DALHOUSIE UNIVERSITY

ENVS/MARI 4005 Coral Reefs and Environmental Change

Faculty of Science Course Syllabus Fall 2025

Department of Earth and Environmental Science

Class Times: Mondays and Wednesday 2:35-3:55 pm **Location**: LSC C334

Tutorial times: Tuesdays 235-325 pm **Location**: LSC B2055

Instructor: Dr. Sue Gass | Email: sue.gass@dal.ca

Student Support Hours: Mondays 1:00 - 2:30 pm In person LSC 3082 or on MS Teams

Communication guidelines

Good communication between the Instructor and students is key to the success of students in a course. I will do my best to respond to your emails within 24 hours except over the weekend where it may be 48 hours. If you have a concern with the course, please reach out.

Class Description

Coral reefs are iconic of highly diverse ecosystems and play a significant role in the economies of most countries where they exist. Cold-water corals are lesser known than their tropical relatives but also enhance the structural complexity and thus habitats within their deep ocean environments. Humans have changed coral reef environments and further changes are predicted to occur in the future. This class will introduce you to the biology of corals and the key characteristics that make up their environments. We will examine some of the major human impacts on these environments including warmer temperatures, acidification, pollution, and commercial activities. Finally, we will consider options to minimize further negative changes and ways to help sustain coral ecosystems into the future. This course runs parallel with ENVS 4003 but includes the addition of a 7-day field trip to the Bermuda Institute of Ocean Science.

Dalhousie University acknowledges that we are in Mi'kma'ki, the ancestral and unceded territory of the Mi'kmaq People and pays respect to the Indigenous knowledges held by the Mi'kmaq People, and to the wisdom of their Elders past and present. The Mi'kmaq People signed Peace and Friendship Treaties with the Crown, and section 35 of the Constitution Act, 1982 recognizes and affirms Aboriginal and Treaty rights. We are all Treaty people.

Dalhousie University also acknowledges the histories, contributions, and legacies of African Nova Scotians, who have been here for over 400 years.

Course pre-requisites, exclusions

Chem 1011/Chem 1012 and Biol 2060. Also restricted to students with six credit hours in Environmental Science or Biology or Marine Biology at or above the 3000 level. This course is an exclusion with ENVS/MARI 4005.

Key knowledge or skills expected of students coming into the course:

- Student should know how to balance chemical equations
- Student should be familiar with reading scientific literature
- Students should be able to describe major drivers of and differences among marine biomes; how abiotic factors influence the distribution and abundance of organisms; and the effects of disturbance on species diversity.
- Students should be able to predict the impacts of human activities (e.g. climate change, nutrient loading) using knowledge of the major biogeochemical cycles on the planet (e.g. water, carbon and nitrogen).
- No previous knowledge of corals is required

Course learning outcomes:

1. Describe the anatomy and identifying features of common tropical and cold-water corals
2. Describe taxonomic relationships among corals
3. Describe the abiotic environment of tropical and cold-water corals including nutrient cycling
4. Predict how changing environmental factors will affect corals (temperature, salinity, ocean acidification, sedimentation, excess nutrients, freshwater inputs)
5. Describe the reproductive strategies of corals and how these influence coral resilience
6. Describe how corals feed and grow
7. Describe different research methods used to study coral responses to environmental change.
8. Differentiate the functional roles of fish groups within coral reef ecosystems
9. Carry out literature-based research and communicate the current state of knowledge on a range of topics related to corals and environmental change
10. Describe localized impacts on coral reefs
11. Describe the causes, the biological process, and the ecological consequences of coral bleaching.
12. Describe how ocean acidification may or may not hinder coral growth
13. Explain the options for coral reef conservation and the challenges faced by Low-Income and High-Income countries when trying to implement these measures.
14. Describe the potential resilience of coral reefs to environmental change
15. Present and critique scientific findings from the literature to fellow students
16. Develop familiarity with the terminology used in the study of corals
17. Evaluate anthropogenic interventions that could be used to protect coral reefs from climate change

Textbook and Readings

1. The Biology of Coral Reefs, 2nd Edition. Charles R.C. Sheppard et al., 2018 (required text).

There are several ways for you to access readings in the textbook:

- Two-hour reserve at the Killam Library
- E-book available for free through the Dalhousie Library https://ezproxy.library.dal.ca/login?url=https://search.ebscohost.com/login.aspx?direct=true&db=e000xna&AN=1640102&site=ehost-live&scope=site
- Hard copies are available to purchase at the Dalhousie bookstore
- E-book is available to purchase from Oxford University Press
- It's the same textbook as in previous years so you may be able to find a second hard copy

Additional Readings List – links and/or pdfs are found on Brightspace. Additional readings may be added.

