## The Maritime Studies Program of Williams College and Mystic Seaport \*\* Oceanographic Processes - Spring Semester 2015 \*\*

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## Introduction and Philosophy

We will examine many important ocean and coastal environmental science issues in this course: carbon dioxide and the ocean’s role in climate, El Niño and the ocean’s role in weather, coastal erosion, coastal pollution, and fisheries – an important food source on the planet. Our focus will be on underlying processes and complexity in the ocean. Through the course activities and assignments, we will work to make sense of uncertain and sometimes contradictory data and develop crucial skills for solving problems that cross disciplinary boundaries. Our approaches will be hands-on and discovery-based, practical and theoretical, global and regional.

This is an oceanography course like no other: we are fortunate to be able to collect data and make observations offshore, around southern New England, and during our travels to the Pacific Northwest and Louisiana. During 11 days at sea in the North Atlantic, you will gain experience with oceanographic sampling and laboratory equipment, collect data and present your findings in a poster session aboard. We will explore New England coastal environments on labs and field trips, during which you will practice writing answerable quantitative research questions. Then, you will conduct your own original field and/or laboratory research project. We will travel to the Pacific Northwest and Louisiana for a comparative study of coastal oceanography, and an in-depth look at interdisciplinary problem solving. We will meet twice a week for our regular class, but there will also be many integrated classes, guest lectures, and other special events that incorporate oceanography with one or more other disciplines at Williams-Mystic. Many of these learning opportunities are multi-disciplinary, that is, integrating more than one other discipline with science. The marine sciences will inform the rest of your Williams-Mystic semester, that is, your trans-disciplinary, or holistic, study of marine issues.

## Course Goals By the end of the semester, you should be able to:

## Design and complete a semester-long research project that is both quantitative and original.

## Use a variety of tools to measure coastal and blue-water oceanographic properties.

## Summarize scientific journal articles you have read in plain English.

## Make reasoned predictions based on scientific data.

## Explain how feedback loops can stabilize or exacerbate change in the ocean.

## Distinguish between gradual, oscillating, and episodic variability in the ocean.

## Compare multiple natural and anthropogenic influences on ocean change.

## Evaluate the U.S. Northeast, Gulf, and Pacific Northwest coasts in terms of coastal hazards, marine resources, and risk resilience.

## Apply systems thinking to make connections between marine science, history, policy, and literature.

## Important dates

Research Project Proposal due Thu 3/5 (0900 h, via e-mail)

Research Project Introduction due Tue 4/7 (0900 h, via-email)

Exam 1 Thu 4/9 (0930-1030 h)

Research Project Methods due Tue 4/21 (0900 h, via-email)

Research Project Results (w/figures!) & Discussion due Thu 4/30 (0900 h, via email)

Research Project Conference Presentations Thu 5/7 (1300-1600 h)

Research Project Paper due Sat 5/9 (1700 h, via email)

Exam 2 Tue 5/19 (0930-1045 h)

## Schedule

We will meet in the Marine Science Center (MSC) on the following days/times unless otherwise noted in the calendar or announced:

Lecture (classroom): 0930-1045 h Tuesday and Thursday

Laboratory (wet lab): 1300-1630 h Tuesday and/or Thursday, depending on tide

I encourage you to come discuss the course, your research projects, extra help, etc., with me. You can make an appointment anytime, but Tuesday or Thursday from 1100 to 1300 generally works well.

## Reading

Our textbook is *Introduction to Ocean Sciences* by Douglas Segar, 1st ed., 1998; ISBN 0314097058. You may sign out a copy from the MSC for the semester. Unreturned or damaged books will incur a $50 replacement charge. Additional articles from journals and other sources will also be distributed in class or via email. Please do the reading listed on the calendar before class. I regularly often give out a ‘Question of the Day’ before class; please come to class ready to participate.

## Grading

15% Labs, assignments, in-class activities, and participation

35% Hour Exams

50% Research Project (5% proposal, 10% drafts, 5% oral presentation, 30% final paper)

## Lectures

During lecture periods both on campus and in the field, you will participate in discussions, hands-on activities, data analysis, problem solving, and presentations. I encourage you to bring to class comments/questions on the reading, current events, previous lectures, field seminars, labs, or anything relevant.

