Bios 4417 Syllabus

**[Marine Ecology, 3 Credits]**

**[Tu Th, 1335-1455h, Cherry Emerson 320]**

**Instructor Information**

|  |  |  |
| --- | --- | --- |
| Instructor | Email | Office Hours & Location |
| [Mark Hay] | [mark.hay@biology.gatech.edu] | [EST 2102, 1300-1500h, Wed; and by appointment] |

**General Information**

**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 2300 or BIOS 2310 or BIOL 2335 or BIOL 2337 are pre-requisites, but a number of students, primarily engineering students, with strong interests in marine biology but without these pre-requisites have petitioned me to wave the pre-requisites and have done well in the course. If you are interested, discuss your interests and background and I’ll consider making an exception.

## Course Goals and Learning Outcomes

[Goals include:

* Learn the state of modern ocean ecosystems, the esosystem 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 (Percentage, points, etc) |
| Pop Quiz | Throughout the course | 5% |
| Exam 1 | 10th class meeting | 20% |
| Exam 2 | 20th class meeting | 20% |
| Exam 3 | The final | 20% |
| summary paper and presentation | Varies by student | 10% |
| Research proposal | Self-scheduled, but before April 15 | 25% |
| 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. I’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. I will post the powerpoints before a test.

**Three tests:**

Tests 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 am not reluctant to ask questions on the tests that have been addressed directly by the papers, but little, if at all, in class. I will 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). 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.

**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 all round) a primary research paper about a topic on our schedule (a good way to look for these is to look at the papers cited [in recent papers] or at papers that have cited the paper I assign [for older papers]). Find something that interests you. If there are special topics that interest you and that we are not covering, ask me if you can do a summary on a paper on that topic. I often OK these requests. Good sources for good papers are *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 VIA EMAIL – PUT YOUR NAME ON THEM… somehow the need for this repeatedly escapes some.

After turning this in and getting feedback from me, prepare a 10 minute powerpoint on this paper. You will then present that powerpoint to the class at the end of one of the classes starting on 24 January (i.e., I’ll give you a couple of weeks to get prepared – **I’ll “volunteer” some of the graduate students to go first on this effort, so they will be the initial guinea pigs**). WE WILL SCHEDULE THIS DURING THE NEXT CLASS – SO COME PREPARED WITH 1ST, 2ND, AND 3RD CHOICES.

**Larger research paper:**

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 be sure of appropriate controls, etc. Thus, this final assignment is for you to write a short proposal proposing 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 5 pages (10 pages for graduate students) single spaced (12 point font, 1 inch margins, - literature cited does not count in the 5 pages). 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. For those of you considering grad school, view this as an opportunity that may provide more than simply a grade in this class. YOU CAN SELF-SCHEDULE THIS AND TURN IT IN ANY TIME BEFORE APRIL 15.

**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 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 in Fiji, the Solomon Islands, French Polynesia (Tahiti, Moorea), etc. so…..

**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’m a rigorous grader, it is not uncommon for there to be few students with 90%+ grades. I commonly curve the grades and it is not unusual for 86%+ to be in the A group. As we progress through the tests, I’ll show you the class distribution on each 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**

**Course Text**

We will read the primary literature (i.e., real scientific papers) for each lecture. There is no text book. Papers for each lecture are listed below and will be available on Canvas or its equivalent.

## Additional Materials/Resources

## If you are interested in specific topics within marine ecology and want additional information, come discuss this with me and I can lead you to specific texts or suggests searches focused on especially impactful researchers, etc.

## Course Website and Other Classroom Management Tools

Readings, schedules, etc. will be posted on Canvas

**Course Expectations & Guidelines**

## 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.

## 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 me 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. I’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. Your proposal and presentation can be self-scheduled (but I’ll “help” with this if I don’t see you doing so). I expect all of these to be done on time. If you are late with assignments, come discuss this with me. If you have a very good reason (you were hospitalized, etc.), we 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/day for each day it continues to be late.

## 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 me and that I 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](http://ctl.gatech.edu/sites/default/files/documents/campus_resources_students.pdf) for a list of these relevant campus resources.

**Course Schedule**

This is a DRAFT schedule. It changes every time I teach the class, and Will change before I begin teaching this class in the spring. This is simply my schedule from the last time I taught it.

**Schedule of Topics and Readings**

**January:**

**10** - **Introduction to the course – This is about marine ecology, but also about SCIENCE** –Read the one page essay attached to this outline and get comfortable with asking “stupid” questions. If we don’t ask these questions, we stay stupid – so speak up; doing so also will help those around you, and the “stupid” questions are often some of the most critical ones….

**What is “Science”?**

**Why MARINE Ecology**?

**The value of discussion instead of just lectures**.

**GLOBAL CHANGE AND OTHER LARGE-SCALE STRESSORS AND PROCESSES**

**12 - Overview of the ecological state of the ocean**

READ – Jackson JBC. 2008. Ecological extinction and evolution in a brave new ocean. *Proc. Nat Acad. Sci*. 105: 11458-11465.

