Resident Director's Report - 2014
Dr. Peter Bushnell and Dr. Ann Grens
Department of Biological Sciences
Indiana University South Bend

Program:
Tropical Marine Biology Field Study in Belize; BIOL-L 342 (3 credits)
San Pedro, Belize; June 2 -June 11, 2014

Success in meeting the program's mission:
Marine biology covers a range of complex environments and a diverse assortment of plants and animals adapted to them. While it is possible to discuss these environments in a lecture course, there is really no substitute for experiencing them in person. The aim of this course is to introduce participants to a variety of habitats, including coral reefs, grass beds, soft and hard bottom communities, intertidal zones, sandy beaches, mangrove swamps and estuaries. A student who completes this course will have observed and learned about the structure and function of a variety of tropical marine ecosystems and their inhabitants, as well as experienced Belize culture firsthand.

Selection Process:
Class participants are primarily selected from Biology majors at IU South Bend who have met the prerequisite course work (Introduction to Biological Sciences I and II (L101/L102), Principles of Chemistry I and II (C105/C106), and Marine Biology (L304) by passing all courses with a C or better. Participants must also pass a swimming test.

Participants: 12
2 instructors: P. Bushnell and A. Grens (IUSB Biological Sciences)

2 faculty participants (C. Sofhauser, S. Anderson - IUSB Nursing)

8 undergraduates (all Biological Sciences majors)

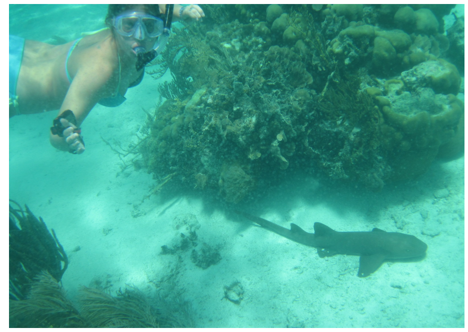
The 2014 Tropical Marine Field Study in Belize (L342) class

Pre-departure Orientation:
Due to research commitments that took Bushnell was out of the country for most of May, the course was run as a traditional Summer Session 1 course with the trip taking place from June 2-11, 2014. During the Spring semester, the class met once in February to discuss course logistics, finances, expectations, and assign groups for research projects. A second meeting in March was used to present research proposals the groups had designed in the intervening time. All students were also required to demonstrate swimming and snorkeling proficiency by either 1) taking and passing a 3 hour snorkeling course given by a local dive shop instructor at the pool at the University of Notre Dame, or 2) holding a valid SCUBA diving certification. Students were also required to acquire passports.

The bulk of the class began with the first two weeks of the Summer I session when the class met with Dr. Grens twice a week for three hours each time to attend lab sessions in preparation for the trip. Exercises include invertebrate identification and water sampling and analysis. The trip to Belize left at week 3.

Educational Program:

<ins>Course curriculum:</ins> The Belize Program is a field course in Tropical Marine Biology taught at the Tropical Research and Education Center (TREC) facility in San Pedro, Belize. The facility is a renovated hotel in a residential neighborhood on the outskirts of the San Pedro, Ambergris Caye. All participants lived and ate at the TREC facility. The 9 days spent on-site revolved around three major types of activities:
1) field trips to explore and study various habitats in the marine ecosystem (coral reefs, mangroves, seagrass beds); 2) identification of specimens from these habitats; 3) the execution of group research projects.



Posing with a nurse shark..not too close though

Most of the field trips were snorkeling expeditions made on a 35 foot boat catamaran, *Goliath*, in order to explore a variety of sites on or near the Belize barrier reef. Typically excursions to the reef lasted the entire day (9:00 am-4:00 pm or later) as it often took 30-60 minutes to reach the snorkeling site. Depending on the schedule, we would snorkel at a particular site for 1-2 hours, get back on the boat, move to a new site, and get back in the water. Lunch (sandwiches, chips, etc) was provided on the boat. On a given day we would visit at least two sites, often three, and sometimes four. Following dinner, time was used for lecture, species identification, work on group projects, or additional field trips (such as a night snorkel or beach seining in the grassbeds just off-shore to observe the difference in organisms active at night as compared to those the students had seen during the day in the same habitats).

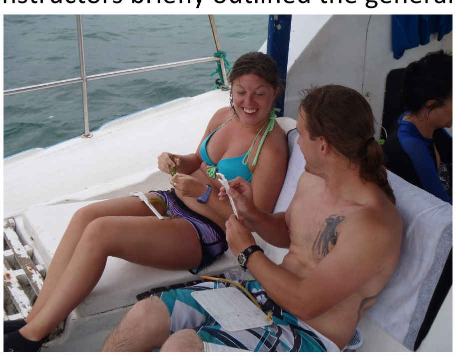
Getting instructions on how to snorkel in the mangroves

Since all the students were required to take the Marine Biology lecture course (Biology L304), they were already familiar with the most important aspects of the ecosystems we were visiting. Therefore, we did not do much formal lecturing in Belize. Each swim was preceded by a 10-15 minute introduction to the ecology of the specific area, a discussion of what the group would see at the site, safety considerations, and any other information that was deemed relevant to the experience. If the activity at the site involved collecting data for independent projects, the particular group in charge of the project also outlined what we were to do, how do it, what instruments to take, etc.