## Field Work and Labs

You will participate in many field and in-class laboratory exercises, leading up to and in addition to your own original research pursuits. You will enjoy field labs more if you are dressed appropriately: knee-high rubber boots and layers of old, comfortable “sacrificial” clothes. Lab tools and equipment will be provided. Unless I specify that you must work alone on a particular lab or assignment, you may discuss your thoughts with others. However, always write answers in your own words. Lab assignments will usually be due at the next class meeting.

## Exams

There will be two exams during the semester. Labs, fieldwork, lectures, readings, assignments, field seminars, and anything else we do or cover during the semester is potential material for exams. Exams are one of the few aspects of this course I require you do alone, without assistance from each other or reference materials.

## Research Project

An important component of this course is the research project you will design, implement, and present. Your research project can be nearly any original scientific investigation within the broad category of ocean science that you can accomplish during your semester here. This is not a literature search or review; you will be making and testing hypotheses quantitatively in the field and/or lab.

We will meet early in the semester to discuss your ideas for a topic before you submit a proposal. Research topic ideas can come from a variety of places including your offshore experience, labs, fieldwork, lectures, and/or work by other researchers. I encourage you to begin by browsing the binders of student papers in the MSC lab. Specific steps to the research project are outlined in the Science Research Projects handout, attached. Please communicate with me at all stages of the project.

***Academic Resources***

Students with documented disabilities who need accommodations for this course should come see me during Weeks 1 or 2. I will make all reasonable accommodations to help every student succeed.

***Writing Help***

Your research paper is an important component of this course. T.A. Catie Alves is available to help you structure your drafts and invites you meet with her >48 hours before a deadline.

## Honor Code

## As in all your pursuits at Williams-Mystic, you are bound by the Williams-Mystic honor code, which will be discussed in a meeting with the Director early in the semester. If you have any questions about ethics or the honor code, please come talk with me, or the Director, at any time.

## Calendar

There are many opportunities for you to learn marine science during your Williams-Mystic semester, and not all of them are detailed in the schedule below*\**. If you already have particular interests that are not listed, please let me know and we will work to include those in the course and/or project.

Week Day Date Time Topic

1 Tue 1/27 1300-1400 Lecture: Sense of place (joint with Marine Ecology, Literature, History, Policy)

Thu 1/28 0900-1015 Lecture: Introduction

\* Syllabus, goals, research projects

\* The ocean is largely unexplored: mapping seafloor features

Thu 1/29 1515-1700 Lecture: Introduction to the offshore field seminar (joint w/Marine Ecology)

\* Goals and itinerary; what to bring; standing deck/lab watch

\* Science plan; laboratory equipment and procedures

Fri 1/29 1245-1515 LAB: Charts and Coastal Piloting (joint with Marine Ecology)

\* Reading charts; plotting a course; basic celestial navigation

Sat 1/31 0830-1000 Lecture: Marine Biodiversity (joint with Marine Ecology)

2 Mon 2/2 0930-1045 LAB: Marine Meteorology (joint with Marine Ecology)

\* Atmospheric circulation, pressure systems, fronts, wind

\* Reading surface analyses, forecasting offshore conditions

Mon 2/2 1100-1145 Lecture: Introduction to the oceanography of the Greater Antilles

Tues 2/3 0300 DEPART FOR OFFSHORE FIELD SEMINAR

aboard *SSV Corwith Cramer…* Puerto Rico and the Greater Antilles

*Reading:* Offshore Reader

3 Fri 2/13 2300 RETURN FROM OFFSHORE FIELD SEMINAR

4 Tue 2/17 0830-0945 Lecture: Origin of ocean basins and oceans

\* Review of offshore data

\* Direct and indirect evidence of Earth structure, plate tectonics

\* External versus internal sources of water

*Reading:* Segar, Chapters 3 and 4

Tue 2/17 1220-1600 LAB:The Rocky Intertidal Zone, Weekapaug, RI (joint with Marine Ecology

\* Intertidal diversity

\* Quantitative measurements: quadrats, lines, randomizing

*Reading:* Segar, Chapter 13; p. 442-447.

