BIOS 4417/6417 MARINE ECOLOGY SPRING 2027

Instructor Information

Instructor	Email	Office Hours & Location (ES&T 2102)
Mark Hay	mark.hay@biology.gatech.edu	By appt – just email, and we will work out a good time Tues after class until 12 PM or by appt Ford ES&T 2102

General Information

Time and Location: Tues Thurs 9:30-10:45 AM, Ford Env Sci and Tech Building L1125

Description: Compared to terrestrial systems, marine ecosystems are larger, older, have a huge impact on global climate and biogeochemical cycles, and support nearly twice as many phyla of animals as do terrestrial systems. This course provides an overview of the biotic interactions and physical forces structuring marine communities, the function and ecosystem services provided by marine communities, and the major threats to their continued function and value.

Pre- &/or Co-Requisites: BIOS 2335 or 2337 are pre-requisites, but in the past several students, primarily engineering students, with interests in marine biology but without these pre-requisites have petitioned to waive the pre-requisites and have done well in the course. If you are interested, discuss your interests and background and I'll likely make an exception.

Course Goals and Learning Outcomes:

- Learn the state of modern ocean ecosystems, the ecosystem services they have traditionally provided, and the present threats to these ecosystems and services.
- Understand the complex biotic interactions that underlie marine ecosystem function and how these interactions may be leveraged to more wisely manage, conserve, and potentially restore marine communities.
- Learn the fundamentals of how good science is conducted by using strong inference and multiple working hypotheses.
- Become comfortable and proficient at reading, evaluating, and challenging the primary literature (i.e., we will not use a book, but will read and evaluate the primary literature related to each lecture topic).

Course Requirements & Grading

Assignment	Date	Weight
Pop Quiz	Throughout the course	5%
Exam 1	4 Feb	20%
Exam 2	4 March	20%
Exam 3	20 April	20%
Summary Paper (5%) and Presentation (10%)	Varies by student	15%
Research Proposal/Career Summary	Self-scheduled - anytime before 22 April	20%
Class Participation/Discussion		3% extra credit

Extra Credit Opportunities: There will be considerable class discussion about the strengths and weaknesses of the assigned papers, major issues in the field of marine ecology, etc. At the end of the semester, I'll add 0 to 3 points to each person's grade based on their contributions in class. Did you participate fully? Did you come with challenging questions or have insightful comments? Were you prepared by having read the paper assigned, etc.?

Description of Graded Components: There is no book for the class. We will read primary literature papers (i.e., real science or scientific summaries of real experiments or topics). Lectures and discussions will cover aspects of the papers, but will be broader in scope so as to better cover the general concepts and studies that the assigned papers represent one aspect of. YOU NEED TO BE IN CLASS AND TO TAKE NOTES – NOT ALL INFORMATION WILL BE IN THE READINGS OR ON THE POWERPOINTS. We'll devote some time in each class period to discussions – some of the test material will come from these discussions – if you are not in class, you won't know of the issues raised and discussed. I do not post powerpoints before the lecture, but will post them a few days before a test.

Exams: Exams will consist of a mix of multiple choice and short answer (a few sentences to a paragraph) questions mandating that you understand and be able to work with the concepts we covered. There are three exams (each covers only the material presented since the previous test). I sometimes ask questions on the tests that have been addressed directly by the papers, but little, if at all, in class. I will also ask questions about topics that come up in class discussions and were not in the reading or in the lecture – thus, you need to be in class. READ the assigned papers and understand them – if you don't understand them, bring that up for discussion.

Pop quizzes: I EXPECT YOU TO READ THE ASSIGNED PAPERS **BEFORE** COMING TO EACH CLASS. I will give pop quizzes designed to see if you read the papers as assigned (i.e., to punish you for not reading the papers and not being prepared to participate). There will be no make-ups for missed pop-quizzes, but you can drop ONE. Thus, don't miss class and don't be late because I give the quiz at the start of class. As you read the papers, make notes on what you question about them and bring that up in discussions in class. A LOT of learning occurs via these discussions. Don't be hesitant to ask questions – If you have that question, others probably do as well.

A note on readings: Assigned readings are subject to change. If new papers are published or found throughout the course of the class that are profound and relevant to the topics discussed, those will be our assigned class readings instead. We will try to give you at least a week notice if papers are changed, but keep an eye out on Canvas for changed readings. THE READINGS POSTED HERE ARE TYPICAL BUT MAY CHANGE DUE TO GT ASKING US TO UPLOAD THIS SYLLABUS EARLIER THAN USUAL.

