

## OCSC 4400 Deep-Sea Ecology

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**Instructor Information: Dr. Amanda Bates, Associate Professor**

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Please email me directly with any questions ([abates@mun.ca](mailto:abates@mun.ca)) and every effort will be made to respond to emails quickly.

**Office Hours:** Tuesday from 13:00-15:00 and by appointment (Zoom or Webex)

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**Course Information:** Deep-Sea Ecology focuses on the deep-sea system, which occupies more than 50% of the surface of the globe. The course will introduce students to the physical and chemical environment of the deep sea, including hydrothermal vents and seeps. While the deep sea was initially envisioned as a tranquil environment with little environmental variation, this paradigm has shifted. The course will focus on exploring this highly dynamic environment, from benthic storms and seasonal processes to patterns in species and biodiversity, considering novel biological adaptations for life at depth. The course will further take a contemporary focus and provide an overview of human exploration in the deep sea, from cabled observatories for science to deep-sea mining and fishing, and discuss novel impacts and research on climate change and plastic pollution in this remote ecosystem.

**Pre-Requisites:** OCSC 2500 and at least one course in Ocean Sciences at the 3000 level

**Summary of Teaching and Learning Methods:** The course will be delivered via on-line lectures, seminars and discussions, and on-line guided computer-based laboratory work.

**Formal Lectures:** On-line lectures will be designed to provide important background knowledge and will cover the main concepts and topics by the use of PowerPoint presentations. Where relevant, cutting edge research examples in the appropriate fields will be incorporated into the sessions. References to the applicable background reading and journal articles will be provided as essential reading for each lecture.

**Seminar Series:** On-line seminars will be delivered by guest speakers covering topics at the forefront of deep-sea ecology, including fishing, mining and other impacts in deep-sea systems.

**Laboratory Exercises:** Using their own laptops/devices, students will perform an analysis of deep-sea data, e.g. ROV dive video from the Juan de Fuca hydrothermal vents, Canada, which they will work on over successive weeks (interspersed with Paper Discussions). They will provide physical, chemical, geological and biological context in the form of a dive log, dive summary, with species distribution maps using ArcGIS (scheduled intermittently from Week 1 – 9). In the final session (Week 10), students will be asked to write a one-page research project proposal based on their observations made during their annotated analysis.

**Paper Discussions:** Four scientific papers representing major recent advances in deep-sea biology and ecology will be discussed and critiqued individually or in small groups during virtual lab sessions. Students or groups will be tasked with answering a set of questions about each paper aiming to build

critical thinking skills. Detailed feedback will be provided after each submission to facilitate progressive improvement.

**Tutorial support:** All students will be encouraged to discuss any aspect of the course with faculty. There will be two hours of scheduled tutorial time for additional support. A wide range of support will be provided for those students who have further or specific learning and teaching needs.

### Learning Goals

1. Determine which factors are of physico-chemical significance in the deep sea.
2. Understand how physico-chemical factors modulate animal communities.
3. Describe dominant biodiversity patterns in the deep sea, including species diversity, biomass and zonation.
4. Identify opportunities and threats to deep-sea systems in the context of global change.
5. Critically evaluate the latest research in the deep sea.

**Required Text and Resources:** The course will use peer-reviewed journal articles and a reading list will be posted prior to the start of each semester and linked to each lecture. Articles will be offered through the course resources widget and Brightspace.

**Method of Evaluation:** Evaluation will be through written evaluations of discussion papers, a scientific report analysing deep-sea data, a one-page research proposal, and a final exam.

1. 20%: Four written critiques of discussion papers will be completed in laboratory time (4 x 5%) due in weeks 4, 6, 9 and 11
2. 30%: Report of analysis of deep-sea data due in week 8
3. 10%: Research proposal due in week 12
4. 40%: Final exam (the final exam will be open-book, and will be comprised of problem-based questions that integrate learning across the course material)