1. Moberg, F. and C. Folke. (1999). Ecological goods and services of coral reef ecosystems. Ecological Economics 29: 215-233.
2. Obura DO (2020) Getting to 2030 - Scaling effort to ambition through a narrative model of the SDGs. Marine Policy 117:103973
3. Hoegh-Guldberg, O. (1999). Climate change, coral bleaching and the future of the worlds coral reefs. Marine and Freshwater Research 50, 839.66.
4. NOAA Coral Reef Watch. (nd). Introduction Tutorial to NOAA's Coral Reef Watch program. Accessed from: https://coralreefwatch.noaa.gov/satellite/education/tutorial/welcome.php
5. Hughes, T.P., J.T. Kerry, A.H. Baird, S.R. Connolly, A. Dietzel, C.M. Eakin, S.F. Heron, et al. (2018). Global warming transforms coral reef assemblages. Nature 556: 492-496
6. Aswani, S., Mumby, P. J., Baker, A. C., Christie, P., McCook, L. J., Steneck, R. S., & Richmond, R. H. (2015). Scientific frontiers in the management of coral reefs. Frontiers in Marine Science, 2. https://doi.org/10.3389/fmars.2015.00050
7. Bellwood, D.R., T.P. Hughes, C. Folke and M. Nystrom. (2004). Confronting the coral reef crisis. Nature 429: 827-833
8. Roberts, J.M., A. Wheeler and A. Freiwald. (2006). Reefs of the Deep: The Biology and Geology of Cold-Water. Science 312: 543-547.
9. Hoegh-Guldberg, O. P., J. Mumby, A. J. Hooten, R.S. Steneck, P. Greenfield, E. Gomez, C.D. Harvell et al. (2007). Coral reefs under rapid climate change and ocean acidification. Science 318: 1737-1742
10. Guinotte, J.M., J. Orr, S. Cairns, A. Freiwald, L. Morgan and R. Goerge. (2006). Will human-induced changes in seawater chemistry alter the distribution of deep-sea scleractinian corals? Frontiers in Ecology and Environment 4(3): 141–146
11. DFO (Fisheries and Oceans Canada). (2015). Coral and Sponge Conservation Strategy for Eastern Canada. Fisheries and Oceans Canada. 70 pp.
12. Mcleod, E., Anthony, K. R. N., Mumby, P. J., Maynard, J., Beeden, R., Graham, N. A. J., Heron, S. F., Hoegh-Guldberg, O., Jupiter, S., MacGowan, P., Mangubhai, S., Marshall, N., Marshall, P. A., McClanahan, T. R., Mcleod, K., Nyström, M., Obura, D., Parker, B., Possingham, H. P., … Tamelander, J. (2019). The future of resilience-based management in coral reef ecosystems. Journal of Environmental Management, 233, 291–301. https://doi.org/10.1016/j.jenvman.2018.11.034

Grading Scheme – ENVS/MARI 4005

Assessment component	%	Due Date
Assignment 1 Coral morphology **Assignment 2** Coral bleaching	10 10	October 15th November 24th
Midterm Exam (in class)	30	October 27th
Reading the primary literature	5	TBD during tutorial
BIOS project presentations	20	December 2nd and 9th
Course engagement	15	7.5% during regular term classes 7.5% during trip to Bermuda Goal setting – due Sept 29th, Goal reflection 1 due Oct 31st, and Goal reflection 2 due December 12th
Course reflection	10	December 10th

All assignments, unless otherwise specified above, are submitted on Brightspace before midnight on the due date

Course engagement and in-class participation

Attendance and engagement with the course material will be worth 10% of your grade. Attendance alone does not earn grades; your grade will increase the more you take advantage of opportunities to engage with the course content. The grading rubric focuses on each student setting personal goals and assessing your own success through reflection with oversight by the course instructor.