Short summary paper and presentation: You are to find, read, and summarize in no more than one page (12 pt font, single spaced, 1 inch margins) a primary research paper about a topic in marine ecology of interest to you (a good way to look for appropriate papers is to look at the papers cited [in recent papers] or at papers that have cited the paper we assign [for older papers]). Find something that interests **you**. If there are special topics that interest you and that we are not covering, ask if you can do a summary on a paper on that topic. I almost always OK these requests. Sources for good papers are the journals *Science, Nature, PNAS, Ecology Letters, Ecology, Marine Ecology Progress Series, Oecologia, Ecological Applications, Trends in Ecology and Evolution*….).

Include the following in each summary:

1) the reference for the paper,

2) a quick summary of the hypotheses, methods, and findings,
3) strengths of the study (what makes it interesting, novel, substantial and rigorous, etc.),
4) limitations of the study (are the methods suitable for the questions addressed? Do the author's conclusions exceed the foundations of their data? etc. Explain your conclusions about these issues), and
5) a short statement on the overall value of the paper given its relative strengths and limitations.
SUBMIT THESE DIRECTLY TO ME VIA EMAIL – PUT YOUR NAME ON THEM… somehow the need for a name repeatedly escapes some.

After turning this in and getting feedback from me, prepare a 10 minute powerpoint on this paper. **THUS, BE SURE TO TURN YOUR SUMMARY PAPER IN SEVERAL DAYS BEFORE YOU ARE SCHEDULED TO PRESENT!** You will then present that powerpoint to the class during one of the classes (**I will "volunteer" some of the graduate students to go first on this effort, so they will be the initial guinea pigs**). After the grad students, I will randomly assigned the rest of you to presentation dates. If a scheduled date is problematic for you, trade with someone and let me know of that change. I'll then change it on the schedule. **Presentation slides should be emailed to me by NO LATER THAN 8:00 AM on the morning of your presentation day. LATE slides may result in a penalty on your presentation grade.** This allows me to download these to my computer, which saves class time as we switch from your presentation to mine.

Research proposal (mandated for grad students but fine for undergrads as well): During the course, we will repeatedly discuss issues of experimental design, rigor, confounding factors in experiments, ways to control for, or lessen the influence of these, etc. By mid-way through the course, I expect you to have a good idea of how to pose and answer a novel question, how to conduct an experiment, how to design appropriate controls, etc. Thus, this final assignment is for you to write a short proposal on an experiment in marine ecology. You need to include: a title, a short abstract of the question, an introduction providing background and justifying the importance of the question, and finally, a detailed experimental design on how you will address the question posed. The paper can be no more than 10 pages for graduate students or 5 pages for undergrads (single spaced, 12 point font, 1 inch margins, - your listing of literature cited does not count in the page limitations). You will be graded on the depth and understanding you show of the topic, of experimental design, and on the novelty and importance of the question you ask. **As you progress through the semester reading papers, be on the look-out for what you see as unanswered questions you have after reading some of your favorite papers – these make good topics for a proposal. In numerous cases, students have used this proposal as a first draft for their M.S. or Ph.D. research**.

Career Summary (available option for undergrad students only): Instead of the above research proposal, you can overview the career publications of a productive/prominent marine ecologist and produce a 5-page paper (format limitations as described above): i) summarizing the main contributions of that scientist (i.e., of their many publications, what are their most impactful findings, how did they demonstrate those, why are these findings so impactful, etc.?) and ii) providing a quick summary of what "should be addressed next" given the new findings that this scientist has produced. In general, I'm expecting item (i) to take 4 - 4.5 pages and item (ii) to take 0.5 - 1.0 page of your text. To find prominent scientists to consider, you can search google scholar using "label:marine_ecology" or "label:marine_biology" and select any of the first 100 listed scientists. However, not all excellent marine scientists have set-up a google scholar page and some exceptional scientists are younger and don't yet have the "mileage" to make it into that top 100, so you can also choose someone from the list of assigned or suggested readings for this course or others you know of or see interesting readings from – however, you will have to OK that selection with me before selecting that person. I'm expecting that a good job on this option will require scanning over most of the abstracts produced by that author and then fully reading and interpreting 10-15 of the most prominent or most interrelated papers for which that author is

primarily responsible. Realize that being the 1st author on a paper indicates primary responsibility for the study, BUT also being the last author (or corresponding author) indicates a primary responsibility (i.e., among more established scientists, graduate students and post-docs are often first authors, but doing work initiated and supported by the last or corresponding author).

