Coastal Ecosystems: Adaptation and Resilience to Environmental Change

Marine Semester- 2nd Block
Fall 2019 (October)

Professor and TA Information

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<th>Professor/TA</th>
<th>Email</th>
<th>Office Location</th>
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Course Overview

Coastal ecosystems are among the most dynamic and complex collection of physical and biological systems on Earth. They are highly productive, highly valued, and highly accessible, making them a natural intersection between the human and natural worlds. This course will focus on saltmarsh, seagrass, and intertidal mudflats of New England. Topics for each ecosystem will include: biology, ecology and geology; key flora and fauna; ecological and
economic importance; natural and anthropogenic threats; and strategies to protect, restore, enhance, and assess the resilience of these coastal ecosystems to a rapidly changing environment. In addition to attending lectures, students will explore and gain proficiency in various research and assessment methods through classroom exercises, as well as field and lab work. They will also be required to carry out a research project that involves fieldwork, lab work, data analyses, and a final report and presentation.

Through this course, students will gain:

- An understanding of the socioeconomic and ecological values of each ecosystem;
- An understanding of major natural, anthropogenic, and climate related threats to each ecosystem;
- An understanding of the autonomous and managed methods that promote adaptation and resilience to associated threats;
- Experience using various methods to monitor and assess the impacts of anthropogenic and climate related stressors to each ecosystem, including: water quality surveys, quantitative field vegetation survey approaches (transect/quadrat, point intercept), sediment cores, habitat mapping with corrected GPS and real-time-kinematic (RTK), and plant and animal identification approaches and collection techniques;
- An understanding and experience with seagrass restoration methods;
- Improved field, lab, written and oral skills.

**Hub Learning Outcomes**

**Scientific Inquiry II**

- Students will apply principles and methods from the natural sciences based on collecting new or analyzing existing data in order to answer questions and/or solve problems. This will include formulating hypotheses, gathering empirical evidence, analyzing and interpreting data.
- Student will use their knowledge of natural science and will engage with issues of climate change.

**Quantitative Reasoning**

- Students will demonstrate their understanding of core conceptual and theoretical tools used in quantitative reasoning using statistics and MATLAB.
- Students will interpret quantitative models (e.g., graphs and tables) and understand a variety of methods of communicating them.
- Students will communicate quantitative information through a graphs, tables, figures, and verbal presentation.
- Students will recognize and articulate the capacity and limitations of quantitative methods and the risks of using them improperly.

**Creativity/Innovation**
• Students will demonstrate understanding of creativity as a learnable, iterative process of imagining new possibilities that involves risk-taking, use of multiple strategies, and reconceiving in response to feedback, and will be able to identify individual and institutional factors that promote and inhibit creativity. This learning outcome will be accomplished via the development of unique research projects.

• Students will be able to exercise their own potential for engaging in creative activity by conceiving and executing original work either alone or as part of a team.

Oral and/or Signed Communication

• Students will be able to develop and deliver responsible, considered, and well-structured oral presentation of their research at the end of the course.

• Students will participate in class discussions.

Teamwork/Collaboration

• Students will work in teams to develop projects. As a result of explicit training in teamwork and sustained experiences of collaborating with others, students will be able to identify the characteristics of a well-functioning team.

• Students will demonstrate an ability to use the tools and strategies of working successfully with a diverse group, such as assigning roles and responsibilities, giving and receiving feedback, and engaging in meaningful group reflection that inspires collective ownership of results.

Prerequisites

Admission to the Marine Semester

Course Structure

The course includes lectures, reading assignments and discussions, field and laboratory work, data analysis, writing, oral presentations, and a final exam.

Lectures

A series of lectures will be given during the first three weeks of the course by both professors in order to familiarize students with the coastal environment and the associated communities.

Readings and Discussion

Students will be required to read and discuss published manuscripts and texts, which will be selected by the professors. Students will also be expected to participate actively in the discussions, ask questions and critically analyze the research.
Example publications:


Field/Lab Research Methods and Final Project

Field, lab, and class room exercises will be used to teach various research and assessment methods. For the research project, students will be required to work in groups (2-3 students) to design and implement a small-scale project that generates new data and information on trends and conditions and/or applies a new or innovative approach to enhance/assess the resilience of the Great Marsh system to natural and anthropogenic threats, including climate change. Students will be required to present and discuss their project in a 30-min presentation. Each student will also be required to present and discuss their project in a report using literature to put their research into greater scientific context. The professors will provide guidance on how to make their oral presentations, and written report more effective.

Final Exam

A final exam will be given on the last day that will test the understanding of the concepts discussed throughout the course.

Class Schedule

During the first two weeks, students will participate in lectures, classroom discussions, as well as learn research and assessment methods through classroom exercises and lab/field work. In the second and third week, students will travel to the Great Marsh and participate in an eelgrass restoration, as well as design and collect data for an independent research project. During the last week, students will spend time analyzing data, working on their research report and presentation, and preparing for their final exam.
Detailed List of Topics

Introduction and ecology, biology, and geology of coastal ecosystems
1. Saltmarsh
2. Seagrass
3. Intertidal mudflats

Ecological/Socioeconomic Values
1. Water Quality/Clarity
2. Stabilize sediments
3. Reduce Wave Energy/Storm surge
4. Nursery
5. Carbon Sequestration
6. Tourism and recreation

Influence of Humans and Climate
1. Eutrophication/Pollution/Microplastics
2. Land Reclamation
3. Invasive Species (green crabs)
4. Sea-Level Rise
5. Warming/Ocean acidification
6. Increased Storminess
7. Changes in precipitation (droughts and floods)
8. Encroachment of infrastructure (development on barrier islands, roads through marshes, culverts)
9. Tourism and Recreation (navigation, destruction of dunes)

Resilience and Adaption of Ecosystems to the Changing Environment
1. Autonomous adaptation methods ( ecological or human)
   a. Acclimatization: changes in physiology or life history toward phenotypes which can persist under changed conditions;
   b. Adaptation: natural selection of genotypes which can persist under changed conditions;
   c. Epigenetic interactions: changes in the function and expression of genes that are not explained at the level of DNA but which enable organisms to persist under changed conditions;
   d. Geographic range shifts: migration into areas with appropriate conditions.
2. Managed (Human)
   a. Minimization of existing non-climatic threats (e.g. invasive species);
   b. Hard-engineering approaches (e.g. sea walls, groynes, armouring etc.);
   c. Soft-engineering approaches (e.g. removing hard-engineering structures, revegetation, beach);
   d. Nourishment and drainage;
e. Ecological engineering (i.e. retrofitting hard engineering structures or introducing new structures to create artificial habitats);
f. Ecosystem engineering (i.e. introduction of species which play a key role in shaping ecosystems structure and function-oysters);
g. Regulation: what laws exist to protect these environments and what organizations enforce them.

Research Methods, Field and Lab Work, and Data Collection

Report and Presentations

Final Exam

Grading

Students will be evaluated based on their performance during lectures and discussions, on the content and quality of their final report and oral presentation. Students will also be evaluated based on a final exam during the last week of the course. No late work will be accepted.

Summary

- Participation and discussion: 25%
- Final research project
  - Report: 40%
  - Oral presentation: 15%
- Final Exam: 20%

Academic Conduct

It is each student's responsibility to know and understand the provisions of the Academic Conduct Code at Boston University.

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<th>Percentage</th>
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<tr>
<td>93-100</td>
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<td>90-93</td>
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Cases of suspected misconduct will be referred to the Dean of the College. If the Dean's office comes to the conclusion that cheating or plagiarism have occurred, a grade of zero will be awarded for the assignment in question.