**17 - Big species and ocean connections – Do whales alter oceans?**

Read – Roman J, et al. 2014. Whales as marine ecosystem engineers. *Front Ecol Environ* 12:377-385.

**19 - Multiple working hypotheses, Strong Inference, and Pseudoreplication: A general discussion of the basics** – **controls, replicates, interspersion**

READ – Chamberlin, T.C. 1965. The method of multiple working hypotheses. *Science* 148: 754-759.

**SUGGESTED ONLY (for those with interest and the time. THIS ONE IS LONG – HOWEVER, GRAD STUDENTS SHOULD READ IT) -** Hurlbert, S.H. 1984. Pseudoreplication and the design of ecological field experiments. *Ecological Monographs* 54:187-211.

**24 - Fishing and effects on marine ecosystems**

READ – Erlandson JM and Ricks TC. 2010. Archeology meets marine ecology: the antiquity of maritime cultures and human impacts on marine fisheries and ecosystems. *Annual Review of Marine Science* 2: 231-251.

Presentation by Drake Lee-Paterson

**26 Climate change, global warming, and effects on marine systems**

READ - Hoegh-Guldberg, O and JF Bruno 2010. The impact of climate change on the world’s marine ecosystems. *Science* 328: 1523-1528

Presentations by Rachana Adhikari/ Maddie Willert

**31 - Ocean acidification and effects on marine ecosystems**

READ – Kroeker KJ, et al. 2013. Impacts of ocean acidification on marine organisms: quantifying sensitivities and interaction with warming. *Global Change Biology* 19: 1884 – 1896, doi: 10.1111/gcb.12179

Presentation by Jennifer Iacono

**February:**

**2 - Marine migrations: Meeting needs and causing cross-system transport**

READ – Costa, DP, Breed GA, and Robinson PW. 2012. New insights into pelagic migrations: Implications for ecology and conservation. *Annual Review of Ecology, Evolution, and Systematics* 43: 73-96.

Presentations by Joseph Miles/ Qianna Xu

**7 - Top-down vs bottom up effects on community structure**

READ – Frank KT, Petrie B, Shackell NL. 2007. The ups and downs of trophic control in continental shelf ecosystems Trends in Ecology and Evolution. 22: 236-242.

Presentation by Mary McWhirt

**9 - EXAM #1**

**FUNDAMENTALS OF MARINE ECOLOGY**

**Sex to Fertilization to Settlement**

**14 - Sex in the sea I: fertilization**

READ - Jensen et al. 2014. Adaptive maternal and paternal effects: gamete plasticity in response to parental stress. *Functional Ecology* 28:724-733.

Presentation by Ciana Ferden

**16 - Sex in the sea II: Sex change**

READ – Munday et al. 2005. Diversity and flexibility of sex-change strategies in animals. *Trends in Ecology and Evolution* 21:89-95.

Presentations by Paul Drews/ Kai Yuan

**21 - Zygote/Larval behavior (now what do the babies do?)**

READ - Doropoulos c. et al. 2012. Ocean acidification reduces recruitment by disrupting intimate larval-algal settlement interactions. *Ecology Letters* 15: 338-346.

Presentations by Casey Moore/

**23 - Guest Lecture – Prof. Joseph Pawlik (Univ. North Carolina Wilmington)**

**Is there warning coloration in the sea?**

READ – Jarett KL et al. 2016. Aposematic coloration does not deter corallivory by fish on the coral *Montastraea cavernosa*. Coral Reefs 35:883-887

AND

Pawlik JR. 2012. Antipredator defensive roles of natural products from marine invertebrates. Pages 678-710 In: Fattorusso E, Gerwick WH, Taglilatela-Scarfati G (Eds.) Handbook of Marine Natural Products. Springer Press.

ALSO – JOE WILL BE PRESENTING A SEMINAR AT 11:00 – 12:00 TODAY IN EEB 1005. ATTEND IF YOU CAN

Presentations by Casey Smith

**28 - Dispersal and open vs closed populations (can populations be locally adapted?):**

READ – Marshall, DJ, K Monro, M Bode, MJ Keough, and S Swearer. 2010. Phenotype-environment mismatches reduce connectivity in the sea. *Ecology Letters* 13:128-140

Presentation by Stephanie Richter

**March:**

**2 - Local recruitment despite pelagic dispersal – Larval behavior and effects on ecosystem resilience and recovery**

READ – Almay GR, Berumen ML, Thorrold SR, Planes S, and Jones GP. 2007. Local replenishment of coral reef fish populations in a marine reserve. *Science* 316: 742-744.

**AND**

Dixson DL, D Abrego, ME Hay. 2014. Chemically-mediated behavior of recruiting corals and fishes: a tipping point that may limit reef recovery. *Science* 345:892-897.

Presentations by Sona Parmar/ Emilea Reiner

**7 - GUEST LECTURE – Dr. Alistair Dove (Director or Research and Conservation – Georgia Aquarium) Title “Whale shark fest”**

READ – Vignaud, TM, et al. (2014) Genetic structure of populations of whale sharks among ocean basins and evidence of their historic rise and recent decline. Molecular Ecology 23:2590-2601.