While in Belize each student was required to identify a collection of organisms based on a species list of ~100 organisms selected to illustrate the broad assemblage of flora and fauna that can be found in the various habitats we visited. Since there are no aquarium facilities at the TREC site and most of the snorkeling sites are "no take" zones, we have developed the “virtual collection" by having students take pictures of organisms in the field with underwater digital cameras purchased by the Biology department; each pair of swim buddies was assigned a camera that they were responsible for throughout the trip. At the end of each day pictures were downloaded onto laptops, also provided by the Biology department, to be used by the student to assemble and organize the collection (*e.g.* post pictures with species identifications) in the form of a Powerpoint file. The completeness and accuracy of the "virtual collection” was evaluated by the instructors and formed one of the graded assessment activities for the each individual in the class.

Large air-breathers check each other out.

As has been the case on past trips, students were required to carry out group research projects (2-3 students/group) that had been planned during the Spring semester. The projects conducted this year were: 1) How does the size of a fish intruder alter a damselfish’s territory defense behavior? 2) What are the effects of physical environmental factors such as wave intensity, water depth, and coral complexity on the diversity of fish inhabiting the area? 3) Does the filtering ability of sponges differ with size and species? 4) Do parrotfish grazing patterns on seagrasses changes with the proximity to blowouts (large sand patches in the middle of a seagrass meadow)? During the pre-departure meeting in February the instructors briefly outlined the general idea of each study, announced the pre-determined research groups, and assigned each project to a group via a random drawing. Over the next 5 weeks the instructors assisted each group in developing their particular study. In March the class met to listen to each group informally present an article from the scientific literature that was relevant to the project they were going to do, and outline the study they proposed to carry out in Belize. After receiving feedback from the class and the instructors about their planned experiments, each group had to prepare and submit a written project proposal similar to a small grant application, in which they were required to include a comprehensive list of <u>everything</u> they thought they would need to carry out the project in Belize. We have found this to be a very effective mechanism to insure that the students have thought about the project, chosen realistic goals, and planned the activities appropriately. This also allowed the instructors to determine what equipment we needed to collect or purchase in South Bend based on what we knew was and was not available in Belize. While every member of the class participated in collecting data for every project, each group was responsible for planning their experiments, directing the data collection efforts, analyzing the data, and presenting the preliminary results in the form of a short oral presentation given in Belize. Upon their return each group wrote a formal 10-15 page paper similar to a scientific journal article in which they reported and analyzed the data. The pre-trip literature and project presentation, the written project proposal, the oral presentation of the project results and the formal research paper were all used to assess the students'



Measuring grass blades with calipers... always a good time.

mastery of research techniques, experimental design, data analysis, and the written and oral communication of scientific information.

Other graded assessment activities included an invertebrate species identification quiz, in which the students were required to identify photographs of 40 different marine invertebrates by scientific Phylum and Class, and a fish identification quiz in which they were required to identify 40 of the most common fish species (in both their juvenile and adult forms) by common name.

In addition to the various aspects of the group research projects listed above (the literature article presentation, the written project proposal, the oral presentation of the results and the formal paper), each member of each group was asked to evaluate his or her own participation and that of the other group members of his/her group, and the average score a student received on this peer evaluation was incorporated as part of their final research project grade. We have found this to be an effective mechanism for preventing any students from "slacking" and failing to do their fair share of the work when requiring them to participate in group projects, and to prevent strong-willed group members from dominating the group and preventing others from making their ideas known.

As can be seen from the attached syllabus, the schedule was deliberately set up to keep the students engaged in their studies but with some time to relax, buy souvenirs, and see tourist attractions. As usual we spent a day traveling to the mainland and exploring the Mayan ruins at Lamanai. The trip to the ruins began at 7:00 a.m. with a two hour boat trip across the lagoon to the mainland and up the Northern River. The trip up the river, through mangroves and tropical forest, gave the students a chance to experience some of the terrestrial biology of Belize. Approximately one hour up the river we left the boats at a marina and boarded an air-conditioned bus to a second marina on the New River. After a one hour trip on the bus we boarded another boat for a second one hour ride through the rainforest to Lamanai. The same boat captain crew accompanied us on all facets of the trip and served as our guide (and lunch caterer) for the two hour tour exploring the extensive Mayan ruins. On our way to and from Lamanai, we made frequent stops to observe flora and fauna along the river and learn about the different cultures found in Belize and their relationship to the rivers on which we were traveling.