Opportunities to engage with the course material come in many forms. It could include coming to class having done the readings and ready to answer or ask questions on the readings, contributing to small group discussions, offering feedback from your small group to the whole class, raising your hand to answer or ask questions in class, participating in whole class discussions, allowing other students to participate by not dominating discussions when you would normally be inclined to speak often. If you are less comfortable speaking out in class, you can post comments and/or questions on lecture material to the Class Discussion

Board. I encourage you to push yourselves outside of your comfort zone and set ambitious goals. I also encourage you to practice your critical thinking skills, i.e., asking questions that arise from the readings and making connections between course topics and with previous courses and the material in this course. Everyone is allowed two free missed classes without deductions, e.g. due to illness, and should submit an SDA for missed classes. After that, your course engagement grade will be pro-rated based on your attendance in class.

Field trip participation

The field trip is focused on learning by doing, while also hearing from a range of experts conducting research on coral reefs and environmental change. You will be expected to actively participate in all the field and lab activities. This will allow you to learn new knowledge and take away as many new skills as possible from your experience in Bermuda. In addition, scientists do not work in isolation; therefore, working effectively with others is a valuable skill to develop. The following parameters will be assessed for the participation during the field trip:

- Participating willingly in activities and allowing others to participate
- Asking questions when things aren't clear
- Being familiar with the readings
- Providing ideas, working with others to solve problems
- Being prepared, punctual and courteous in the field
- Lending a hand in the field or lab when help is needed
- Being safe and looking out for fellow students

Mid-term exam

There will be a mid-term exam on the material covered up to and including the lecture held on October 8th. The mid-term will be held in class and is scheduled for **October 27th**.

Assignments

There will be 2 assignments. Assignment 1 is due before midnight on **October 15th** via Brightspace. Assignment 2 is due **November 24th** before midnight and should be submitted online via Brightspace. Assignment instructions are posted on Brightspace.

Primary Literature Article Discussion

You will hold a small group discussion based on a primary literature article published by researchers at the Bermuda Institute of Ocean Sciences. Your primary literature discussion is worth 5% of your grade. You will receive a peer evaluation grade based on your contributions to the group discussion. You will be provided with instructions and expectations for this discussion.

BIOS Project Presentations

You will participate in three field trips and one lab to collect data and further your understanding of coral reefs and environmental change while at BIOS. You will work in groups to prepare an oral presentation focused on the Bermuda reef environment, the field methodology, and results for one of these four experiences. A detailed description of what is required for the presentations will be posted on Brightspace.

Policy on late assignments

Missed or Late Academic Requirements due to Student Absence

Dalhousie students are asked to take responsibility for their own missed deadlines (3 days or less) by contacting their instructor by email **prior to** the academic requirement deadline or scheduled time **and** by submitting a completed Student Declaration of Absence (SDA) to their instructor in case of missed or late academic requirements. The SDA form can be found on our Brightspace page under "Assignments". Only **TWO** separate SDA forms may be submitted per term for missed classes and **TWO additional** SDAs may be submitted for late assignments. Once the SDA has been submitted, you will have three days to submit your assignment. If you miss the mid-term due to illness, you must follow the protocol as above and a make-up mid-term will be scheduled one week later.

Assignments submitted late without prior notification **and** the submission of an SDA, or without an approved extension will be deducted 10% per day. Extensions are granted with good reason and **must be requested prior** to the assignment's original due date. If you have any questions or concerns, please do not hesitate to reach out to the instructor.

Course Policies related to Academic Integrity

Although you are allowed and in same cases encouraged to work together on course assignments, unless specifically stated in the assignment instructions, the final work that is submitted must be completed individually.

You will find that the use of AI generative tools will not be helpful to the first two assignments in this course because of the novel and specific nature of each assignment and you are not permitted to use AI in these cases.

You should note that the material generated by these AI programs may be inaccurate (creates hallucinations), lacks human judgement and comes with a series of ethical considerations such as training with copyrighted content, the use of unpaid labour, a large carbon footprint, and it perpetuates biases, stereotypes, and prejudices found in the training data. Further, you should be aware that use of generative AI may also stifle your own development as an independent critical thinker and stifle your creativity.

Generative AI programs are not allowed under any circumstances to be used for generative editorial work and autonomous content creation. You may use it for study aids such as helping to explain concepts while you review lecture material or to help you with time management/planning.

