DALHOUSIE UNIVERSITY

COURSE SYLLABUS
ENGM 4680/6680 OCEA 4680/5680
Ecosystem Modeling of Marine and Freshwater Environments
Fall 2017

CALENDAR DESCRIPTION

Students develop and apply mathematical models of marine and freshwater ecosystems to study biological production, biogeochemical cycling, etc. Lectures provide theoretical background for coupling nutrient-plankton dynamics, including parameterizing biological processes and physical effects. Computer sessions provide hands-on modeling experience. Students also critique literature and conduct an independent research project.

COURSE OVERVIEW

Quantitative studies of marine and freshwater ecosystems are essential for addressing many scientific and socio-economic issues including climate change, pollution, fisheries, conservation, etc. Mechanistic modeling is an effective tool for this purpose, as it can synthesize data, estimate unmeasured quantities, assess causal relationships, identify critical knowledge gaps, and predict responses to environmental change. Such models are integral components of major research programs and commonplace in the literature. An understanding of the methodologies involved is therefore essential for those wishing to incorporate modeling into their research. There is a wide array of models in existence and it can be challenging to critique the literature, use and adapt existing models, let alone create new models.

This course focuses on the modeling process, i.e. development of new models, design of strategic simulations suited to specific questions, analysis of results, and ways to test robustness of conclusions to model assumptions. It provides step-by-step guidance on what model structures to adopt and processes to include, how to characterize these choices mathematically, and how to assess results, etc. This will be done using hands-on examples, coded in MATLAB, and based on published studies. Students will construct and analyze Nutrient-Phytoplankton-Zooplankton (NPZ) models including dependencies on physical factors (light, temperature, mixed-layer depth). Classes will also cover how to incorporate additional biological complexity (e.g. bacteria, detritus, multiple nutrient stoichiometry, omnivory), physical transport (e.g. advection, mixing, sinking) and organism behaviour. In addition, students will have an opportunity to explore and apply modeling techniques specific to their area of interest/research.

The course is meant to be as hands-on as possible. There are 3 hours of lecture each week, 1.5 hrs in a classroom where new theory is presented, and 1.5 hrs at a computer where we develop and use models illustrate concepts presented in lecture. Weekly assignments cover theory and coding, during which students adapt the template codes. There is also a weekly 1 hr journal-club, during which students critique articles from the literature that are relevant to the topics we cover. Students propose and complete a modeling project, and give a conference-style oral presentation along with a written report.

COURSE OBJECTIVES

- Develop students' understanding of the modeling process, i.e. going from observation of a real-world problem, to developing a conceptual model, to formulating mathematical relationships describing the concepts, to implementing code that can solve the math, to analyzing results, and communicating those results in context of the original problem.
- Provide students with basic knowledge about planktonic ecosystem structure and function and classic approaches to ecosystem modelling.

- Train students how to implement models using numerical methods and programming packages.
- Train students in ways to design strategic model studies that provide output useful for the model application, assess sources of error and uncertainty, and to analyze and interpret model results.
- Introduce ways to critique modeling literature, and effectively communicate modeling studies.

COURSE PREREQUISITES
Students enrolling in this class will ideally have a basic understanding of (i) planktonic ecosystem structure and function, (ii) dynamical systems based on mass conservation equations, (iii) differential equations and numerical methods, and (iv) computer programming. Due to the multidisciplinary nature of this course, and the diversity of students it attracts, there will undoubtedly be areas for which each student is an expert and others for which they are novices. Thus, there are no official prerequisites and instruction will provide relevant background material and additional references.

INSTRUCTOR:
Wendy Gentleman
wendy.gentleman@dal.ca (*preferred mode of contact*)
902-494-6086
MA101, Morroy Building, 5269 Morris, Sexton Campus

MEETING TIMES
Each week there will be 1.5 hrs classroom lecture + 1.5 hrs hands-on computer session + 1 hr journal club. Due to conflicting schedules among graduate and undergraduates, departments and faculties, the meeting days/times will only be finalized after the introductory lecture, once the professor has collected the student scheduling information. Presently, the combined lecture + computer session is tentatively set for Weds evenings 5:30-8:30 pm, rm C300, Sexton campus.

COURSE MATERIALS
There is no required textbook. Course notes, handouts, articles and homework will be provided through Brightspace. To access the course on Brightspace, go to http://www.dal.ca and click on Brightspace at the top of the page and follow the link.

LEARNING OUTCOMES
- Demonstrated understanding of theory related to ecosystem processes
- Demonstrated use of simulations to quantitatively address specific questions
- Demonstrated ability to design a modeling study
- Demonstrated ability to meaningfully communicate model results
- Demonstrated thoughtfully critique of modeling literature

ASSESSMENT
Final grades are based on weekly homework (approximately 10, worth a total of 50%), participation in journal club (10% of final grade), and completion of a modeling research project (independent for graduate students; group for undergraduates) on a topic chosen by the students that demonstrates the process of modeling. Assessment of the research project is (5% for the proposal, 15% for the oral presentation, and 20% for the written report).

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Conversion of numeric grades to final letter grades follows the Dalhousie Common Grade Scale:

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)	

COURSE POLICIES

Lecture notes, which are pared down versions of the lecture presentation, will be provided each week. It is the students' responsibility to complete the notes during class. Models developed during in class will also be provided online to ensure coding consistency among students.

Weekly assignments are often long, and include open-ended questions designed to get students to think about the issues as opposed to working out a correct answer. Working in groups is strongly advocated, although the submission must be the students' individual work.