AND

de la Parra Venegas R, Hueter R, Gonza´lez Cano J, Tyminski J, Gregorio Remolina J, et al. (2011) An Unprecedented Aggregation of Whale Sharks, *Rhincodon typus*, in Mexican Coastal Waters of the Caribbean Sea. PLoS ONE 6(4): e18994. doi:10.1371/journal.pone.0018994

AND

Clingham E, et al. (2016). Evidence that St. Helena island is an important multi-use habitat for whale sharks, *Rhincodon typus*, with the first description of putative mating in this species, Peer J (Preprint)

**The Role of Competition in Marine Systems**

**9 - Competition – 1) A general overview and 2) Is competition most critical among similar or dis-similar species?**

READ - Burkepile, DE, JD Parker, CB Woodson, HJ Mills, J Kubanek, PA Sobecky, and ME Hay. 2006. Chemically-mediated competition between microbes and animals: microbes as consumers in food webs. *Ecology* 87:2821-2831.

Presentations by emery Cuellar/ Filippos Tagklis

**14 - Guest Lecturer – Cody Clements**

**Enemies as mutualists**

READ **–** He Q and MD Bertness. 2014. Extreme stress, niches, and positive species interactions along stress gradients. *Ecology* 95: 1437-1443.

**16 - EXAM #2 (This will cover the lectures of Feb 14 through March 9 - the March 14 lecture will be on the next test)**

**21 - SPRING BREAK**

**23 - SPRING BREAK**

**28 - Allelopathy as an example of how mechanisms matter – and create evolutionary cascades of offensive and defensive adaptations**

READ **-** Rasher DB, ME Hay. 2014. Competition induces allelopathy but suppresses growth and anti-herbivore defence in a chemically rich seaweed. **Proceedings of the Royal Society** **B** 281: 1-9 <http://dx.doi.org/10.1098/rspb.2013.2615>

Presentation by Emma Siegfried/ Kyle Hamilton

**The Role of Predation in Marine Systems**

**30 - Consumer-Prey interactions I (Effects of consumers on prey and community structure)**

READ – Estes JA et al. 2011. Trophic downgrading of planet Earth. *Science* 333: 301-306.

Presentation by Allie Caughman/ Sam Pak

**April:**

**4 - Consumer-Prey interactions II (Prey defenses – escape, deter, tolerate)**

READ – Duffy, J.E. and M.E. Hay. 2001. Ecology and evolution of marine consumer-prey interactions.  Pages 131-157, In Bertness, M, M.E. Hay and S.D. Gaines (eds.) Marine Community Ecology, Sinauer Press, Sunderland, Massachusetts

Presentations by Nico Villa-Roel/

**6 - Guest Lecture – Deanna Beatty**

**Microbe-host interactions – A new era of discovery in marine ecology**

READ – McFall-Ngai M, et al. 2013. Animals in a bacterial world, a new imperative for the life sciences. *Proceedings of the National Academy of Sciences* 110:3229-3236.

**11 - Keystone consumers, trophic cascades, and multiple stable states(?)**

READ – Myers RA, et al. 2007. Cascading effects of the loss of apex predatory sharks from a coastal ocean. *Science* 315:1846-1850.

**AND**

Springer AM, et al. 2003. Sequential megafaunal collapse in the North Pacific Ocean: an ongoing legacy of industrial whaling? *Proceedings of the National Academy of Sciences* 100: 12223-12228.

Presentation by Zixuan Hu

**13 - Trait mediated interactions: The ecology of fear.**

READ –Maden EMP, Gaines SD, Warner RR. 2010. Field evidence for pervasive indirect effects of fishing on prey foraging behavior. Ecology 91: 3563-3571.

Presentation by Mitch See/David Moore

**YOUR RESEARCH PAPER IS DUE TODAY – FINISHING IT BEFORE TODAY IS A VERY GOOD IDEA. I WILL ACCEPT PAPERS W/O PENALTY UP UNTIL CLASS TIME ON 13 APRIL, BUT AFTER THAT, YOU LOSE 5 POINTS/DAY**

**18 - Biogeography of prey defenses, consumer offenses, and impacts on the tropicalization of marine systems**

Read – Pennings SC and Silliman BR. 2005. Linking biogeography and community ecology: latitudinal variation in plant-herbivore interaction strength. *Ecology* 86: 2310-2319

AND

Vergés et al. 2014. The tropicalisation of temperate marine ecosystems: Climate-mediated changes in herbivory cause community phase shifts. *Proceedings of the Royal Society B* 281: 20140846.

**20 - Facilitation/positive interactions and the structure of marine communities**

READ – Bruno JF, Stachowicz JJ, and Bertness MD. 2003. Inclusion of facilitation into ecological theory. *Trends in Ecology and Evolution* 18: 119-125

Presentation by Gabriel Hesketh

**25 - Effects of native biodiversity loss – and of non-native “gain”**

**Read –** Duffy JE, et al. 2015. Biodiversity mediates top-down control of eelgrass ecosystems: a global comparative-experimental approach. Ecology Letters 18:696-705.

**May**

**4 - FINAL EXAM (11:30-2:20 – the final is NOT cumulative)**