FOR THE RESEARCH PROPOSAL/CAREER SUMMARY, YOU CAN SELF-SCHEDULE THIS AND TURN IT IN VIA EMAIL TO ME ANY TIME BEFORE APRIL 22. BUT, I suggest not waiting until then.

Job Opportunities, Summer Courses, etc: Some of you will be interested in summer jobs involving marine ecology, summer classes, going on to grad-school, etc. Information I get regarding these opportunities will be sent to you via email, or possibly announced in class. Doing well, preferably very well, in this class enhances my ability to promote you for such opportunities. I also may hire assistants for the summer, and I work on tropical islands in the South Pacific and Caribean - French Polynesia (Tahiti, Moorea), Cook Islands, Curacao, Panama, Brazil, etc. Just saying….

Grading Scale: I grade rigorously and expect you to do well. Your final grade will be assigned as a letter grade according to **roughly** the following scale. However, given that I am a rigorous grader, it is not uncommon for there to be few students with 90%+ grades. **I curve the grades and it is not unusual for 86%+ to be in the A group.** As we progress through the semester, I'll show you the class distribution on each test and you can see your placement within the class distribution.

A	90-100%
B	80-89%
C	70-79%
D	60-69%
F	0-59%

Course Materials, Expectations & Guidelines

Course Text and Website: You will read the primary literature (i.e., real scientific papers) for each lecture. There is no textbook. Required papers for each lecture are listed in the schedule below and will be available on Canvas.

Additional Materials/Resources: If you are interested in specific topics within marine ecology and want additional information, discuss this with me and I can lead you to specific texts or suggest searches focused on especially impactful researchers, etc.

Academic Integrity: Georgia Tech aims to cultivate a community based on trust, academic integrity, and honor. Students are expected to act according to the highest ethical standards. For information on Georgia Tech's Academic Honor Code, please visit http://www.catalog.gatech.edu/policies/honor-code/ or http://www.catalog.gatech.edu/rules/18/. Any student suspected of cheating or plagiarizing on a quiz, exam, or assignment will be reported to the Office of Student Integrity, who will investigate the incident and identify the appropriate penalty for violations. The use of artificial intelligence (ChatGPT, etc) to complete coursework is NOT allowed in this course.

Accommodations for Students with Disabilities: If you are a student with learning needs that require special accommodation, contact the Office of Disability Services at (404)894-2563 or http://disabilityservices.gatech.edu/, as soon as possible, to make an appointment to discuss your special needs and to obtain an accommodations letter. See me or e-mail to discuss your learning needs and we will find a way that is fair and works.

Attendance and/or Participation: Lectures and discussions will cover aspects of the papers, but will be broader in scope so as to better cover the general concepts and studies that the assigned papers represent one aspect of. YOU NEED TO BE IN CLASS AND TO TAKE NOTES – NOT ALL INFORMATION WILL BE IN THE READINGS OR ON THE POWERPOINTS. We'll devote some time in each class period to discussions – some of the test material will come from these discussions – if you are not in class, you won't know of the issues raised and discussed.

Collaboration & Group Work: Science is often a collaborative, interactive effort. During discussions in and out of class it is fine to share ideas, build and learn based on group discussions and interactions, etc. but for your presentation, research proposal, tests, etc. I expect all work to be your independent effort.

Extensions, Late Assignments, & Re-Scheduled/Missed Exams: If you have an excused absence for missing an exam, I'll give you a make-up exam, but it may be oral instead of written, may be a research paper on topics covered instead of a standard test, etc. Your proposal can be self-scheduled. I expect these to be completed on time. If you are late with assignments, come discuss this. If you have a very good reason (you were hospitalized, etc.), I will work out a way to give you additional time. If your reason for being late is less persuasive, I'll deduct 5% of that grade's value for each day it continues to be late (I consistently threaten this, but don't always do it…).

