MR 500 B1: The Ecology of Coral Reef Fishes

SYLLABUS

CONTACT INFORMATION

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LECTURE

See course schedule.

RESEARCH LAB

See course schedule.

OFFICE HOURS

Pete Buston: Tue/Thu, 12:00-13:00
Robin Francis: TBD

PREREQUISITES

Admission to the Marine Semester [Introduction to Oceanography (EE144), Marine Biology (BI260), Statistics I (MA115)] and permission of instructor. This course builds on courses such as Introductory Biology (BI107), and complements courses such as Behavioral Biology (BI225), Evolutionary Ecology (BI303), Evolution (BI309), Animal Behavior (BI407), and Ichthyology (BI531).

ENROLLMENT LIMIT

15

OBJECTIVES (AND SOME LOGISTICS)

The principal objectives of this course are to introduce students to the ecology, evolution, and behavior of coral reef fishes, with a special focus on the coral reef fishes of Belize. In Boston, in the mornings, prior to the field (November 28 – December 6; 7 days), students will be introduced to the organisms, the environments, and key concepts in behavioral, population, and community ecology. In Boston, in the afternoons, prior to the field, students will conceive a project, design an experiment, and develop a proposal for a feasible research project in one of the areas of behavioral, population, or community ecology. The course will travel to Belize, to get first-hand experience of these organisms and their environments (Traveling to Belize on December 7 and returning from Belize on December 19). In Belize, the first three days will be spent engaging in snorkel safety training (1 day) and doing ecosystem tours (2 days), to get students comfortable in their new environment (December 8-10). The next three days will be spent piloting research projects (2 days) and taking a well-earned break (1 day), so that students are ready to conduct their research projects (December 11-13). The final five days in Belize will be spent in project data collection, data management, data analysis, preparing final oral presentations and written reports (December 14-18). In Boston, the day after returning from the field, students will learn how to clean and store field gear, finalize and submit their written report, and debrief (December 20). Students will be free to leave Boston on December 21. By the end of the course students will have a better understanding of the ecology, evolution, and behavior of coral reef fishes, and a deeper appreciation of the challenges of conducting field research on these organisms.

INSTRUCTIONAL FORMAT, COURSE PEDAGOGY, AND APPROACH TO LEARNING

Books and other materials
There is no perfect text for this course. I will provide lecture notes and all recommended readings via Blackboard (see Course Schedule). The readings will provide a different perspective and additional context for the lecture notes. Below I list the books used heavily in the development of this course, for your future reference.

General Fish Biology
Helfman GS, Colette BB, Facey DE, Bowen BW. 2009. The diversity of fishes. 2nd edition. Wiley-Blackwell.
Moyle PB, Cech JJ. 2003. Fishes: an introduction to ichthyology. 5th edition. Pearson.
Caillet G, Love M, Ebeling A. 1996. Fishes: a field and laboratory manual. Waveland.

The Ecology of Coral Reef Fishes
Mora, C. 2015. Ecology of Fishes on Coral Reefs. Cambridge University Press, Cambridge, UK.
Sale, PF. 2006. Coral Reef Fishes: Dynamics and Diversity in a Complex Ecosystem. Academic Press, USA.
Sale, PF. 1991. The Ecology of Fishes on Coral Reefs. Academic Press, Inc. San Diego, California, USA.

The Diversity of Coral Reef Fishes
Kells VA, Rocha LA, Baldwin CC. 2022. A field guide to coastal fishes. First edition. Johns Hopkins University Press.
Humann, P., Deloach, N. 2014. Reef fish identification. Fourth edition. New World Publications, USA
Nelson JS. 2006. Fishes of the world. Fourth edition. John Wiley & Sons, New Jersey, USA.