<u>Course strengths and weaknesses:</u> Overall the trip was a great success and there is little that we would change. Ken and Maureen Mattes, the owner/operators of TREC, were very knowledgeable, friendly and helpful. They accompanied us on all of our snorkeling trips, briefed us on what we would see at each site, discussed any potential safety issues (prevailing currents, dangerous organisms, etc.), and then swam with us to point out organisms of interest. We were all appreciative of their efforts, patience, and good humor.

This was one of the best groups we have ever taken on this trip as they were very enthusiastic, good natured, and hard working. We still feel that that lack of “dry” time and minimal opportunities to explore the mainland tropical rainforest ecology remains a weakness of this course. While we reconsider the itinerary every time we offer the course, we are still unwilling to eliminate a portion of the course in order to replace it with something else. Unfortunately, as the current trip cost continues to escalate we do not feel we can extend the course time in order to incorporate other trips to terrestrial environments.

OK, so maybe they needed a break every now and then.

Recommended changes: Everything went largely as expected and planned. As discussed above, the only aspect of the course we are considering changing is adding 2-3 more days to the length of the course in order to incorporate a bit more mainland exploration. We are, however, concerned that added ~$250-$350 cost per student will increase the cost of the course to the point that enrollment will suffer.

Assessment and Final Grade Distribution:

Grades in the course were assigned according to the following scheme.

Attendance and enthusiastic participation	**40%**
Group project	**40%**
Reference paper presentation	(5%)
Project proposal	(5%)
Project presentation (in Belize)	(5%)
Paper	(20%)
Group member's evaluation	(5%)
Species identification	**20%**
Invertebrate identification quiz	(5%)
Fish identification quiz	(5%)
Species identification project	(10%)

In general the students worked very hard on their group projects, and all of them earned very high marks on the species identification exercises (the average score on the fish identification quiz was an 89%, and the invertebrate identification quiz, for which they had to provide the scientific genus and species names for 40 different organisms, was a 93%!) and on their presentations. As is often the case, not all of the projects worked out as initially proposed. While the students often see this as a source of consternation, we are not become overly concerned. Instead we are more focused on their ability to identify potential problems, rectify them when possible, modify the experimental approach if necessary, and above all make the best out of the situation. Being able to adapt on the fly is an essential part of field work and one of the skills we want them to develop during this course.

Final grade distribution: A =2; A-=5; B+=1.

Student Housing and Meals:
Students were housed on site at TREC in triple or quad occupancy rooms with private baths. Morning and evening meals were prepared by the resident cooks and served buffet style in the large eating area. The menu consisted of Belizian and American cuisine (grilled chicken, spaghetti, etc). Water and juice were available all of the time, both at the TREC facility and on the boat. Sandwiches, fruit and cookies were provided on board the boat for lunch. We heard no complaints about the food, and our group endeared themselves to the cooks by eating voraciously. There is also small general store 2 blocks away from TREC which the students availed themselves on a regular basis for snacks and soft drinks.

Health and Safety:

You can lead a horse to water...

As is usually the case, and despite the best efforts (*i.e.* nagging) of the instructors, the most common injury on the trip is sunburn. A few people were also stung by mildly venomous invertebrates that are commonly found in the tropical oceans or scraped by coral. No injuries were severe to require medical attention beyond treatment at the TREC facility by our own on-staff nurse, Drs. Cyndi Sofhauser and Sue Anderson, nursing faculty members who have participated in the course at least 6 times previously. Since virtually all activities were done as a group, safety was never an issue. On the occasions when a group of students went into town (San Pedro), they were accompanied by an instructor who carried a two-way radio to remain in contact with those at the TREC lab. We are very militant about knowing where everybody is at all times, both in and out of the water, and while the students initially resent it, we believe they respect the reasons and eventually come to appreciate it.

Overall Recommendations:

Based on the feedback we received, it appears that both the students and the instructors were very pleased with the course as it was run and have no substantive recommendations to make. While we have we have no reason to take the class to a different location we are still convinced that it is worth the investment to locate an alternate site just in case Belize/TREC becomes too expensive, or the lab closes for economic reasons or due to hurricane damage.

No caption needed!

Dr. Grens and I are very pleased with the historically strong enrollments in the class and the unique experience it provides our students. We are however very concerned about the potential conflict between student/faculty ratios set by safety concerns and minimum enrollments set by financial considerations. Based on years of experience with students on the boats and in the water we are convinced that an 8:1 student/faculty ratio should not be exceeded for this kind of field intensive course. As minimum enrollment numbers set by administrators is currently set at 12-15 students per instructor for a summer course, we need to be mindful that safety is not jeopardized.

