Ocean 621: Biological Oceanography Spring 2016

(Monday, Wednesday, Friday 9:30-10:20 AM; MSB 315)

Instructors:

Matthew Church, Office: C-MORE HALE 119, 956-8779, mjchurch@hawaii.edu

Anna Neuheimer, Office Marine Science Building 614, 956-2613, annabn@hawaii.edu

Guest Lecturers:

Grieg Steward, University of Hawaii, Department of Oceanography

Kyle Edwards, University of Hawaii, Department of Oceanography

Course Overview:

Biological Oceanography (OCN 621) is one of several required core courses for graduate students in the Department of Oceanography at the University of Hawaii. The course meets three times each week (MWF) from 9:30-10:20 AM in the Marine Science Building classroom 315. Lectures and exams cover fundamental concepts in biological oceanography, including topics pertinent to the study of the ecology of pelagic and benthic organisms. Lectures include information related to the biomass and productivity of diverse marine ecosystems, assessment of bioelemental cycling of marine organisms, examination of environmental controls on the growth and mortality of marine organisms, and overview of how models can be applied to test hypotheses about ecosystem behaviors. The course focuses on plankton ecology, food web control of elemental cycling, and fisheries oceanography.

There is no required textbook for this course; however, instructors will assign reading material in the form of papers or book chapters. Students are expected to be familiar with material in these assigned readings.

Student Learning Outcomes:

1) Students should be able to define the major forms of life in the sea, describe the characteristics that distinguish these forms, and describe how these forms relate to each other ecologically.

2) Students should be able to explain how marine organisms influence cycling of bioelements.

3) Students should be able to describe prominent characteristics of the primary marine habitats.

4) Students should be able to define processes that control the biomass, growth, and productivity of organisms in the marine environment.

5) Students should be able to describe methodological approaches appropriate for evaluating the biomass, growth, and mortality of plankton, nekton, and sessile marine organisms.

Grading:

Grading for the course will be based on four criteria:

1) Regular attendance and participation in weekly lectures (5%)

2) Performance on two written, in class exams (35% each)

3) Participation and leadership during student-led paper discussions (15%), and written summaries and questions for the student-led paper discussions (10%)

Students are expected to attend all lectures and paper discussions, and should come familiar with the reading material assigned for each lecture or discussion. Discussion leaders will be assigned early in the semester, and these leaders should provide (at least 2 days in advance of the discussion) students and instructors with a list of 5-6 questions intended to help promote discussion of the assigned paper(s). Prior to attending each paper discussion, all students submit a brief written summary of the paper, including 3-4 questions for contribution to the in-class paper discussions (~1 page total).

Exams:

Exam I (Plankton biogeochemistry and ecology) - March 11, 2016

Exam II (Zooplankton, pelagic ecology, fisheries, and benthic oceanography) - May 9, 2016

Any student who feels s/he may need an accommodation based on the impact of a disability is invited to contact the course instructors privately. We would be happy to work with you, and the KOKUA Program (Office for Students with Disabilities) to ensure reasonable accommodations in the course. KOKUA can be reached at (808) 956-7511 or (808) 956-7612 (voice/text) in room 013 of the Queen Lili'uokalani Center for Student Services.

Course Schedule (Jan. 11-Feb. 19, 2016) - Classes meet 9:30-10:20 AM

Date	Topic	Lecturer	Reading
Monday Jan. 11	Introduction to Biological Oceanography: The ocean as a habitat	Church	
Wednesday Jan. 13	Metabolism and energetics	Church	Munn, Chapter 3
Friday Jan. 15	The ocean carbon cycle	Church	Falkowski (2000)
Monday Jan. 18	NO CLASSES - MLK Day		
Wednesday Jan. 20	Nutrient cycling and elemental stoichiometry	Church	Redfield et al. (1963)
Friday Jan. 22	Plankton biomass (I)	Church	Whitman (1998)
Monday Jan. 25	Plankton biomass (II)	Church	
Wednesday Jan. 27	Phytoplankton traits	Edwards	
Friday Jan. 29	Phytoplankton physiology	Edwards	
Monday Feb. 1	Photosynthesis and primary productivity (I)	Church	
Wednesday Feb. 3	Primary productivity (II)	Church	
Friday Feb. 5	Plankton respiration	Church	
Monday Feb. 8	Net community production	Church	
Wednesday Feb. 10	The spring bloom	Church	
Friday Feb. 12	Student-led paper discussion	Church	Alkire et al. (2012). Estimates of net community production and export using high-resolution, Lagrangian measurements of O_2, NO_3^-, and POC through the evolution of a spring diatom bloom in the North Atlantic. Deep-Sea Res. I 64: 157-174.
Monday Feb. 15	NO CLASSES - Presidents Day		
Wednesday Feb. 17	Export and the biological pump	Church	
Friday Feb. 19	Life at the microscale	Steward	

