SEMESTER AT SEA COURSE SYLLABUS

Voyage: Spring 2013
BIOL 1559 501 (section 1) and 502 (section 2): Marine Biology
Faculty Name: Frank von Hippel
Time: A Day, 1250-1405 (section 2) or 1540-1655 (section 1)
Pre-requisites: **None**

COURSE DESCRIPTION: This course explores the biology of the oceans, which cover about 70% of the Earth's surface. The course begins with an introduction to the oceans as physical habitats, including ocean currents, topographical structure, climate regimes, and ocean chemistry. The course then examines marine food webs, from primary producers to top carnivores, and how human activities have affected the structure of marine food webs, fisheries, ocean chemistry and sea level. Challenges to life in different ocean habitats are examined, including the deep sea (e.g., deep ocean trenches, hydrothermal vents), the open ocean, shallow near-shore waters (e.g., kelp forests, seagrass communities), intertidal zones, and estuaries and salt marshes. Latitudinal trends are examined from the polar seas to tropical communities, such as coral reefs and mangrove forests. The course also examines symbiotic relationships between algae and animals and among animals. Special attention is paid to the diversity of marine habitats visited on the Semester at Sea voyage, and human impacts on the marine environment.

COURSE OBJECTIVES: Students will complete this course with a thorough understanding of physical processes that govern ocean habitats, the ecology of major marine ecosystems, and the influence of human activities on marine ecology. Students will learn to analyze problems in the ocean environment from a multidisciplinary perspective, employing the disciplines of geography, geology, chemistry and biology. Students will learn how marine biology research is conducted, and how to think critically about scientific problems in the marine environment.

REQUIRED TEXTBOOKS
AUTHOR: Jeffrey S. Levington
TITLE: Marine Biology. Function, Biodiversity, Ecology
PUBLISHER: Oxford University Press
ISBN #: ISBN13: 9780195326949; ISBN10: 0195326946
DATE/EDITION: Nov 2008, Third Edition

TOPICAL OUTLINE OF COURSE

Class #	Date	Topic	Reading
1	Jan 11	**Physical and chemical properties of the oceans Part 1: ocean currents and topography** - How do ocean currents relate to terrestrial climate? What is the historical significance of major ocean currents? What is the relationship between plate tectonics and ocean topography? *Case study: the East and West Pacific Ocean Garbage Patches*	Chapter 1

		Case study: tracking marine debris from the Japanese tsunami	
2	Jan 13	**Physical and chemical properties of the oceans Part 2: climate regimes** - What is the relationship between El Niño Southern Oscillation and rainfall patterns in the Amazon, Arizona and Alaska? How does El Niño drive the mating habits of red foxes in the Aleutian Islands? What is the link between El Niño and global climate change? *Case study: Papahānaumokuākea Marine National Monument*	Chapter 2
3	Jan 17	**Ecological and evolutionary principles** - What drives evolutionary change? What are density-dependent and density-independent mortality factors? What structures food webs? What is special about ecology and evolution in the marine environment? What are important marine symbioses?	Chapter 3
4	Jan 19	**Physical and chemical properties of the oceans Part 3: salinity, pH, dissolved ions, and links between chemistry and biology** - What is the relationship between salinity and water density? How does this affect ocean currents and life in the ocean? What are the important ions dissolved in marine water and how are they connected to life processes?	Chapter 4
5	Jan 23	**Special features of life in water** - How do organisms regulate their depth? What is a vertical migration? How do organisms maintain the right chemistry in their bodies? What is the relationship between light and life? What is the relationship between pressure and life?	Chapter 5
6	Jan 25	**Reproduction, dispersal and migration** - What are the constraints on reproduction, dispersal and migration in the marine environment? What patterns does passive dispersal produce? Why are there bipolar species? How do animals navigate on extensive marine migrations?	Chapter 6
	Jan 27	*Field Lab: Aqua Museum, Yokohama Hakkeijima Sea Paradise*	
7	Feb 1	**The water column: plankton** - What are the types of plankton and how do they influence food webs? How does energy flow in a marine ecosystem? What are the challenges of life in the open water?	Chapter 7
8	Feb 9	**The water column: nekton** - What is the difference between active swimming and passive floating? How are active swimmers constrained? How do they influence food webs?	Chapter 8
9	Feb 11	**Dynamics of plankton-based food webs** - What is a trophic cascade? How many trophic levels can an ecosystem support?	Chapter 9
10	Feb 19	**Ocean productivity** - What limits the productivity of ocean ecosystems? Is productivity dependent upon latitude? Is productivity related to biodiversity? Is productivity dependent upon ocean currents? How does ocean productivity drive human settlement patterns?	Chapter 10
11	Feb	**Benthic marine invertebrates** - What are the types of benthic	Chapter 11