### Course Policies

- Late submissions penalized (loss of 10% per day) and missed assessments will be handled on a case-by-case basis.
- Memorial University of Newfoundland is committed to supporting inclusive education based on the principles of equity, accessibility and collaboration. Accommodations are provided within the scope of the University Policies for the Accommodations for Students with Disabilities ([www.mun.ca/policy/site/policy.php?id=239](http://www.mun.ca/policy/site/policy.php?id=239)). Students who may need an academic accommodation are asked to initiate the request with the Glenn Roy Blundon Centre at the earliest opportunity ([www.mun.ca/blundon](http://www.mun.ca/blundon)).
- Students will be expected to adhere to those principles that constitute proper academic conduct. A student has the responsibility to know which actions, as described under Academic Offences in the University Regulations, could be construed as dishonest or improper. Students found guilty of an academic offence may be subject to a number of penalties commensurate with the offence including reprimand, reduction of grade, probation, suspension or expulsion from the University. For more information regarding this policy, students should refer to the University Regulations for Academic Misconduct (Section 6.12) in the University Calendar.
- All efforts will be made to provide a safe learning environment regardless of race, colour, nationality, ethnic origin, social origin, religious creed, religion, age, disability, disfigurement, sex (including pregnancy), sexual orientation, gender identity, gender expression, marital status, family status, source of income or political opinion.
- Additional support can be found here: [www.mun.ca/currentstudents/student/](http://www.mun.ca/currentstudents/student/) and <https://munsu.ca/resource-centres/>
- Feedback on the course and its progression will be requested through an anonymous survey in week 4, and via the Course Evaluation Questionnaire. This feedback will be valued and used to improve the course.

## **Example Course Schedule (the order may change depending on guest lecturer availability)**

### **Week 1**

- *1.1 Lecture (2 hr):* The history of deep-sea research and water masses in the world ocean
- *1.2 Lab (3 hr):* Introduction to the lab component of the course

### **Week 2**

- *2.1 Lecture (2 hr):* Physiology of temperature and pressure adaptation
- *2.2 Lab (3 hr):* Students will start working on a dive log, recording observations of importance (e.g. chemical, physical, geological, ecological) based on hydrothermal vent video footage

### **Week 3**

- *3.1 Lecture (2 hr):* Life histories of deep-sea organisms
- *3.2 Lab (3 hr):* Continuing from the previous lab session (2.2), students will be asked to read research cruise reports and formulate their dive summary. The aim will be to provide an overview of the dive for future scientists visiting the area, and a record of events for those scientists participating in the research cruise

### **Week 4**

- *4.1 Lecture (2 hr):* Deep-sea biodiversity and biogeography
- *4.2 Discussion (3 hr):* Students will be critiquing a discussion paper, e.g. *Deep-Sea Diversity Patterns Are Shaped by Energy Availability* doi:10.1038/nature17937

### **Week 5**

- *5.1 Special Seminar (2 hr):* Specialized deep-sea sampling
- *5.2 Lab (3 hr):* Continuing from lab sessions 1.2, 2.2 and 3.2, students will use ArcGIS to map species distributions based on their observations of presences from dive video.

### **Week 6**

- *6.1 Lecture (2 hr):* Deep pelagic zones and bioluminescence
- *6.2 Discussion Paper (3 hr):* Students will be critiquing a discussion paper, e.g. *Bioluminescence in the Ocean: Origins of Biological, Chemical, and Ecological Diversity* doi:10.1126/science.1174269

### **Week 7**

- Break

### **Week 8**

- *8.1 Lecture (2 hr):* Chemosynthetic environments: hydrothermal vents
- *8.2 Lab (3 hr):* Students will develop a research proposal based on the dive footage observations and ArcGIS mapping (achieved in lab sessions 1.2, 2.2 and 5.2)

### **Week 9**

- *9.1 Lecture (2 hr):* Chemosynthetic environments: seeps and whale falls
- *9.2 Discussion (3 hr):* Students will be critiquing a discussion paper, e.g. *Exponential Decline of Deep-Sea Ecosystem Functioning Linked to Benthic Biodiversity Loss* doi:10.1016/j.cub.2007.11.056

### **Week 10**

- *10.1 Special Seminar (2 hr):* Deep-sea food webs and fishing pressure
- *10.2 Lab (3 hr):* Students will be provided the opportunity to present their proposal to the full group for comments/feedback prior to submission of the research proposal

### **Week 11**

- *Special Seminar 11.1 (2 hr):* Deep-sea mining
- *Discussion Paper 11.2 (3 hr):* Students will be critiquing a discussion paper, e.g. *Tighten Regulations on Deep-Sea Mining* doi:10.1038/470031a

### **Week 12**

- *Lecture 12.1 (2 hr):* Climate change and pollution in the deep ocean
- *Lab 12.2 (3 hr):* Practice exam questions will be provided

**Week 13**

- *Lecture 13.1 (2 hr)*: Review of lecture material and open question session
- *Lab 13.2 (3 hr)*: Practice exam question answers will be discussed

**Land Acknowledgement:** We respectfully acknowledge the territory in which we gather as the ancestral homelands of the Beothuk, and the island of Newfoundland as the ancestral homelands of the Mi'kmaq and Beothuk. We would also like to recognize the Inuit of Nunatsiavut and NunatuKavut and the Innu of Nitassinan, and their ancestors, as the original people of Labrador. We strive for respectful partnerships with all the peoples of this province as we search for collective healing and true reconciliation and honour this beautiful land together.