Week Day Date Time Topic

4 cont’d Thu 2/19 0930-1045 Lecture:Tides

\*Theoretical: deformation of water and solid Earth, Coriolis,

shallow water waves

\* Practical: sea level variation on the coast, nearshore currents,

bores, tidal power, fish reproduction, climate change

\* Working with local tide predictions (research impacts)

*Reading:* Segar, Chapter 10

Thu 2/19 1430-1700 LAB:The Salt Marsh, Barn Island, CT (joint with Marine Ecology)

\* Isostasy and eustasy; records of marsh accretion, hurricanes

\* Salt marsh flora and fauna

\* Modified coastal systems: human impacts on the marsh

5 Tue 2/24 1045-1200 Lecture: Thermohaline circulation

\* Unique properties of water

\* Sources and sinks of dissolved substances in the ocean

\* Density-driven currents; tracers

*Reading:* Segar, Chapter 5

Tue 2/24 1300-1630 LAB:The Mystic River Estuary, CT (joint with Marine Ecology)

\* Coastal monitoring: YSI, current meter, water sampling,

weather station, secchi disk, etc.; engineered shorelines

\* Plankton sampling and analysis

Tue 2/24 1930-2130 LAB:The Plankton at Night (joint with Marine Ecology)

\* controls on life in the ocean; diel migration

Thu 2/26 0930-1045 Lecture: Geostrophic circulation

\* Upwelling and Ekman transport

\* Applications: ocean pollution, fish migration

*Reading:* Segar, Chapter 8

Thu 2/26 1300-1630 LAB:The Barrier Beach, Napatree, RI

\* Sediment origins and maturity; longshore drift; dune systems

\* Erosion, waves, and engineered shorelines

6 Tue 3/3 0930-1045 Lecture: Deep sea sediments

\* Origins of sediments in the ocean, oozes, carbonate

compensation depth

\* Rates of sediment transportation, accumulation

*Reading:* Segar, Chapter 6

Tue 3/3 1200-1400 LAB:Sense of Place, Stonington and Groton (with History and Literature)

**Thu 3/5 0900 Research Proposals due**

Thu 3/5 0930-1045 Lecture: Preview of the Pacific Northwest

\* Hazard and risk Tsunami, earthquakes, glaciers, landslides, and volcanoes

*Reading:* Diamond, 2013. That Daily Shower Could be a Killer, *New York Times*

7 Sat 3/7 0300 DEPART FOR PACIFIC NORTHWEST FIELD SEMINAR

Seattle, WA to the Columbia River, and south to Coos Bay, OR

*Reading:* PNW Reader

8 Sun 3/15 2200 RETURN FROM PACIFIC NORTHWEST FIELD SEMINAR

Thu 3/19 0930-1045 Lecture: Hurricane hazards and tracks **[bring laptop to class]**

\* Hurricane formation, historic tracks, and making predictions

*Reading*: Hurricane formation*. http://serc.carleton.edu/details/files/41192.html*

Thu 3/19 1300-1630 RESEARCH LAB

Week Day Date Time Topic

9 Tue 3/24 0930-1045 Lecture: Hurricane risk and society

\* Hurricane energy

\* Impacts, evacuations, and costs on a developed coast

*Reading*: Schwartz & Robertson, 2012. Hurricane Isaac Makes Landfall Along Gulf Coast, *New York Times.*