Any additional uses of AI, without prior written consent from the instructor, will be deemed an academic offence under the Academic Integrity policy at Dalhousie. Any plagiarism or other form of cheating will be dealt with severely under relevant Dalhousie University policies.

The Meaning of Grades

Evaluation will be completed and expressed in raw marks throughout the course. Letter grades will be assigned only to the final distribution of marks for the course.

A+	(90-100)	B+ (77-79)	C+ (65-69)	D (50-54)
A	(85-89)	B (73-76)	C (60-64)	F (<50)
A-	(80-84)	B- (70-72)	C- (55-59)	

Class schedule

Week	Topic	Monday	Wednesday	Readings
Week 1 Sept 24	Introduction and ecosystem services		Lecture 1 • Introduction to the course • Value of coral reefs • Ecosystem goods and services & sustainable development goals	Chapters 1 Moberg and Folke (1999) Obura (2020)
Week 2 Sept 29&Oct 1	What is a coral?	Lecture 2 • Discussion questions from previous lecture • What is a coral? • What is a coral reef?	Lecture 3 • Coral ID Lab Assignment 1 (due October 13th) Sign up for a 30 mins slot in the McCullough Museum	Chapter 2
Week 3 Oct 6 & 8	Abiotic environment Growth & feeding	Lecture 4 • Salinity • Temperature • Light • Nutrients	Lecture 5 • Coral calcification • Growth	Chapters 3 & 4
Week 4 Oct 13 & 15	Reproduction and recruitment **Assignment 1 due October 15th**	**No Class - Thanksgiving**	Lecture 6 • Feeding and symbiosis	Chapter 4
Week 5 Oct 20 & 22	Coral bleaching	Lecture 7 Reproduction & Recruitment	Lecture 8 • Introduction to coral bleaching • Predicting bleaching events using remotely sensed data • Hotspots and DHWs	Hoegh-Guldberg et al. 1999 NOAA Coral Reef Watch Introduction

Week 6 Oct 27 & 29	Midterm and coral bleaching	**Midterm in class**	Lecture 9 • Recording past bleaching events • What is El Nino? • Graphing coral bleaching data	
Week 7 Nov 3 & 5	Midterm & coral reef fisheries	Lecture 10 • Background information for Assignment 2 (Due November 24th) • Changes in bleaching frequency according to Hughes et al. 2018 *Class ends 30 mins early*	Lecture 11 • Coral reef fish	Hughes et al. 2018 Chapter 6
Week 8	**Study Break – Field Trip to Bermuda**			
Week 9 Nov 17 & 19	Marine management	Lecture 12 • Coral reef fisheries	Lecture 13 • Local stressors • Coral reef management *Class ends 30 mins early*	Chapter 7 & 8 Aswani et al.
Week 10 Nov 24 & 26	Cold water corals **<u>Assignment 2 due Nov 24</u>**	Lecture 14 • Coral reef management for resilience and restoration	Lecture 15 No class – work on group presentations	Bellwood et al. 2004 McLeod et al. 2020
Week 11 Dec 1 & 3	Cold-water corals	Lecture 16 No class - work on group presentations	Lecture 17 • Introduction to cold-water corals • Corals of Atlantic Canada *Class ends 30 mins early*	Roberts et al. 2006
Week 12 Dec 8-10		Lecture 18 • Tropical corals and ocean acidification	Lecture 19 • Cold-water corals and ocean acidification	Hoegh-Guldbert et al. 2007 Guinotte et al. 2006

Week	Tutorial
Week 1 Sept 23	Introduction to field trip Review logistics
Week 2 September 30	No tutorials – University closed
Week 3 Oct 7	Intro to Predeparture modules
Week 4 October 14	Complete predeparture modules
Week 5 Oct 21	Primary literature discussion
Week 6 Oct 28	Bermuda Coral IDs Intro to Lab
Week 7 Nov 4	Bermuda Fish IDs Intro to Lab
Week 8	**Field trip – no tutorials**
Week 9 Nov 18	Oral presentation guidelines Work on BIOS project presentations
Week 10 Nov 25	Work on BIOS project presentations
Week 11 Dec 2	BIOS project presentations
Week 12 Dec 9	BIOS project presentations