Useful websites
Smithsonian Tropical Research Institute: https://biogeodb.stri.si.edu/caribbean/en/pages
Fishbase: https://www.fishbase.se/search.php
iNaturalist: https://www.inaturalist.org/observations?place_id=162575&subview=map
Eschmeyer's Catalog of Fishes: https://researcharchive.calacademy.org/research/ichthyology/catalog/fishcatmain.asp

BUMP Media Library
Fishes: https://bumarine.smugmug.com/ORGANISMS/METAZOA-animals/CHORDATA/FISHES
Sites: https://bumarine.smugmug.com/HABITATS/On-the-REEF/BELIZE-REEF-SITES
BI569 Tropical Marine Inverts: https://bumarine.smugmug.com/COURSES/Tropical-Marine-Invertebrates-

ASSIGNMENTS AND GRADING

Lecture series (5 concept lectures; 5 diversity and natural history lectures; 7 days)	
Pre-field trip exam based on lecture material	10%
Research planning series (7 sessions; 7 days)	
Preliminary oral presentation (10-15 mins)	5%
Preliminary scientific proposal/report (2 pages)	5%
Preliminary data and metadata	5%
Performance as a field scientist (13 days)	45%
Travel etiquette	*5*
Research station etiquette	*5*
Snorkel training and conduct	*5*
Boat training and conduct	*5*
Ecosystem tours and conduct	*5*
Pilot project execution (round 1)	*5*
Full project execution (round 2)	*5*
Full project execution (round 3)	*5*
Gear cleaning and storage	*5*
Scientific Deliverables	
Final oral presentation (10-15 min)	10%
Final scientific report (2 page final report)	10%
Final data and metadata	10%

RESOURCES, SUPPORT, AND HOW TO SUCCEED IN THIS COURSE

Accommodations for Students with Documented Disabilities
If you are a student with a disability or believe you might have a disability that requires accommodations, please contact BU Disability and Access Services at (617) 353-3658 or access@bu.edu to coordinate any reasonable accommodation requests. BU Disability and Access Services is located at 25 Buick Street (Suite 300).

COMMUNITY OF LEARNING: CLASS & UNIVERSITY POLICIES

Positive Learning Environment
Students will commit to a growth mindset, working to improve their understanding throughout the course, being responsive to feedback from the professor, teaching fellow, and their peers, with the ultimate goal of mastering material and becoming consummate field biologists. Students will commit to learning via teamwork and collaboration, listening and responding thoughtfully to others, working together to deepen their understanding.

Attendance & Absences
Attendance of the lecture series, research planning series, and the field course is essential to facilitate learning of the material and transferable skills. In the event that one of these sessions must be missed, students must provide a valid university excuse (e.g., religious observances, varsity sports, flu/COVID). Students should be aware that missing one day of a marine semester course is equivalent to missing an entire week of the regular semester.

Assignment Completion & Late work
Assignments must be completed in on time. Late work will not be accepted if it is not well justified. Similarly, there will be no opportunities for make-ups that are not well justified. It is simply not possible, given the pace of marine semester courses. If you have questions regarding the grading, you must resolve the issue within one day of the session or assignment that you are querying. Extra credit assignments are not available.

Anticipated Workload
This is a 4 credit course, compressed into 21 contact days, including 18 class days, 2 travel days, and 1 day of rest in the field. So, for equivalence with a semester long 4 credit course, you should anticipate spending 8-10 hours per class day on this course (140-180 hours total). A reasonable breakdown might be: 3 hours outside of class time when we are in Boston; 10 hour days we are in Belize. The workload is anticipated to be heavy, but manageable, and even enjoyable. We will work hard, cover a lot of material, and learn A LOT!

Academic Conduct
All students are expected to know and understand the provisions of BU's Academic Conduct Code:
https://www.bu.edu/academics/policies/academic-conduct-code/
All cases of suspected academic misconduct will be referred to the appropriate Dean's Office.

COURSE SCHEDULE (subject to change).