Tue 3/24 1300-1630 RESEARCH LAB

Fri 3/27 0930-1045 Lecture: Sea-level rise and land loss

\* Underlying processes

\* Comparison of U.S. East, PNW, and Gulf Coast data

10 Tue 3/31 0300 DEPART FOR GULF COAST FIELD SEMINAR

New Orleans to Cocodrie and Grand Isle, LA

*Reading:* Louisiana Reader

Fri 4/3 2330 RETURN FROM GULF COAST FIELD SEMINAR

11 **Tue 4/7 0900 Research Paper Introduction due, via email**

Tue 4/7 0930-1045 Lecture: ENSO and fisheries

\* Using data to make predictions about ENSO and fish

\* Fish and farm management in a climate oscillation context

*Reading:* Segar, Chapter 7

Tue 4/7 1300-1630 RESEARCH LAB

Wed 4/8 2000-2100 Review Session

**Thu 4/9 0930-1045 Exam 1**

12 Tue 4/14 0900-1200 Lecture: Interdisciplinary Climate Panel (with Policy, Lit., & Ecology)

Tue 4/14 1300-1630 RESEARCH LAB

Thu 4/16 0930-1045 Lecture: Carbon dioxide and climate \* Solubility pump, acidification, MOC, SLR

\* Records of recent change in the Arctic

\* Isotopic records in ice and sediments

13 Mon 4/20 0930-1045 Lecture: The primacy of overfishing

\* Controls on spatial distribution of fish and fisheries

\* Comparison of U.S. East, PNW, and Gulf Coast data

\* Predictive models

*Reading*: Jackson, et al., 2001. Historical overfishing and the recent collapse of coastal ecoystems, *Science.*

**Tue 4/21 0900 Research Project Methods due, via email**

Tue 4/21 1300-1630 RESEARCH LAB

Thu 4/23 0930-1045 Lecture: The whale pump

\* Climate, whales, and the iron hypothesis \* Stabilizing and reinforcing feedbacks

*Reading*: Roman and McCarthy, 2010. The Whale Pump: Marine Mammals Enhance Primary Productivity in a Coastal Basin, *PlosOne.*

Fri 4/24 0830-1230 Lecture: Interdisciplinary Whaling Panel (with History, Policy, Lit., & Ecology)

Week Day Date Time Topic

14 Tue 4/28 0930-1045 Lecture: Eutrophication

\* Comparison of U.S. East, PNW, and Gulf Coast data

\* Ecosystem feedbacks

*Reading:* Bricker et al., 2003, An integrated methodology for assessment of

estuarine trophic status, *Ecological Modeling.* (excerpt)

Tue 4/28 1300-1630 RESEARCH LAB

**Thu 4/30 0900 Research project Results and Discussion due, via email**

Thu 4/30 0930-1045 Lecture: Harmful algal blooms

\* Student presentations: see 4/28 handout

\* Why are HABs increasing? Predictions and monitoring

\* How to write a scientific abstract

*Reading*: Durbin et al., 2002. North Atlantic right whale, *Eubalaena glacialis*, exposed to paralytic shellfish poisoning (PSP) toxins via a zooplankton vector, *Calanus finmarchicus*. *Harmful Algae I.*

15 Tue 5/5 0930-1045 Lecture: Ocean oil spills & society

\* Oil spill case studies: physical considerations, interventions

\* Trophic cascades and other ecological considerations

\* Visual flow rate calculations

\* Systems diagrams I

\* Making concise research presentations; engaging dialogue

*Reading*: Joye et al., 2011. A Persistent Oxygen Anomaly Reveals the Fate of Spilled Methane in the Deep Gulf of Mexico, *Science*.

Tue 5/5 1300-1630 RESEARCH LAB

Thu 5/7 0930-1045 Lecture: Pacific decadal and Atlantic multi-decadal oscillations

\* Systems diagrams II, feedback loops, tipping points

\* Importance of baseline data

\* Environmental drivers of change: natural and anthropogenic;

gradual, oscillatory, and episodic

**Thu 5/7 1300-1600 Research Project Conference Presentations**

**Sat 5/9 1700 Final research paper due, via email**

16 Mon 5/11 all day Fisher’s Island Field Seminar

Tue 5/12 0930-1045 Lecture: TBA

Thu 5/14 0930-1045 Lecture: Synthesis

\* Complexity and interconnectedness in the ocean

17 **Tue 5/19 0930-1045 Exam 2**

*\*This calendar is subject to change. Whenever possible, changes will be announced in advance on the weekly schedule.*

**Thank you and have a great summer!**