University Policies and Statements

Recognition of Mi'kmaq Territory

Dalhousie University would like to acknowledge that the University is on Traditional Mi'kmaq Territory. The Elders in Residence program provides students with access to First Nations elders for guidance, counsel, and support. Visit or e-mail the Indigenous Student Centre at 1321 Edward St or elders@dal.ca. Additional information regarding the Indigenous Student Centre can be found at: https://www.dal.ca/campus_life/communities/indigenous.html

Internationalization

At Dalhousie, 'thinking and acting globally' enhances the quality and impact of education, supporting learning that is "interdisciplinary, cross-cultural, global in reach, and orientated toward solving problems that extend across national borders." Additional internationalization information can be found at: https://www.dal.ca/about-dal/internationalization.html

Academic Integrity

At Dalhousie University, we are guided in all our work by the values of academic integrity: honesty, trust, fairness, responsibility, and respect. As a student, you are required to demonstrate these values in all the work you do. The University provides policies and procedures that every member of the university community is required to follow to ensure academic integrity. Additional academic integrity information can be found at: https://www.dal.ca/dept/university_secretariat/academic-integrity.html

Accessibility

The Student Accessibility Centre is Dalhousie's centre of expertise for matters related to student accessibility and accommodation. If there are aspects of the design, instruction, and/or experiences within this course (online or in-person) that result in barriers to your inclusion, please contact the Student Accessibility Centre (https://www.dal.ca/campus_life/academic-support/accessibility.html) for all courses offered by Dalhousie with

the exception of Truro. For courses offered by the Faculty of Agriculture, please contact the Student Success Centre in Truro (https://www.dal.ca/about-dal/agricultural-campus/student-success-centre.html)

Conduct in the Classroom – Culture of Respect

Substantial and constructive dialogue on challenging issues is an important part of academic inquiry and exchange. It requires willingness to listen and tolerance of opposing points of view. Consideration of individual differences and alternative viewpoints is required of all class members, towards each other, towards instructors, and towards guest speakers. While expressions of differing perspectives are welcome and encouraged, the words and language used should remain within acceptable bounds of civility and respect.

Diversity and Inclusion – Culture of Respect

Every person at Dalhousie has a right to be respected and safe. We believe inclusiveness is fundamental to education. We stand for equality. Dalhousie is strengthened in our diversity. We are a respectful and inclusive community. We are committed to being a place where everyone feels welcome and supported, which is why our Strategic Direction prioritizes fostering a culture of diversity and inclusiveness (Strategic Priority 5.2). Additional diversity and inclusion information can be found at: http://www.dal.ca/cultureofrespect.html

Student Code of Conduct

Everyone at Dalhousie is expected to treat others with dignity and respect. The Code of Student Conduct allows Dalhousie to take disciplinary action if students don't follow this community expectation. When appropriate, violations of the code can be resolved in a reasonable and informal manner - perhaps through a restorative justice process. If an informal resolution can't be reached, or would be inappropriate, procedures exist for formal dispute resolution. The full Code of Student Conduct can be found at: https://www.dal.ca/dept/university_secretariat/policies/student-life/code-of-student-conduct.html

Fair Dealing Policy

The Dalhousie University Fair Dealing Policy provides guidance for the limited use of copyright protected material without the risk of infringement and without having to seek the permission of copyright owners. It is intended to provide a balance between the rights of creators and the rights of users at Dalhousie. Additional information regarding the Fair Dealing Policy can be found at: https://www.dal.ca/dept/university_secretariat/policies/academic/fair-dealing-policy-.html

Originality Checking Software

The course instructor may use Dalhousie's approved originality checking software and Google to check the originality of any work submitted for credit, in accordance with the Student Submission of Assignments and Use of Originality Checking Software Policy. Students are free, without penalty of grade, to choose an alternative method of attesting to the authenticity of their work and must inform the instructor no later than the last day to add/drop classes of their intent to choose an alternate method. Additional information regarding Originality Checking Software can be found at: https://www.dal.ca/dept/university_secretariat/policies/academic/student-submission-of-assignments-and-use-of-originality-checking-software-policy-.html

Student Use of Course Materials

Course materials are designed for use as part of this course at Dalhousie University and are the property of the instructor unless otherwise stated. Third party copyrighted materials (such as books, journal articles, music, videos, etc.) have either been licensed for use in this course or fall under an exception or limitation in Canadian Copyright law. Copying this course material for distribution (e.g. uploading to a commercial third-party website) may lead to a violation of Copyright law.