Next Program Date:

Due to the limited student pool here at IUSB, we offer this course only every other year. It will be offered again in Summer Session I of 2016.

Issues raised by the Advisory committee during approval process: none.

L342 - TROPICAL MARINE BIOLOGY FIELD STUDY

Summer 2014

Instructors:

Dr. Peter Bushnell
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520-4888
pbushnel@iusb.edu

Dr. Ann Grens
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520-4426
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Required texts: Peterson Field Guide to Coral Reefs of the Caribbean and Florida
Peterson Field Guide to Southeastern and Caribbean Seashores
both by Eugene Kaplan

Optional texts: Reef Fish Identification Florida-Caribbean-Bahamas, by Paul Humann
Reef Creature Identification Florida-Caribbean-Bahamas, by Paul Humann

Tentative Schedule for Spring and Summer Session I 2014

Day	Date	Activity	Location
Sat.	1 Feb 12:00 noon	Introductions, course overview, meet your group, choose group project topics	Northside 149
Fri.	**7 Feb**	**Deposit/first payment due ($800)**	Northside 137
Fri.	**7 March**	**Second payment due ($800)**	Northside 137
Sat.	8 March 12:00 noon	Paper presentations for group projects **Overseas Study paperwork due**	Northside 152
Fri.	**4 April**	**Final payment due ($850)** Project proposals due	Northside 137 Dr. Bushnell (NS 136)
Mon.	*5 May* *11:30 am*	*L304 final exam*	
Tues.	20 May 1:00 pm	Practice fish and invertebrates quiz Invertebrate ID lab #1	Northside 148
Thur.	22 May 1:00 pm	Invertebrate ID lab #2	Northside 071
Tues.	27 May 1:00 pm	Water sampling and analysis lab	Northside 148
Thur.	29 May 1:00 pm	Final information distributed Practice fish and invertebrates quiz Project overview presentations	Northside 148
Mon.	2 June	Leave for Belize	Northside parking lot
Wed.	11 June	Return from Belize	Northside parking lot
Fri.	27 June	**Project papers and species ID powerpoints due**	Dr. Grens (NS 128A)

Tentative Schedule of Activities in Belize

Date	Morning	Afternoon	Evening
Monday June 2	Leave for Belize	Arrive Belize Snorkeling practice	Intro to Belize
Tuesday June 3	Reef snorkel Pillar Coral	Reef snorkel Tres Cocos	Practice fish, invertebrates quizzes
Wednesday June 4	Reef snorkel Mexico Rocks	Grassbeds Conch, parrotfish projects	Night seining
Thursday June 5	Reef snorkel Fish diversity, damselfish projects	Grassbeds Conch, parrotfish projects	Night snorkel
Friday June 6	Lamanai (tropical forest and Mayan ruin)	Lamanai (tropical forest and Mayan ruin)	Dinner in town
Saturday June 7	Snorkel Caye Caulker north cut Manatees?	Caye Caulker snorkel Coral Gardens	Fish Quiz Invertebrates Quiz
Sunday June 8	Mangroves Invertebrate diversity project	Tuffy channel	Work on project presentations
Monday June 9	Reef snorkel Playa Blanca	Reef snorkel Sponge Gardens	Project presentations
Tuesday June 10	Turtle Island Hol Chan	Shark/Ray Alley	End of trip party
Wednesday June 11	Pack up and clean up	Leave Belize	Arrive South Bend

Please note that all activities in Belize are weather permitting, and the schedule will be adjusted as necessary due to weather conditions and the resident directors' recommendations.

Grading:

Attendance and enthusiastic participation	40%
Group project	40%
Reference paper presentation	*(5%)*
Project proposal	*(5%)**
Project presentation (in Belize)	*(5%)*
Paper	*(20%)**
Group members evaluation	*(5%)*
Species identification	20%
Invertebrate identification quiz	*(5%)*
Fish identification quiz	*(5%)*
Species identification project	*(10%)**

*Late submissions will lose 5% of the possible points on that assignment for each day that they are late, and will not be accepted more than one week late.

Equipment - Required

Passport; visa for Belize if necessary (not required if you have a US passport)
Snorkel, mask and fins
Light-weight gloves
Swim suits (at least 2; 3 would be better....putting on a wet swim suit is no fun)
Lycra "skinsuit", light-weight wetsuit, or long-sleeved rash guard and tights (required for the night snorkel and the mangrove snorkel)
Sunscreen - SPF $\geq$30, must be waterproof ("Bullfrog Amphibious Sunblock" and "Coppertone Sport" are two that have worked well in the past)
T-shirt, rash guard or other cover-up to snorkel in (to keep your back from burning)
Shorts and/or lightweight pants (2 or 3)
T-shirts or other light-weight tops (remember, this is the tropics; it's hot and humid)
Flip-flops/Tevas/other slip-on footwear to wear around the hotel
Sturdy walking shoes for the Mayan ruins
Socks (to wear while hiking; also socks to wear with your fins if you have "pocket" rather than "rocket" style fins and won't be wearing dive boots with your fins)
Sunglasses, hat
Insect repellent
Water bottle or canteen, with a carry strap or belt attachment
Flashlight - preferably waterproof. Make sure it has fresh batteries and a working bulb
Inexpensive waterproof watch
4 C-cell batteries (for the underwater spotlights for the night snorkel; leave in original package)
Field guides (see first page - these books are required)
USB jump drive for saving data and photos
Pens/pencils, notebook, etc