Monday, November 28 – Boston Day 1	
10:00 - 10:50	***Lecture 1a: Introduction to The Ecology of Coral Reef Fishes*** Reading 1: Course syllabus
11:00 - 11:50	***Lecture 1b: Travelers Guide to Belize*** Reading 1: Lecture Handout
12:00 - 12:50	***Lunch***
1:00 – 1:50	***Diversity & Natural History 1: Nurse Sharks, Numbfishes, Whiptail Stingrays, Tarpons, Bonefishes, Moray Eels, Herrings, and Lizardfishes, Mullets, and Needlefishes*** Reading 1: Kells VA, Rocha LA, Baldwin CC. 2022. A field guide to coastal fishes. Introduction, pp 12-21 Reference 1: Kells VA, Rocha LA, Baldwin CC. 2022. A field guide to coastal fishes. pp 58-194
2:00 – 4:00	***Research Planning Session 1a:*** - Expedition planning: people, place, permissions, projects Reading 1: Belize Fisheries Scientific Research Proposal Reading 2: Belize Fisheries Scientific Report Format ***Research Planning Session 1b:*** - Fundamental questions: i) which fishes live in Belize, ii) are there differences between environments, iii) do methods matter? - Online resources for pre-departure survey: BUMP media library, iNaturalist - Emphasis on team and class collaboration Reading 1: Nagelkerken I et al. 2000. Importance of shallow-water biotopes of a Caribbean bay for juvenile coral reef fishes: patterns in biotope association, community structure, and spatial distribution. *Marine Ecology Progress Series* 202: 175-192 Reading 2: Usseglio P. 2015. Quantifying reef fishes: bias in observational approaches. In: *Ecology of Fishes on Coral Reefs*. Mora C ed. Chapter 33, Pp 270-273 ***Research Planning Session 1c: Scientific Deliverables: how to produce a good oral presentation and scientific report*** Reading 1: Kirshner J. 1996. Alfred Hitchcock and the Art of Research. Political Science and Politics 29: 511-513
Evening	***Learn fish families 1-10*** ***Assignment 1: Teams assigned by instructors***

Tuesday, November 29 – Boston Day 2	
10:00 - 10:50	***Concepts 2a: The Evolution of Coral Reef Fishes: Global Origins, Global Biogeography, and Global Biodiversity*** Optional Reading 1: Bellwood DR, Goatley CHR, Cowman PF, Bellwood O. 2015. The evolution of fishes on coral reefs: fossils, phylogenies, and functions. In: *Ecology of Fishes on Coral Reefs*. Mora C ed. Chapter 6, Pp 56-64 Optional Reading 2: Mora C. 2015. Large-scale patterns and processes in reef fish richness. In: *Ecology of Fishes on Coral Reefs*. Mora C ed. Chapter 9, Pp 88-96
11:00 - 11:50	***Concepts 2b: The Environments of Coral Reef Fishes: Coral Reefs, Seagrass Beds, Mangroves, and Sand Flats*** Optional Reading 1: Jaxion-Harm J et al. 2012. Distribution of fish in seagrass, mangroves, and coral reefs: life stage dependent habitat use in Honduras. *Rev. Biol. Trop*. 60: 683-698. Optional Reading 1: Mumby PJ et al. 2004. Mangroves enhance biomass of coral reef fish communities in the Caribbean. *Nature* 427: 533-536
12:00 - 12:50	***Lunch***
1:00 – 1:50	***Diversity & Natural History 2: Squirrelfishes, Sea Horses, Trumpetfishes, Cornetfishes, Scorpionfishes, Sea Basses, Jawfishes, Fairy Basslets, Cardinalfishes, Sand Tilefishes*** Reference 1: Kells VA, Rocha LA, Baldwin CC. 2022. A field guide to coastal fishes. pp 206-298
2:00 – 4:00	***Research Planning Session 2:*** - Teams start pre-departure survey - Identify every fish photo to family x environment x method and enter data - XL, data entry (counts of family / day), data quality control (check entries), data management (file name), metadata (data description)
Evening	***Learn fish families 11-20*** ***Assignment 2: Teams read and prepare to lead discussion on one of next day's papers on adult biology*** Team 1: D'Aloia et al. 2011. Predictors of the distribution and abundance of a tube sponge and its resident goby. *Coral Reefs* 30: 777-786 Team 2: Majoris et al. 2018. Differential persistence favors habitat preferences that determine the distribution of a reef fish. *Behavioral Ecology* 29: 429-439 Team 3: Francis et al. 2022. Characteristics of breeding habitat, genetic mating system, and determinants of male mating success in the sponge-dwelling goby *Elacatinus lori. Behavioral Ecology and Sociobiology* in press.