	23	invertebrates and how to do they influence food webs? What are the challenges of life on the bottom? What is the lottery hypothesis?	
12 2	March	**Midterm Exam**	
13	March 5	**Seaweeds, sea grasses and benthic microorganisms** - What is the relationship between organisms that provide habitat structure and biodiversity? How does this relate to oil spills? How diverse are marine microorganisms?	Chapter 12
14	March 13	**Benthic ecology** - What drives dynamics between species living on the bottom? How is benthic ecology linked to surface water ecology? What differentiates a species' realized niche from its theoretical niche?	Chapter 13
15	March 16	**Tidelands: rocky shores, soft-substratum shores, marshes, mangroves, and estuaries** - What are the most diverse coastal ecosystems? What drives that diversity? What are the special challenges to life in these constantly changing habitats? What conservation challenges do these habitats face?	Chapter 14
	March 18	*Field Lab: Port Louis coastal ecosystems*	
16	March 19	**Sea grass beds, kelp forests, rocky reefs, and coral reefs** - How could the over-harvesting of whales in previous centuries be linked to the collapse of kelp forests today? Why are coral reefs bleaching?	Chapter 15
17	March 22	**Ecology of the continental shelf** - Why is life on the continental shelf so different from life in the open ocean or deep sea? Why does the continental shelf have different topographies in different places? How does the continental shelf relate to human evolution and human migration?	Chapter 16
18	March 24	**Ecology of the deep sea** - How does life survive in the deep sea? What are the special challenges of extreme pressure and no light? How does bioluminescence work? Where do deep sea organisms get their energy? How are hydrothermal vents colonized? How diverse are organisms in the deep sea?	"
19	April 1	**Biodiversity and conservation of the ocean Part 1** - Why are the oceans in so much trouble? What are the major threats to the oceans? What will climate change and sea level rise do to the different ocean ecosystems? What are the major threats to coastal marine habitats?	Chapter 17
20	April 4	**Biodiversity and conservation of the ocean Part 2** - What can be done to protect the ocean and coastal marine habitats? What are marine conservation reserves? How are they designed and how do they function?	"
21	April 11	**Food from the sea** - What is the history of food exploitation from the marine environment? How can fisheries be	Chapter 18

		sustainable? Why is seafood healthy? When is seafood toxic?	
22	April 14	**Marine pollution** - What are the major sources of petroleum pollution in the marine environment? How does oil pollution relate to habitat structure? Which ocean fish are contaminated with mercury and why? Why are the oceans so full of debris? What can be done to prevent pollution of the oceans? How can the oceans be cleaned up?	Chapter 19
23	April 17	**Final Exam**	"

FIELD WORK

FIELD LAB

BIOL 1559-103: Aqua Museum, Yokohama Hakkeijima Sea Paradise
27 January (Attendance is mandatory)
1200-1300 Pre-trip orientation during lunch
1300 Depart ship
2100 Arrive ship

Morphology and behavior of marine fishes

We will visit Japan's largest collection of marine life, with over 500 species of fishes and thousands of other marine organisms. We will review the major associations between habitat type, life history (e.g., herbivore vs. predator, anadromous vs. strictly marine) and morphology of fishes, along with correlated physiological processes. We will also review the process of sexual selection and how it leads to sexually dimorphic species. These concepts will be illustrated by visiting exhibits in the aquarium. Students will be provided with a template for formulating a hypothesis related to one of the concepts. Students will use the exhibits to collect data to test their hypothesis. The majority of the field trip time will be occupied with data collection. After the field trip concludes, students will write a scientific paper (Abstract, Introduction, Methods, Results, Discussion, References) based on their data collection, and incorporating statistical analysis (due by February 11). Students will use faculty edits and comments to revise their paper, thereby improving writing and analysis skills. Revised papers will be due March 5.