Student-Faculty Expectations Agreement: At Georgia Tech we believe that it is important to strive for an atmosphere of mutual respect, acknowledgement, and responsibility between faculty members and the student body. See http://www.catalog.gatech.edu/rules/22/ for an articulation of some basic expectation that you can have of us and that we have of you. In the end, simple respect for knowledge, hard work, and cordial interactions will help build the environment we seek. Therefore, I encourage you to remain committed to the ideals of Georgia Tech while in this class.

Student Use of Mobile Devices in the Classroom: No mobile phone use. You can use your computer for notes, for looking at the specifics of the papers we are discussing, etc, but usage needs to be for academic activities.

Campus Resources for Students: Georgia Tech has a range of services to help support your mental, emotional, and physical well-being. Click here for a list of these relevant campus resources.

Course Schedule of Topics and Readings

Date	Who	Topic	Reading	Presenters
Jan 12	MH	Introduction to the course What is "Science"?	1-page essay on Canvas	

		Why MARINE Ecology? The value of discussion instead of just lectures		
Jan 14	MH	Multiple working hypotheses Strong Inference Pseudoreplication	Chamberlin 1965, Hurlbert 1984 (required for grad, suggested for undergrad)	
THE STATE OF MARINE ECOSYSTEMS				
Jan 19	MH	Overview of threats to and the state of the ocean	Jackson 2008	
Jan 21	MH	Animal movement, behavior, and the "connectedness" of separated ecosystems	Graham et al. 2018, Roman et al. 2014	
FUNDAMENTALS OF MARINE POPULATIONS				
Jan 26	MH	Sex in the sea I: fertilization	Jensen et al. 2014	
Jan 28	MH	Sex in the sea II: sex change	Munday et al. 2006	
Feb 2	MH	Zygote/Larval Behavior & stresses disrupting it	Doropoulos et al. 2012, Munday et al. 2010	
Feb 4	MH	EXAM #1		
Feb 9	MH	Dispersal and open vs closed populations: Local recruitment despite pelagic dispersal – Larval behavior, adaptability, and effects on ecosystem resilience and recovery	Almay et al. 2007, Marshall et al. 2010	
Feb 11		Effects of fishing	Erlandson and Ricks 2010	
SPECIES INTERACTIONS IN MARINE COMMUNITIES				
Feb 16	MH	The Challenge of Long Ecological Fuses in the Anthropocene	Clements et al. 2024	
Feb 18	MH	Competition: A general overview	Connell 1984	

Feb 23	MH	Killing your neighbor - Allelopathy in the benthos	Rasher and Hay 2014	
Feb 25	MH	Consumer-Prey interactions I (Effects of consumers on prey and community structure)	Estes et al. 2011	
Mar 2	MH	Consumer-Prey interactions II (Prey defenses – escape, deter, tolerate)	Duffy et al. 2001	
Mar 4	MH	EXAM #2		
Mar 9&11	MH	SPRING BREAK		
Mar 16	MH	Trait-mediated interactions: the ecology of fear	Urmy and Benoit-Bird 2021	
Mar 18		Top-down versus bottom-up effects on marine communities	Burkepile and Hay 2006	
Mar 25	MH	Disturbance, succession, and the maintenance of diversity	Sousa 1979	
Mar 30		Keystone consumers, trophic cascades, and multiple stable states(?)	Myers et al. 2007, Spring et al. 2003	
LARGE-SCALE PROCESSES AND STRESSORS				
Apr 1	MH	***Marine ecology as a template for other systems – (meeting ecological heroes before they "pass on")	Hay et al. 2025	*** this class will begin at 9:10 AM so that we have time to watch the documentary
Apr 6	MH	The function of biodiversity, its value, and some of the processes involved	Burkepile and Hay 2008 Clements and Hay 2021	
Apr 8	MH	Mutualism, specialization, and what drives such relationships	Feeney et al. 2018	
Apr 13	MH	Tropicalization of marine communities	Vergés et al. 2014	
Apr 15	MH	Effects of disease on the structure and function of marine communities	Harvell et al. 2019	

Apr 20	MH	EXAM #3		
Apr 22		For both Apr 22 and 27 I'm saving space for 1) possible visiting speaker(s), 2) additional student presentations, or 3) a discussion and overview of the state of marine ecology		
Apr 27		See above		
Apr 22		Research Proposals/Career Summary Due by 11:59 PM to me via email		
		FINAL EXAM - There is no final – your research paper counts as your final)		