Deep-Sea Ecology

Biology 457/557

Summer Term, 2019

Course Description:

This course will plunge you into the world of perpetual darkness to study the ecology of benthic organisms living in the largest ecosystems on the planet. We will survey habitats and communities found beyond SCUBA depths, including underwater sand flats, gravel beds and reefs on the continental shelf; and abyssal plains, seamounts, hydrothermal vents, methane seeps, and trenches in the deep ocean. Emphasizing factors that control animal diversity, distribution and abundance, local field work will feature conventional benthic sampling methods as well as OIMB's 600-m Phantom ROV (Remotely Operated Vehicle), and a video camera sled. Some lectures will review the rich history of deep-sea exploration and the geological setting for chemosynthesis in the deep ocean. For a class project, we will assist the Oregon Department of Fish and Wildlife in analyzing animal diversity using ROV footage taken in one of Oregon's five marine reserves. Class exercises and projects are intended to introduce you not only to underwater organisms and communities, but also some of the useful technologies and statistical methods by which deep-sea systems are studied.

Instructors: Professor Craig M. Young

Teaching Assistant: Caitlin Plowman

Credit Hours: 4

Place: McConnaughey Teaching Laboratory on the OIMB Campus

Meeting Day and Time: Mondays, Fridays 9:00-5:00; Wednesdays 9:00-3:00. There may be early departures and/or late returns on cruise days.

Grading: Grades will be based on the following:

1. ***Scientific paper based on the analysis of underwater transects (50% of grade).*** Several lab periods will be devoted to the analysis of underwater video transects from Oregon reserves. Students will work together to extract the data from images and to analyze spatial distributions, abundance patterns and species diversity. Each student will then work independently to write a report in the format of a scientific paper. Some of the best papers will be submitted to ODFW (Oregon Department of Fish and Wildlife) for use in their long-term monitoring program. These papers should follow the "instructions for authors" guidelines for the international journal Marine Ecology.

Each report should include an **Abstract** summarizing the findings, a statement of the question and a brief review of the relevant literature in the **Introduction** (include some classic papers, not just those found easily in Google), a clear **Materials and Methods** section written with enough detail to enable someone else to repeat your study if they wanted to (including a map of study sites produced in Google Earth), a **Results** section that presents your data and observations with graphs, tables, diagrams, photos and text, and a **Discussion** of your findings that should include references to relevant prior studies. **References** at the end should be in the proper journal format. All information and images collected during class will be shared on Canvas. Students may work together on the analysis, but each student should research the literature independently, and the write-ups should be original and unique.

Oregon Shelf Invertebrates (20% of grade). Over more than two decades, various OIMB faculty and students have collaborated on *Oregon Estuarine Invertebrates*, a useful reference work published by the OIMB library. Students in Deep-Sea Ecology have begun work on a companion volume, *Oregon Shelf Invertebrates*, dealing with animals of the Oregon shelf. Each student will have the opportunity to contribute a page to this new volume and will receive permanent authorship credit for acceptable contributions.

Midterm exam (30% of grade). There will be no final exam. The single midterm will cover information taught during lectures and labs during the first three weeks of the course. Each student may prepare a one-sided 8.5x11 "cheat sheet" for use in the exam. The exam format will include short answer questions, matching, and definitions of terms.

Important: ***Although PDF versions of Powerpoint slides from the lectures will be made available on Canvas, the presentations themselves contain many photos and video clips that that will be narrated verbally during the lectures. It is therefore unwise to rely entirely on the PDF's for study; they do not contain all of the details that might appear on the exam. Students are strongly advised to take notes during the lectures and to ensure that these notes contain sufficient detail for later review.***

Learning objectives (Knowledge and skills you should acquire)

Knowledge. Students completing this class should:

1. Know the major events, people and discoveries in the history of deep-sea biology.
2. Know and understand some of the key physical and biological factors that determine the distributions and abundances of deep-sea species.
3. Know how food sources and abundances of functional trophic groups change along a depth gradient and understand the underlying mechanisms.
4. Know how suspension-feeding animals adapt to low particle density below the euphotic zone and be able to cite some examples.
5. Know the importance and timing of allochthonous foods such as phytodetritus and macrofaunal falls in the deep ocean.
6. Know the geological processes that facilitate chemosynthesis at deep-sea hot vents and methane seeps.
7. Know the major kinds of organisms that dominate various deep-sea environments, and be able to explain their adaptations for nutrition and reproduction.
8. Know some ways that pressure influences marine animals and their distributions.
9. Know something about the larval development and dispersal of deep-sea animals.