BIOL 1559-104: Port Louis coastal ecosystems
18 March (Attendance is mandatory)
1000 Depart ship
1800 Arrive ship

Mangrove forest and coral reef restoration

Mangrove forests and coral reefs harbor much of the biodiversity of tropical marine ecosystems. Mangrove trees and corals provide structural complexity to near shore marine habitat, allowing the co-existence of diverse species assemblages. When that structure is damaged or removed, these ecosystems can collapse. Mangrove forests have been cleared throughout much of the

tropics for coastal development, while coral reefs are threatened by ocean acidification and other human sources of habitat degradation. In this lab, we will explore both habitat types to learn about their ecology, conservation problems, and restoration efforts. Each student will collect data and record observations in both habitat types. After the field trip concludes, students will write a scientific paper (Abstract, Introduction, Methods, Results, Discussion, References) that integrates their observations with the theoretical framework of structural complexity and biodiversity (due by April 1). Students will use faculty edits and comments to revise their paper, thereby improving writing and analysis skills. Revised papers will be due by April 14.

FIELD ASSIGNMENTS

In addition to the field lab described above, each student will complete a field book entry for 6 of the 13 ports/11 countries that we visit after we depart Mexico and before we arrive in Spain (the student chooses the ports/countries to include). Each field book entry will address a question from the course that has relevance to the chosen location. The field book entry will be a descriptive analysis of the question or hypothesis testing, and may include species lists, list of rank-ordered threats, analysis of conservation actions, illustrations, interviews, habitat inventories, data with statistical analysis, and the like. Field book assignments will be due on the second day at sea following the port departure. Field book entries will be evaluated based on clarity, content, quality of writing, depth of analysis, and effectiveness of illustration or data presentation. Feedback will be given for each entry in order for the student to improve future entries.

METHODS OF EVALUATION / GRADING RUBRIC

Field lab assignment = 20%
Field book entry for each port or country = 5% x 6 ports/countries = 30%
Midterm exam = 25%
Final exam = 25%

RESERVE LIBRARY LIST

AUTHOR: Rachel Carson
TITLE: The Sea Around Us
PUBLISHER: Oxford University Press
ISBN #: ISBN13: 9780195069976, ISBN10: 0195069978
DATE/EDITION: 1991 (other editions are available of this classic and are also suitable in place of this edition; originally published in 1951)

ELECTRONIC COURSE MATERIALS

Supplemental readings and handouts will be provided as pdf's on the ship.

ADDITIONAL RESOURCES

Each student must have a rite-in-the-rain bound notebook for their field entries. Each student must have a good supply of pencils and a sharpener.

HONOR CODE

Semester at Sea students enroll in an academic program administered by the University of

Virginia, and thus bind themselves to the University's honor code. The code prohibits all acts of lying, cheating, and stealing. Please consult the Voyager's Handbook for further explanation of what constitutes an honor offense.

Each written assignment for this course must be pledged by the student as follows: "On my honor as a student, I pledge that I have neither given nor received aid on this assignment." The pledge must be signed, or, in the case of an electronic file, signed "[signed]."

PDF to Word

The CD-ROM, "Marine Biology Explorations." This in-text CD takes students on a guided tour of marine environments and animals with approximately 450 full-color photographs and illustrations, annotated with informative descriptions. Images are from both the Atlantic and Pacific coasts of North America, Europe, Australia, and Antarctica.Â This new and revised second edition of Jeffrey S. Levinton's Marine Biology: Function, Biodiversity, Ecology promises to be as fascinating and informative as the first, with additions that bring it up-to-date on current research issues. Designed for one-semester junior/senior courses, this established volume stands as one of the most current and thorough resources for students in the multidisciplinary field of marine biology.