

Marine Ecology BIOL 4417

Professor Mark E. Hay

(Tu, Th 1335-1455h in Howey (Physics) L5)

Office is 2102 in the Ford Env. Science and Eng. Building

Office phone – 404-894-8429

mark.hay@biology.gatech.edu

Class Requirements and Grading -

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 represents 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.

Three tests:

Tests will consist of a mix of short answer (a few sentences to a paragraph) questions mandating that you understand and be able to work with the concepts we have covered and multiple choice questions. 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).

Short summary paper and presentation:

You are to find, read, and summarize in one page or less (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. 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.), 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 seems to escape some. After turning this in a getting feedback from me, prepare a 5-10 minute powerpoint on this paper. You will then present that powerpoint to the class at the end of classes starting on 22 January (i.e., I'll give you a couple of weeks to get prepared – **Mary Reichert and Jeff Beauvais have been “volunteered” to go first on this effort – you two need to be looking for papers on ocean acidification**). **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 paper 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 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. HOWEVER, THE OFFICIAL DUE DATE IS APRIL 16. I WILL ACCEPT PAPERS W/O PENALTY UP UNTIL CLASS TIME ON 23 APRIL, BUT AFTER THAT, YOU LOSE 5 POINTS/DAY.**

Grading –

Pop Quizzes	5%
Exam 1	20%
Exam 2	20%
Exam 3	20%
A summary paper and presentation	10%
Research paper:	25%
Class participation/discussion	3% extra credit

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, etc. so.....

Schedule of Topics and Readings

January:

- 6** - 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 you and those around you, and the “stupid” questions are often some of the most critical ones....
Why MARINE Ecology?

GLOBAL CHANGE AND OTHER LARGE-SCALE STRESSORS

- 8** - 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.
- 13** - Guest Lecture - Prof. Montoya
Human impacts on oceanic nutrient cycles
Read – Gruber N. and Galloway JN. 2008. An Earth-system perspective of the global nitrogen cycle. *Nature* 451: 293-296.
- 15** - Guest Lecture - Prof. Montoya
Oxia, hypoxia, anoxia in the ocean
Read – Keeling RF, Kortzinger A, and Gruber N. 2010. Ocean deoxygenation in a warming world. *Annu. Rev. Mar. Sci* 2: 199-229.
- 20** - Two parts to today’s lecture
A) 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

- B) Multiple working hypotheses: A general discussion of the basics** – controls, replicates, interspersions
 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.) -
 Hurlbert, S.H. 1984. Pseudoreplication and the design of ecological field experiments. *Ecological Monographs* 54:187-211.

- 22 - **Ocean acidification and effects on marine ecosystems**
 READ - Doney SC, VJ Fabry, RA Feely, JA Kleypas. 2009. Ocean Acidification: The Other CO² Problem. *Annu. Rev. Mar. Sci.* 1: 169-192.

FUNDAMENTALS OF MARINE ECOLOGY

SEX to FERTILIZATION to SETTLEMENT

- 27 - **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.
- 29 - **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.

February:

- 3 - **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.
- 5 - **EXAM #1**
- 10 - **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
- 12 - **Local recruitment despite pelagic dispersal – how might it be achieved?**
 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
 Dixon DL, GP Jones, PL Munday, S Planes, MS Pratchett, M Srinivasan, C Syms and SR Thorrold 2008. Coral reef fish smell leaves to find island homes. *Proc. R. Soc. B* **275**, 2831-2839
- 17 - **Guest lecture – Dr. Rohan Brooker**
Larval behavior and effects on ecosystem resilience and recovery
 READ – Dixon 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.

THE ROLE OF PREDATION

- 19 - **Guest Lecture – Dr. Rohan Brooker**
 - **Predation in the sea: the ecological importance of escape, deterrence, and crypsis**
Read – Brooker RM, Munday PL, Chivers DP, Jones GP. 2015 You are what you eat: diet-induced chemical crypsis in a coral-feeding reef fish. *Proc. R. Soc. B* 282: 20141887.
<http://dx.doi.org/10.1098/rspb.2014.1887>

- 24 - **Consumer-Prey interactions I**
 READ – Estes JA et al. 2011. Trophic downgrading of planet Earth. *Science* 333: 301-306.
- 26 - **Consumer-Prey interactions II (Prey defenses and effects on populations, communities, and ecosystems)**
 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

THE ROLE OF COMPETITION

March:

- 3 - **Competition – 1) A general overview and 2) Is competition most critical among similar or dissimilar 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.
- 5 - **EXAM #2**
- 10 - **Allelopathy as an example of how mechanisms matter – and create evolutionary cascades of offensive and defensive adaptations**
 READ - Rasher DB, S Engel, EP Stout, J Kubanek and ME Hay. 2011. Macroalgal terpenes function as allelopathic agents against reef corals. *Proceedings of the National Academy of Sciences* 108: 17726-17731
 AND
 Dixson DL and ME Hay. 2012. Corals chemically cue mutualistic fishes to remove competing seaweeds *Science* 338: 804-807
- 12 – **Top-down vs bottom up effects on community structure**
 READ - Burkepile, DE and Hay ME. 2006. Herbivore versus nutrient control of marine primary producers: Context-dependent effects. *Ecology* 87: 3128-3139.
- 17 **Spring Break**
 19 **Spring Break**
- 24 - **Trophic Cascades**
 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, van Vliet GB. 2014. Climate change, pink salmon, and the nexus between bottom-up and top-down forcing in the subarctic Pacific Ocean and Bering Sea. *Proc Natl Acad Sci USA* 111:E1880–E1888.
- 26 - **Trait mediated interactions: The ecology of fear.**
 READ – Peckarsky BL, et al. 2008. Revisiting the classics: considering nonconsumptive effects in textbook examples of predator-prey interactions. *Ecology* 89:2416-2425.
- 31 - **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

April:

- 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.

7 - Biogeography of marine processes

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

CAN ECOLOGICAL INSIGHTS ENHANCE MANAGEMENT? (I.E., SO NOW WHAT DO WE DO?)

9 - Effects of biodiversity loss

Read – Cardinale et al. 2012. Biodiversity loss and its impact on humanity. *Nature* 468: 59-67.

14 - Global change and the tropicalization of marine systems?

Read - 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. <http://dx.doi.org/10.1098/rspb.2014.0846>

16 - 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.

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 23 APRIL, BUT AFTER THAT, YOU LOSE 5 POINTS/DAY.

21 - Eco-Engineering sustainable ecosystems (an example)

READ - Burkepile DE and ME Hay. 2008. Herbivore species richness and feeding complementarity affect community structure and function: the case for Caribbean reefs. *Proc. Nat. Acad. Sci.* 105:162021-16206.

23 - Buffer day for visiting speakers

30 Final Exam 2:50 – 5:40