Wednesday, November 30 – Boston Day 3	
10:00 - 10:50	***Concepts 3: The Ecology of Adult Coral Reef Fishes: Competition and Predation*** Optional Reading 1: Forrester G. 2015. Competition in reef fishes. In: *Ecology of Fishes on Coral Reefs*. Mora C ed. Chapter 4, Pp 34-40 Optional Reading 2: Hixon MA. 2015. Predation: piscivory and the ecology of coral reef fishes. In: *Ecology of Fishes on Coral Reefs*. Mora C ed. Chapter 5, Pp 41-54
11:00 - 11:50	***Discussion 3: A Model System Caribbean Coral Reef Fish Ecology: The Neon Gobies — Adult Biology*** Team 1: D'Aloia et al. 2011. Predictors of the distribution and abundance of a tube sponge and its resident goby. *Coral Reefs* 30: 777-786 Team 2: Majoris et al. 2018. Differential persistence favors habitat preferences that determine the distribution of a reef fish. *Behavioral Ecology* 29: 429-439 Team 3: Francis et al. 2022. Characteristics of breeding habitat, genetic mating system, and determinants of male mating success in the sponge-dwelling goby *Elacatinus lori. Behavioral Ecology and Sociobiology* in press.
12:00 - 12:50	***Lunch***
1:00 – 1:50	***Diversity & Natural History 3: Remoras, Jacks, Snappers, Mojarras, Grunts, Porgies, Drums, Goatfishes, Sweepers, and Sea Chubs*** Reference 1: Kells VA, Rocha LA, Baldwin CC. 2022. A field guide to coastal fishes. pp 204-366
2:00 – 4:00	***Research Planning Session 3:*** - Teams continue pre-departure survey - Identify every fish photo to family x environment x method and enter data - JMP/R, importing data, frequency distributions: families x environment x team
Evening	***Learn fish families 21-30*** ***Assignment 3: Teams read and prepare to lead discussion on one of next day's papers on larval biology*** Team 1: Majoris et al. 2022. Paternal care regulates the timing, synchrony, and success of hatching in a coral reef fish. *Proceedings of the Royal Society of London, Series B.* in press. Team 2: Majoris et al. 2019. Ontogeny of larval swimming abilities in three species of coral reef fishes and a hypothesis for their impact on the spatial scale of dispersal. *Marine Biology* 166: 159- Team 3: Majoris et al. 2021. An integrative investigation of sensory organ development and orientation behavior throughout the larval phase of a coral reef fish. *Scientific Reports* 11: 1-13.

Thursday, December 1 – Boston Day 4	
10:00 - 10:50	***Concepts 4: The Ecology of Larval Coral Reef Fishes: Swimming and Sensory Abilities of Larval Coral Reef Fishes*** Optional Reading 1: Leis, J. 2015. Is dispersal of larval reef fishes passive? In: *Ecology of Fishes on Coral Reefs*. Mora C ed. Chapter 23, Pp 223-226 Optional Reading 2: Atema J, Gerlach G, Paris CP. 2015. Sensory biology and navigation behavior of reef fish larvae. In: *Ecology of Fishes on Coral Reefs*. Mora C ed. Chapter 1, Pp 3-15
11:00 - 11:50	***Discussion 4: A Model System for Caribbean Coral Reef Fish Ecology: The Neon Gobies — Larval Biology*** Team 1: Majoris et al. 2022. Paternal care regulates the timing, synchrony, and success of hatching in a coral reef fish. *Proceedings of the Royal Society of London, Series B.* in press. Team 2: Majoris et al. 2019. Ontogeny of larval swimming abilities in three species of coral reef fishes and a hypothesis for their impact on the spatial scale of dispersal. *Marine Biology* 166: 159- Team 3: Majoris et al. 2021. An integrative investigation of sensory organ development and orientation behavior throughout the larval phase of a coral reef fish. *Scientific Reports* 11: 1-13.
12:00 - 12:50	***Lunch***
1:00 – 1:50	***Diversity and Natural History 4: Butterflyfishes, Angelfishes, Hawkfishes, Damselfishes, Wrasses, Parrotfishes, Combtooth Blennies, Scaled Blennies, Tube Blennies, and Gobies*** Reference 1: Kells VA, Rocha LA, Baldwin CC. 2022. A field guide to coastal fishes. pp 368-493
2:00 – 4:00	***Research Planning Session 4:*** - Teams continue pre-departure survey - Identify every fish photo to family x environment x method and enter data - JMP/R, family accumulation curves: families x environment x team x day
Evening	***Learn fish families 31-40*** ***Assignment 4: Teams read and prepare to lead discussion on one of next day's papers on molecular ecology*** Team 1: D'Aloia et al. 2015. Patterns, causes, and consequences of marine larval dispersal. *Proceedings of the National Academy of Sciences USA* 112: 13940-13945. Team 2: D'Aloia et al. 2020. Unraveling hierarchical genetic structure in a marine metapopulation: a comparison of three high-throughput genotyping approaches. *Molecular Ecology* 29: 2189-2203 Team 3: D'Aloia et al. 2022. Population assignment tests uncover rare marine larval dispersal events. *Ecology* 103: e03559