Equipment - Optional

Beach towel - the field site provides bath towels only
Mesh bag (available in dive shops) - great for carrying your snorkeling gear
Alarm clock
Clothespins - for hanging wet swim suits and towels out to dry
Ziplock bags - handy for keeping sunglasses and other items dry on the boat
Seasickness medication, Benadryl, Solarcaine - if appropriate
Spare glasses or contact lenses if you wear them

Toiletries - the housing at the field site will provide soap and toilet paper, but you need to bring your own shampoo, toothpaste, etc.

Prescription medication - please bring any medication you take in the original container from the pharmacy, and bring a typed copy of the prescription with you as well. This will make it easier to get a refill in Belize if necessary, and will make the DEA inspector happy when you re-enter the U.S.

Spending money - preferably in small bills. US dollars are accepted throughout Belize, but you may not get change for US dollars in US currency. The Belize dollar is fixed to the US dollar at a rate of BZ$2 = US$1.

SCUBA gear (except tanks and weights) and dive card if you plan to dive

Airline regulations allow ONE carry-on bag and ONE checked bag, weighing no more than 50 pounds, per person, so you need to pack everything you are bringing in one bag to check and one bag small enough to meet carry-on restrictions. Fees for extra bags, and for overweight bags, are frightening ($50 for one extra checked bag; $200 for a second extra bag; $100 per bag, starting with the first checked bag, for any bag that weighs more than 50 pounds!). Please pack your mask and snorkel and one swim suit in your carry-on bag, so that you can go snorkeling on Monday even if the airline misdirects your checked bag. **DO NOT** pack **anything** the airport security guards might possibly consider to be a weapon in your carry-on bag; this includes dive knives, razors, pocket knives, pointed nail files and any other sharp objects, matches and lighters, and any liquid in a container over 3 ounces. You are permitted only as many 3 ounce containers of liquids as will fit in one quart-size ziplock bag in your carry-on bag; all other liquids must go in your checked bag. If a guard finds any "dangerous" item in your carry-on bag (or your pockets), it **will** be confiscated. As with any travel, do not bring anything that you would be heartbroken to come home without. While security at the field site is quite good, a trip like this one creates a multitude of opportunities for you to forget or lose something you brought with you.

The Biology Department will provide one laptop computer per group, and will ask that one member of your group transport it to and from Belize as his or her "small personal item" (in addition to a carry-on bag). You may bring your own laptop if you wish, but we do NOT encourage it and you do so at your own risk. We will also provide waterproof digital cameras for generating the "virtual critter collection", although you may bring your own waterproof camera if you wish. Your cell phone probably will not work in Belize unless you have an "international chip" installed in it. There are two Internet cafes in the town of San Pedro, and there may be Internet access at the field station (but this is the developing world, so things like phone and internet service are less reliable than you may be accustomed to).

We will be staying at:

Tropical Research and Education Center (TREC)
Grouper Street, San Pedro
Ambergris Caye, Belize

The phone number there is 011-501-226-3389

Please note that phone calls from the Belize to the US are extremely expensive and should be reserved for emergencies. If someone in the US needs to contact you, they can call TREC, preferably during breakfast or dinner hours when we're most likely to be there. Here again, this should be limited to emergency/major disaster issues, as there is only one phone at the field station, which is shared by all visiting guests and the resident directors. San Pedro, Belize, is in the Central Time Zone (the same as Chicago) but does not observe Daylight Savings Time, so it will be 2 hours earlier there than it is in South Bend.

Fish Diversity

Brandon Gutierrez

Mackenzie Meade

Background and Significance

Coral reefs are among the most diverse ecosystems on earth. Diversity in reef fish communities is important in order to maintain species interactions necessary to preserve the reef community or habitat. There are many key factors that can increase or decrease species diversity such as water quality, wave action and living space. . One major factor of species diversity is the habitat they call home (Gladfelter 1980) It is necessary to determine which coral species support species diversity and richness in order to work towards preservation of these ecosystems.(Bell 1984) This understanding will help to support the development of artificial reefs in order to increase and preserve fish diversity. Many reef fish species cohabitate in different coral reef species (McGehee1994). There are three different categories of reefs: fringing reefs, barrier reefs, and atolls. The location we will be examining in Belize is a barrier reef that consists primarily of boulder, columnar, branching, and encrusting corals. There are many different fish families we plan to examine including; wrasse, damselfish, butterfly fish, surgeon fish, angel fish, Jack, silverside, grunt, snapper, parrotfish, goatfish, and squirrelfish.

