA, Côté IM, Gill JA, Grant A, Watkinson AR (2005) Hurricanes and Caribbean coral reefs: impacts, recovery patterns, and role in long-term decline. *Ecology* 86: 174-184.
- Graham EM, Baird AH, Connolly SR (2008) Survival dynamics of scleractinian coral larvae and implications for dispersal. *Coral Reefs* 27: 529-539.
- Guzman HM, Cortes J (2007) Reef recovery 20 years after the 1982-1983 El Nino massive mortality. *Mar Bio* 151: 401-411.
- Hernández-Pacheco, R., E. A. Hernández-Delgado, *et al.* (2011). Demographics of bleaching in a major Caribbean reef-building coral: *Montastraea annularis*. *Ecosphere* 2(1)
- Hoegh-Guldber O., *et al.* (2007) Coral Reefs Under Rapid Climate Change and Ocean Acidification. *Science* 318
- Hughes TP, Baird AH, *et al.* (2000). Supply-side ecology works both ways: the link between benthic adults, fecundity, and larval recruits. *Ecology*, 81: 2241-2249
- Hughes, T.P., Bellwood, D.R., Folke, C., Steneck, R.S., Wilson, J., 2005. New paradigms for supporting the resilience of marine ecosystems. *Trends in Ecology & Evolution* 20, 380-386.
- Hughes, T.P., Connell, J.H., 1999. Multiple stressors on coral reefs: A long-term perspective. *Limnology and Oceanography* 44, 932-940.
- Jackson JBC (1997) Reefs since Columbus. *Coral Reefs*, 16, Suppl: S23-S32.
- Jones AM, Berkelmans, R van Oppen, MJH, Mioeg JC, Sinclair, W (2008) A community change in the algal endosymbionts of a scleractinin coral following a natural bleaching event: field evidence of acclimatization. *Proceedings of the Royal Society of London Series B* 275: 1359-1365
- Knowlton & Jackson (2008). Shifting baselines, local impacts and global change on coral reefs. *PLoS Biology* 6: e54
- Lessios, H.A., 1988. Mass Mortality of *Diadema Antillarum* in the Caribbean: What Have We Learned? *Annual Review of Ecology and Systematics* 19, 371-393.
- Lirman D, *et al.* (2014) Growth dynamics of the threatened Caribbean staghorn coral *Acropora cervicornis*: influence of host genotypes, symbiont identity, colony size, and environmental setting. *PLoS One*, 9(9): e108253.
- Lohr KE, Bejarano S, *et al.* (2015) Optimizing the productivity of a coral nursery focused on staghorn coral *Acropora cervicornis*. *Endangered Species Research*.
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