Friday, December 2 – Boston Day 5	
10:00 - 10:50	***Concepts 5: The Molecular Ecology of Coral Reef Fishes: Larval dispersal and population connectvity*** Optional Reading 1: Jones GP. 2015. Mission impossible: unlocking the secrets of coral reef fish dispersal. In: *Ecology of Fishes on Coral Reefs*. Mora C ed. Chapter 2, Pp 16-27 Optional Reading 2: Eble JA, Bowen BW, Bernardi G. 2015. Phylogeography of coral reef fishes. In: *Ecology of Fishes on Coral Reefs*. Mora C ed. Chapter 7, Pp 64-75.
11:00 - 11:50	***Discussion 5: A Model System in Belizean Coral Reef Fish Ecology: The Neon Goby (Elacatinus lori) — Molecular Ecology*** Team 1: D'Aloia et al. 2015. Patterns, causes, and consequences of marine larval dispersal. *Proceedings of the National Academy of Sciences USA* 112: 13940-13945. Team 2: D'Aloia et al. 2020. Unraveling hierarchical genetic structure in a marine metapopulation: a comparison of three high-throughput genotyping approaches. *Molecular Ecology* 29: 2189-2203 Team 3: D'Aloia et al. 2022. Population assignment tests uncover rare marine larval dispersal events. *Ecology* 103: e03559
12:00 - 12:50	***Lunch***
1:00 – 1:50	***Diversity and Natural History 5: Spadefishes, Surgeonfishes, Barracudas, Tunas, Flounders, Triggerfishes, Filefishes, Boxfishes, Pufferfishes, Porcupinefishes*** Reference 1: Kells VA, Rocha LA, Baldwin CC. 2022. A field guide to coastal fishes. pp 496-542
2:00 – 4:00	***Research Planning Session 5:*** - Teams finish pre-departure survey - Identify every fish photo to family x environment x method and enter data - JMP/R, principal component analyses: communities x methods x environments
Evening	***Learn fish families 41-50*** ***Assignment 5: Teams work on scientific deliverables*** - *Draft scientific report* - *Draft oral presentation* - *Draft metadata & data* - ***Revise notes for pre-field trip exam.***

Monday, December 5 – Boston Day 6	
8:00 – 8:30	**COVID Test – Student Health Annex**
9:00 – 9:50	***Scientific Snorkeling A – Review of snorkeling skills*** Donning equipment, mask-snorkel clearing, replacing fins, floating face down, swimming face down, floating with snorkel vest, helping.
10:00 - 10:50	***Scientific Snorkeling B – Practice sampling techniques*** Laying a transect, swimming a transect, using a slate, using a camera
12:00 - 12:50	***Lunch***
1:00 – 1:50	***Pre-field trip exam: Show us what you know***
2:00 – 4:00	***Research Planning Session 6: Work on Scientific Deliverables*** - *Draft scientific report* - *Draft oral presentation* - *Draft metadata and data*
Evening	***Assignment 6: Teams work on scientific deliverables*** - *Finish first draft of scientific deliverables*