Specific Aims

1) To determine the effect of coral species and rugosity on diversity of fish species.
   Hypothesis: Coral species with higher rugosity will support higher fish species diversity.

2) To determine the effect of percentage of live coral cover on fish diversity.
   Hypothesis: Higher percentages of live coral cover will support increased species richness and diversity.

3) To determine the effect of the physical environment on fish diversity.
   Hypothesis: Increased wave action will correlate with higher fish species diversity.

Methods.

Before the data collection begins, 13 fish families will be selected for population density analysis. The selected species will be written on underwater slates followed by an “unknown” category. Data will be collected from multiple dive sites. At each site, four 3m by 3m quadrats will be measured with rope, and weights attached to streamers will be dropped in each corner to mark the quadrat. Dive pairs will break off to collect data from their own quadrat. This will allow for four replications of experimental data at each dive site. Each pair will first determine the depth of their quadrat by measuring the depth of two corners at a diagonal of the quadrat to the middle of the wave to be averaged. Next the wave action will be observed and scored as low, moderate, or high. Each pair will count how many of each fish type they observe in their quadrat for a total of five minutes marking tally’s on the underwater slates. For the 13 fish families determined, the number of individuals will be counted. Any additional species observed will be marked with a single tally to mark the presence of an additional species regardless of population. We will also be measuring the rugosity (Kuffner 2007) of the coral by stretching a sinking rope over the coral and then tucking the rope in the crevices of the coral and measuring how far much rope was used. Data will be collected from a minimum of 3 dive sites. The first dive site will be Pillar Coral which consists predominantly of columnar coral. The second dive site to be surveyed will be tres cocos which consists of a heterogeneous mixture of coral types. The third dive site will be Mexico rocks which consists predominantly of boulder coral. If time allows, a fourth dive site, Coral Gardens, will be surveyed in order to observe branching and soft corals. The data collected will be analyzed using a series of indices including the Simpsons diversity index, the Shannon diversity index, the Jaccard index, and possibly the one way a nova index.

Appendix

Materials List

- Plastic 1 foot ruler
- Rope 30 meters
- Clothes line (rope that sinks) 20m
- 2 1 pound weights
- Mesh bag for rope
- 16 lead weights
- Ribbons for corner markers
- Floats for corner markers
- Camera
- Tape measure for depth
- Slates
- Pencils
- Water proof watches

Size of Territory Invaders and its Correlation to Damselfish Behavior

Toni Boger and Katie Riley

Background and Significance

The three spot Damselfish *stegastes planifrons* and dusky damselfish *stegastes adustus* are both commonly known for their aggressive territoriality to protect their food source, territory, and their nesting sites. Both the *S. planiforns* and the *S. adustus* have and average size of about 5 inches long, but their territory where their food source is located is typically less than 5 times the length of the fish that protect it from the various intruders (Robertson, *et al.* , 1981). Their habitats involve coral patch reefs and coral rubble (Robertson, *et al.* , 1981). Their food source grows within the coral and thus damselfish protecting their territory is an important aspect to survival and fitness. Within these patches of coral habitat, the *S. planiforon* and the *S. adustus* have not only their food source, but they attach their eggs to the substrate in these algae mats, which is also why it is important to their fitness (Robertson, *et al.* , 1981). These algae mats are made up of benthic algae and invertebrates that the male typically attach to the substrate (Robertson, *et al.*, 1981). Usually these damselfish will spend their entire mature life protecting one single area, which is usually densely surrounded by other algae matts, which creates a kind of colony where all of these adult damselfish live and reproduce (Sau-Fung Lee and Barlow, 2000). Since these fish are very protective of their algae territories, they will "attack" most fish that enter their area, whether these invading fish are herbivores, carnivores, or omnivores, and even some damselfish will become territorial against some of the omnivorous sea urchins (Robertson, *et al.*, 1981). These attacks on the various intruders are varied on the size of the biomass turf. But they are directly related because the rate and the effectiveness of these attacks on the various intruders increase with the increasing size of the biomass turf (Foster, 1985). This means that the larger the area of the biomass turf, the more protective the fish are of the area and also the larger biomass area is usually better defended from the various intruders. However, they also attack their own damselfish neighbors fiercely if they are ever forced to do so. Their algal mats that they protect rarely overlap in each other's territory, but sometimes their territories will overlap (Robertson, *et al.*, 1981). With this overlap, the opportunity to try and steal your neijhbor's resources and territory increases and this will aid in the data for attacks on smaller fish size (Robertson, *et al.*, 1981).