Skills. Students completing the class should be able to:

1. Use Primer software to describe the structure of biological communities with multivariate statistics, rarefaction, and diversity indices.
2. Analyze the spatial distribution of a population by comparing it statistically to a Poisson distribution.
3. Prepare and examine sessile animals such as sponges and bryozoans for identification with a scanning electron microscope.
4. Participate in an ROV crew by launching, navigating, and piloting a small Remotely Operated Vehicle.
5. Deploy and recover over-the-side benthic sampling gear including box dredge, Agassiz trawl, and camera sled.
6. Identify several kinds of benthic animals using dichotomous keys.
7. Write an original research project in the standard form of a scientific paper.

Tentative Course Schedule

WEEK 1.

Monday, June 24.

A.M. Lecture: (Young): Expectations, safety, grading, syllabus.

A.M. Lecture: (Young): Some fundamentals of ecology; Introduction to the deep sea.

A.M. Lecture (Young): Sampling and exploration in the deep ocean: HOVs, ROVs and AUVs.

P.M. Lab: ROV umbilical maintenance. Handling, launching and recovering an ROV. Pre-dive checklist, handling the umbilical and control box, capturing images and video. Seamanship, knots, over-the-side sampling skills, line handling, and safety at sea.

Wednesday, June 26.

A.M. Cruise on RV Pluteus: ROV deployment, recovery and handling.

P.M. Lecture (Young): Marine protected areas in the deep ocean.

P.M. Lab: Introduction to community analysis with Primer

Friday, June 28.

A.M. Lab: Spatial distribution and species diversity. Begin data collection from marine reserve videos.

P.M. Lecture (Young): History of deep-sea biology (with field trips to the OIMB library and to Craig's house, with a visit to his Victorian library and microscope collection).

WEEK 2

Monday, July 1.

A.M. Cruise: Deployment of food drops, baited traps and time-lapse camera

A.M. Lecture (Young): Detrital based ecosystems in the deep sea

P.M. Lecture (Plowman): Ecology of the Hadal Trenches

P.M Lab: Continue video transect data collection.

Wednesday, July 3.

A.M. Cruise: Recovery of baited traps and food fall.

A.M. Lab: Review of time-lapse camera footage and examination of trap contents.

P.M. Lecture (Young): Hard-bottom communities on the shelf and slope. Ecology of fjords and rock walls. Submarine canyons, deep coral reefs & seamounts. Filter- feeding adaptations to flow.

P.M. Lab: Complete video transect analysis. Input data for primer.

Friday, July 5.

A.M. Cruise: Benthic sampling near Cape Arago (box dredge, Agassiz trawl).

P.M. Lab: Taxonomic identification of animals from shelf and slope. Preparation of sponges, hydroids and bryozoans for SEM. Select species for *Oregon Shelf Invertebrates* project.

WEEK 3

Monday, July 8.

A.M. Lecture (Young): Geology and biology of hydrothermal vents.

A.M. Lab: Scanning electron microscopy; library research for Oregon Shelf Invertebrates.

P.M. Lab: Continue scanning electron microscopy; free time to work on Primer analysis and writing projects.

Wednesday, July 10.

A.M. Cruise. Camera sled transects on gravel bottoms.

P.M. Lecture (Young): Geology and biology of methane seeps.

P.M.: Free time to prepare for midterm.

Friday, July 12

A.M. Midterm Exam.

Mid-day Field trip (sack lunches): Pillow lavas at an ancient underwater volcano.

P.M. Free time to work on writing projects (Craig and Caitlin available to help).

WEEK 4.

Monday, July 15.

A.M. Cruise: ROV off Cape Arago

P.M.: Free time to work on writing projects (Craig and Caitlin available to help).

Wednesday, July 17.

A.M. Lecture: Barophysiology and thermal tolerances of deep-sea animals.

A.M. Field trip: Charleston docks to collect invertebrates for pressure experiments.

P.M. Lab: Pressure tolerances of shallow-water invertebrates.

Friday, July 18.

9:00 A.M.: All writing assignments due

A.M. Lecture (Plowman): Gametogenesis in the deep sea.

A.M. Lab (Plowman): Measuring gametogenic patterns with gonad histology and image analysis.

P.M. Lecture (Young): Sex under pressure: how babies are made in the depths of the sea.

P.M. Lab cleanup.