Tuesday, December 6 – Boston Day 7	
10:00 - 10:50	***Mini-lecture 7a: performance as a field scientist*** Reading 1: Lecture Handout ***Mini-lecture 7b: potentially hazardous marine life*** Reading 1: Lecture Handout
11:00 - 11:50	***Discussion 7 – Scientific Deliverables*** Each team provides preliminary scientific deliverables: oral presentation; scientific report; metadata and data
12:00 - 12:50	***Lunch***
1:00 – 4:00	***Research Planning Session 7: Finish packing for Belize*** - *Team bags* - *Packing list* - *Buddy check*
Evening	***Assignment 7: Finish packing for Belize*** - *Personal bags* - *Early to bed to arrive at airport w. team on time*

Date	Class	Topic	Reading	Assignment
Wednesday, December 7 (FLY 1)	Travel Boston to Belize City	Details?		
	Travel Airport to the Dock	Details?		
	Travel Dock to Calabash Caye	Details?		
Thursday, December 8 (BZE 1)	Open Water Snorkel Training	Instructed by DSO		
	Tour of Calabash Caye	Led by TASA Guide		
	Movie Night	• Sharing experience of first day on atoll		
Friday, December 9 (BZE 2)	Ecosystem Tour 1: Seagrass Turneffe Lagoon			
	Ecosystem Tour 2: Mangrove Crooked Creek			
	Movie Night	• Sharing and evaluating photos, videos, and experiences.		
Saturday, December 10 (BZE 3)	Ecosystem Tour 3: Sand flats Wonderland			
	Ecosystem Tour 4: Forereef Blackbird Caye Forereef			
	Movie Night	• Sharing and evaluating photos, videos, and experiences. • Prepare materials for pilot projects: slates, cameras, etc		
Sunday, December 11 (BZE 4)	Pilot Project 1: Seagrass	• Try out community surveys in seagrass		
	Pilot Project 2: Mangrove	• Try out community surveys in mangrove		
	Movie Night	• Discussion of issues confronted Revised plan for next day • Enter pilot data from slates, and clean slates for next day • Plan and prepare materials for full project		
Monday, December 12 (BZE 5)	Pilot Project 3: Coral Reef	Try out community surveys on coral reef		
	Pilot Project 4: Sand Flats	Try out community surveys on sand flats		
	Movie Night	• Discussion of issues confronted • Enter data and clean slates • Plan and prepare materials for next day		

Tuesday, December 13 (BZE 6)	Rest & Recovery Day	Details?		
		Details?		
		Details?		
Wednesday, December 14 (BZE 7)	Full Project 1	Seagrass Bed 1		
	Full Project 2	Mangrove 1		
	Movie Night	• Discussion of issues confronted • Enter data and clean slates • Plan and prepare materials for next day		
Thursday, December 15 (BZE 8)	Full Project 3	Coral Reef 1		
	Full Project 4	Sand Flat 1		
	Data Management 2	• Enter data and clean slates • Preliminary Analyses on A • Plan and prepare materials for next day		
Friday, December 16 (BZE 9)	Full Project 5	Mangrove 2		
	Full Project 6	Seagrass 2		
	Data Analysis 1	• Enter data and clean slates • Plan and prepare materials for next day • Work on oral presentation, scientific report, metadata, data		
Saturday, December 17 (BZE 10)	Full Project 7	Sand 2		
	Full Project 8	Coral Reef 2		
	Oral Presentation – Preparation	• Enter data and clean slates • Plan and prepare materials for next day • Work on oral presentation, scientific report, metadata, data		
Sunday, December 18 (BZE 11)	Oral Presentation – Final			
	Packing and Clean-up			
	Celebration			-

Monday, December 19 (FLY 2)	Travel Calabash Caye to Dock	Details?		
	Travel Dock to Airport	Details?		
	Travel Belize City to Boston	Details?		
Tuesday, December 20 (BOS 8)	Unpacking and Clean-up			
	Scientific Report – Final Metadata & Data – Final			
	Course wrap-up and review			
	Celebration			

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