In our experiment we are testing the size of the invaders of the damselfish territory and the effect of the damselfish size on the attack pattern it has when it faces the various invaders. Our specific question can help us determine how the damselfish's overall fitness can either be improved or hindered by certain invaders. Others have done experimental research on certain families of fishes that they know for sure will elicit a response from. Damselfish have to evaluate which fish they can fight against and which ones pose more of a threat to them (Schacter et al 2013). Making these decisions can help the fish's overall survival and fitness rates. But the overall size difference also depends on the species of fish that enters their territory and the capability of their stealing their food or resources.

Specific Aims and Methods

The overall important question we are asking is: does the size of the intruding fish elicit different behavioral responses from the Damselfish? Do larger fish get any response or do smaller fish get a larger response? Schacter et al. did scientific research in the Virgin Islands to try and answer this question but by a different method (Schacter et al 2013). But to start of our experimental analysis, first we have to do some observing of each damselfish for a 5 minute period to try and find out where their territory is exactly. Once the territory is mentally mapped out, the observers can then use 5 different sized fish models to try and elicit a response from the damselfish. These fish models with all have a similar shape and color, only their size will differ. The selected sizes will be 2 inches, 4 inches, 6 inches, 8 inches, and 12 inches. They will be made out of a Plexiglas material. This does only provide a 2D structure, however, the only thing we are looking for is a size comparison, not specific modeled fish. A fish weight will be attached to each model and then attached to a wire that can be extended into the territory from a safe distance to get a good behavioral response. The behavioral responses will be rated on a 1-5 scale. (1: fish does not give any noticeable response, 2: Fish attacks the invader until invader swims away, 3: Fish attacks and follows the invader out of the territory, 4: Fish hides or tries to abandon the territory. 5: Fish panics and exhibits strange behavior such as swimming in circles, up and down, or any other noticeable panicked behavior). We define an attack as when a fish directly swims toward the invader and accelerates rapidly. Not necessarily hitting the invader, but any attempted attack/excess movement to get the invader to swim away. Observers will collect the data for as many damselfish as possible but the goal should be 2-3 fish per group and all 5 of the models must be used on each fish. Underwater slates with the behavior scale and each size of model on them will be used to record the data. Thus only check marks will be needed to record the observations. Observers should wait 1-2 min before attempting to use another fish model in order to give the fish a second to reset the situation each time. The fish models will be slowly entered into the environment through horizontal movement. Therefore, the models should not be entered from above and dropped in or rapidly just shoved into their territory. Slowly and horizontally as if a real fish invader were entering its territory. Observers should also take note of the size of each damselfish being used in these experiments. This measurement can be estimated in comparison to the fish models in inches and then placed into a category if need be such as small (1-3 inches) medium (4-7 inches) and large (8-12 inches). This will give us a sense if the size of the damselfish has any effect on the size of intruders it will attack.

With these results, we should be able to determine if large invaders are more of a threat to damselfish or if smaller fish are more strongly attacked. This can give us a better idea of how aggressive territory behaviors inhibits or improve the fitness of a damselfish. In comparison to the research done by Schacter et al. they did test the effect of size on a behavior scale. However, their behavior scale was similar but only had three possible responses, and just observed the number of attacks on real fish invaders, estimating the size of each fish (Schacter et al 2013). They also looked at the distance of each of the attacks and used four different families of fish that they knew would elicit certain responses because some fish are more of a threat to their resources than others (Schacter et al 2013). Overall, they concluded that there were more attacks on smaller fish than larger fish and the distance the fish went to attack the intruder varied (Schacter et al 2013). Based on these results, we can expect that the same trend may happen. Where larger invaders will not be attacked and the smaller fish will be attacked more aggressively. This data can then be put into bar graphs and line graphs where averages and standard deviations can be used to establish mean sizes of invaders. We can also do a comparison graph between the sizes of the damselfish compared to the size of fish they attacked.

As a back- up plan if our models should somehow fail us and give us absolutely no data, we will use real live fish and just observe their approximate size and still rate them on our behavior scale. Just in case we should run into any obstacles it is always good to have a plan B on hand. But, overall these results will be a great additional analysis of how territory behaviors work in damselfish in comparison to other fish.

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Appendix-Supplies and Equipment

Underwater slates and writing utensils

Copper wire to attach to each of the models

Pexiglas for 5 fish models for each group? (do we need 5 for each group or will we be doing these separately as groups at different times?)