Course Schedule (Feb. 22-Apr. 1, 2016) - Classes meet 9:30-10:20 AM

Date	Topic	Lecturer	Reading
Monday Feb. 22	Marine protists	Steward	
Wednesday Feb. 24	Marine viruses	Steward	
Friday Feb. 26	The microbial loop	Steward	
Monday Feb. 29	Dissolved organic matter	Church	
Wednesday Mar. 2	Nitrogen cycling	Church	
Friday Mar. 4	The HNLC condition	Church	
Monday Mar. 7	Student-led paper discussion	Church	Behrenfeld (2014). Climate-mediated dance of the plankton. Nature Climate Change 4: 880–887.
Wednesday Mar. 9	Exam review	Church	
Friday Mar. 11	MID-TERM EXAM	Church	
Monday Mar. 14	Size in the Ocean/ Zooplankton 1	Neuheimer	Andersen et al. 2016. Characteristic sizes of life in the ocean. Annu. Rev. Mar. Sci. 8:3.1-3.25
Wednesday Mar. 16	Zooplankton 2	Neuheimer	
Friday Mar. 18	Student-led discussion paper - Zooplankton	Neuheimer	Jónasdóttir et al. 2015. Seasonal copepod lipid pump promotes carbon sequestration in the deep North Atlantic. PNAS 112: 12122-12126.
Monday Mar. 21	NO CLASS -SPRING BREAK		
Wednesday Mar. 23	NO CLASS -SPRING BREAK		
Friday Mar. 25	NO CLASS -SPRING BREAK		
Monday Mar. 28	Zooplankton 3	Neuheimer	
Wednesday Mar. 30	Zooplankton 4	Neuheimer	
Friday Apr. 1	Pelagic community ecology 1 - Food webs	Neuheimer	

Course Schedule (April 4-May 9, 2016) - Classes meet 9:30-10:20 AM

Date	Topic	Lecturer	Reading
Monday Apr. 4	Food Webs Case Study	Neuheimer	Hunt et al. 2011. Climate impacts on eastern Bering Sea foodwebs: a synthesis of new data and an assessment of the Oscillating Control Hypothesis. ICES J. Mar. Sci. 68:1230-1243.
Wednesday Apr. 6	Pelagic community ecology 2 - Food web variation in time	Neuheimer	
Friday Apr. 8	Pelagic community ecology 3 - Food web variation in space	Neuheimer	
Monday Apr. 11	Ocean resources 1	Neuheimer	
Wednesday Apr. 13	Ocean resources 2	Neuheimer	
Friday Apr. 15	Fisheries oceanography 1	Neuheimer	
Monday Apr. 18	Fisheries oceanography 2	Neuheimer	
Wednesday Apr. 20	Student-led discussion paper – Fisheries	Neuheimer	Woodson & Litvin 2015. Ocean fronts drive marine fishery production and biogeochemical cycling. PNAS 112:1710-1715.
Friday Apr. 22	Benthic oceanography 1	Edwards	
Monday Apr. 25	Benthic oceanography 2	Edward	
Wednesday Apr. 27	Nearshore habitat structure & coral reefs	Neuheimer	
Friday April 29	High latitude ecosystem structure	Neuheimer	
Monday May 2	Climate-driven changes in marine biota	Neuheimer	
Wednesday May 4	Exam Review	Neuheimer	
Monday May 9	FINAL EXAM	Neuheimer	

COURSE OUTLINE AND MAJOR CONCEPTS

I. Introduction

A. Course objectives and overview

B. Habitats and ecosystems

C. Organizational details

II. Bioenergetics - transformations of energy by living organisms

1. Photosynthesis

2. Chemosynthesis

III. Plankton biomass

A. Measuring standing stocks

B. Phytoplankton biomass distributions

C. Food web structure and the “inverted pyramid?”

IV. Plankton carbon cycling and the biological pump

A. Pathways and fluxes of carbon

B. The balance of photosynthesis and respiration

C. Particle flux as a linkage between the atmosphere and deep sea

D. Dissolved organic matter pumping

E. Photosynthetic production

F. Gross and net production

G. Irradiance dependent growth

H. Carbon and oxygen dynamics

V. Measurements of and controls on primary production

A. Oxygen

B. Carbon

C. Isotopes

D. Controls on photosynthetic production

1. Nutrients

2. Light

3. Temperature

VI. Dissolved organic matter and the microbial loop

A. DOM composition

B. Sources

C. Sinks

D. Ages and reactivity

E. The microbial loop

F. Bacterial biomass in the sea

G. Bacterial production

H. Plankton Respiration

VII. The metabolic balance – Net Community Production

A. Measurements and methods

B. Relationship to export

C. Controls and variability

D. Case studies – subtropical gyres, upwelling regions, global implications

VIII. Nutrient cycling and plankton dynamics

A. Nitrogen assimilation

B. New production

C. N_2 fixation

D. Dissimilatory N cycle processes

1. Nitrification
2. Denitrification
3. Anammox

E. Nutrient stoichiometry

F. The HNLC condition, iron, and plankton metabolism

IX. Pelagic consumers (Diversity, energetic, and behaviors)

A. Pelagic Consumers

1. Microzooplankton
2. Mesozooplankton (Metazoans)
3. Fish

B. Feeding rates and behaviors

1. Functional response relationships
2. Selective feeding
3. Methods used to Measure Feeding Rates

C. Carbon and energy utilization

1. Assimilation and egestion

2. Metabolism

3. Growth and reproduction

D. Vertical migratory behavior

X. Structure and dynamics of pelagic communities

A. Community organization

1. Food web structure

2. Examples: Subtropical gyres, HNLC regions, physically energetic regions (i.e. deeply mixed, upwelling)

XI. Fisheries oceanography

A. Fisheries Recruitment: Larval ecology and survival

1. First feeding and the critical period

2. Growth and mortality

3. Larval transport and nursery grounds

4. Environmental variability and larval survival

B. Fisheries management: Case histories

1. Anchovetta/Sardines

2. Alaskan Pollock

C. Global Fisheries: Current Thoughts

1. Management: Single and Multispecies approaches

2. Global Fish Catches and Maximum Sustainable Yields

3. Marine Protected Areas

XII. Nearshore habitat structure

A. Land-sea interactions

B. Coral reefs

XIII. High latitude ecosystem structure

A. Temperature and light effects

B. Sea ice

XIV. Climate effects on marine biology

A. Oscillations and trends

B. Climate signals in biota