A fish weight for each of the models to weigh it down

Waterproof paint (Green/yellow)

Real live damselfish in their natural habitat

Black Permanent markers

Waterproof stop watches (Just in case)

Metric tape (just in case)

Parrotfish grazing as a result of seagrass blowouts

Sample, Sydney

Background and Significance

Seagrass meadows, which are submerged marine flowering plants, are found in shallow coastal waters around the world. They provide food and shelter for a multitude of animals, including invertebrates, fish, and endangered species (Greenway 1995). Within continuous seagrass beds, there can be patchy, or bare, unvegetated areas called blowouts (Patriquin 1975). These unvegetated blowouts can be caused by localized grazing (Bjorn- dal 1980, Williams 1988, Valentine & Heck 1991), bioturbation (Fonseca et al. 1996, Townsend & Fonseca 1998), or abiotic factors (Scoffin 1970, Patriquin 1975). A blowout is usually crescent shaped with a vertical wall, known as a scarp, along a clearly defined eroding edge (Macia & Robinson 2005). The unvegetated area of the blowout is usually deeper than the surrounding seagrass bed, and the scarp (vertical wall) may have a vertical break of up to 80 cm (Patriquin 1975, Macia & Robinson 2005). Seagrass patchiness, and therefore blow outs, have a significant impact on the broader community including changes in local sediment size (Bowden et al., 2001), abundance of fishes and shrimps (Murphey & Fonseca 1995, Hyndes et al. 2003, Salita et al. 2003), survivorship, growth and predation rates of bivalves and crabs (Irlandi & Peterson 1991, Irlandi 1994, Irlandi et al. 1995, Hovel et al. 2002), and infaunal species richness (Bowden et al. 2001). This is because the presence of blowouts creates unique microhabitats by means of disrupting the typically continuous covering of a dense seagrass meadow. (Macia & Robinson 2005). It is believed that some of these microhabitats, such as the overhanging seagrass root/rhizome mats, located at the scarp of a blowout, could be used by various fishes as a means of protection from predators (Macia & Robinson 2005). With the many fishes and invertebrates that utilize the seagrass beds, of particular interest are Parrotfish of family Scaridae, specifically the Redtail Parrotfish, *Sparisoma chrysopterum*, common in the Caribbean Sea of Belize. This is where research will take place. According to the results of Macia & Robinson (2005) the length and density of seagrass blades increased significantly as distance from the edge of the blowout increased. This raises the question, do Parrotfish of different sizes utilize seagrass blowouts differently? Does seagrass density affect the extent to where in the seagrass beds a Parrotfish can hide from predators? Do larger Parrotfish tend to use the overhang of the root/rhizome mat at the edge of the blowout as protection, because seagrass density further from the blowout inhibits their ability to find refuge?

Specific Aims and Methods

Because it is not possible to capture *S. chrysopterum* and directly measure bite widths of the species, bite size must be used as a proxy to fish length. As previously reported by Macia & Robinson (2005), larger fishes will have larger bite widths. To definitively establish the relationship between bite size and fish length, Macia & Robinson (2005) used a drop-net to capture 3 species of Parrotfish (one of which was *S. chrysopterum*). Total length of each fish was measured, and then each fish was placed in an individual outdoor aquarium with an open water system. Each tank had seagrass 'shoots', consisting of 3 or 4 blades of unbitten *Thalassia testudinum,* which were held together with a clothespin in a way that made the blades float upright. The fishes were kept in the aquaria until they had made at least 10 bites on each seagrass blade. The results of which revealed that the mean bite width of *S. chrysopterum,* measuring 85 and 95 mm in length, was approximately 4 cm. And *S. chrysopterm,* ranging in length from 135-160 mm, had a bite width of approximately 7-8 cm. In order to answer whether or not Scaridea of different sizes use blowouts differently, 4 different blowouts will be used to collect data. Each blow out will be transected into fourths, perpendicular to the edge of each blowout using PFC piping. Each transect will be a foot apart and grass blades will be collected at 5 distances along the transect: 0,1,2,3,4 ft. At each distance, all seagrass blades in each quadrant will be hand collected and taken back to the boat to measure bite width. To ensure clarity, blades collected from each distance of a transect will be stored in separate ziplock bags; each bag will have a different colored pipe cleaner as reference to which distance the diver collected the blades at. Color of pipe cleaner does not have to be the same for each diver, but divers will mark on their dive-slate which color they associate with each distance. As stated before, bite width is directly related to fish length. Using the data from Macia & Robinson (2005) as reference for this experiment, a large fish would be associated with a bite width of 7mm $\geq$ and a small fish would be associated with a bite width of 4 mm $\leq$. After measuring bite widths from the different quadrants, it will be possible to determine whether or not larger fish graze near the blowout or further away from it, and therefore use that area as refuge; the same of course with smaller fish.

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Appendix – Supplies and Equipment

4 sets of PFC pipe (4 feet by 4 feet)

Set of 50 ziplock baggies (quart size)

4 dive-slates

30 each of: red, blue, orange, green, purple pipe cleaners

10 rulers