Students are expected to submit weekly assignments on time. Late assignments will be incrementally penalized for each day late, with a zero mark assigned if the assignment is later than 1 week as solutions are discussed at subsequent lecture.

Journal club participation is based on attendance, and the discussion will be led by a different student or group of students each week. Missed journal clubs may be "made up" by providing a written summary of the article as indicated by the instructor.

Rubrics for the oral presentation and written report will be distributed ahead of time. Presentations will be evaluated by the other students and the TA as well as the professor. The written report will be due no less than one week following the presentations in order to afford time to incorporate feedback.

TENTATIVE COURSE SCHEDULE

Note: this may be adjusted during the term, based on student interest and experience

Dates	**Topics covered in lecture + computer session**	**Journal article**	**Assignments**
Sept 5 – Sept 8	Course Introduction.	Jackson et al., 2000	
Sept 11 – Sept 15	Phytoplankton and Primary Production. Intro to MATLAB	Anderson & Gentleman, 2012	A1 Given
Sept 18 – Sept 22	Nutrient-Phytoplankton coupling (Uptake/Growth)	Aksnes & Egge, 1991	A1 Due A2 Given
Sept 25 - Sept 29	Phytoplankton-Zooplankton coupling (Grazing)	Gentleman & Neuheimer, 2008	A2 Due A3 Given
Oct 1 – Oct 5	Zooplankton loss processes (Metabolism & Predation).	Steele & Henderson, 1998	A3 Due A4 Given
Oct 10 – Oct 13	Basic NPZ Models (Detritus and Regeneration).	Fasham et al., 1990	A4 Due A5 + Project Proposal Given
Oct 16 – Oct 20	Adding physical complexity I: Light and temperature	Evans & Parslow, 1985	A5 Due A6 Given

Oct 23 – Oct 27	Adding physical complexity II: Transport in box models	Frost & Franzen, 1992	A6 + Project Proposal Due A7 Given
Oct 30 – Nov 3	Adding biological complexity I: Multiple nutrients	Flynn, 2003	A7 Due A8 Given
Nov 6 – 10	**Study Break. No Classes**		
Nov 14 –Nov 17	Adding biological complexity II: Multiple prey	Anderson et al., 2012	A8 Due A9 Given
Nov 20 –Nov 24	Adding physical complexity II: Spatial variation (Advection-Diffusion-Reaction)	Jamart et al., 1977	A9 Due A10 Given
Nov 27 –Dec 1	Other modeling approaches (e.g. Individual Based Models & Particle tracking)	None	A 10 Due
Dec 4 --Dec 8	Presentations to occur prior to Dal Exam period. Project due during Exam period.		

UNIVERSITY POLICIES, STATEMENTS, GUIDELINES

This course is governed by the academic rules and regulations set forth in the University Calendar and the Senate. https://academiccalendar.dal.ca/Catalog/ViewCatalog.aspx?pageid=viewcatalog

Academic Integrity

At Dalhousie University, we are guided in all of our work by the values of academic integrity: honesty, trust, fairness, responsibility and respect (*The Center for Academic Integrity, Duke University, 1999*). As a student, you are required to demonstrate these values in all of 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. (read more: http://www.dal.ca/dept/university_secretariat/academic-integrity.html)

Accessibility

The Advising and Access Centre and the Student Success Centre (Agricultural Campus) serve as Dalhousie's centres for expertise on student accessibility and accommodation. Our work is governed by Dalhousie's Student Accommodation Policy to best support the needs of Dalhousie students. Our team work with students who request accommodation as a result of: disability, religious obligation, an experienced barrier related to any other characteristic protected under Canadian Human Rights legislation. (read more at: https://www.dal.ca/campus_life/academic-support/accessibility.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. If an informal resolution can't be reached, or would be inappropriate, procedures exist for formal dispute resolution. (read more: https://www.dal.ca/campus_life/safety-respect/student-rights-and-responsibilities/student-life-policies/code-of-student-conduct.html)

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. (read more: http://www.dal.ca/cultureofrespect.html)

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Recognition of Mi'kmaq Territory

Dalhousie University acknowledges that the University is located on Traditional Mi'kmaq Territory.

You may also wish to provide the following information: The Elders in Residence program provides students with access to First Nations elders for guidance, counsel and support. Visit the office in the McCain Building (room 3037) or contact the programs at elders@dal.ca or 902-494-6803 (leave a message).

University Policies and Programs

- Important Dates in the Academic Year (including add/drop dates) http://www.dal.ca/academics/important_dates.html
- University Grading Practices: Statement of Principles and Procedures

https://www.dal.ca/dept/university_secretariat/policies/academic/grading-practices-policy.html

- Scent-Free Program http://www.dal.ca/dept/safety/programs-services/occupational-safety/scent-free.html

LEARNING AND SUPPORT RESOURCES

General Academic Support – Advising

Halifax: https://www.dal.ca/campus_life/academic-support/advising.html

Truro: https://www.dal.ca/about-dal/agricultural-campus/student-success-centre/academic-support.html

Fair Dealing Guidelines https://libraries.dal.ca/services/copyright-office/guidelines/fair-dealing-guidelines.html

Other

- Black Students https://www.dal.ca/campus_life/communities/black-student-advising.html
- International Students https://www.dal.ca/campus_life/international-centre.html
- Indigenous Students https://www.dal.ca/campus_life/communities/indigenous.html
- Student Health Services http://www.dal.ca/campus_life/health-and-wellness/health-services.html
- Counselling https://www.dal.ca/campus_life/health-and-wellness/counselling.html
- Library http://libraries.dal.ca
- Copyright Office https://libraries.dal.ca/services/copyright-office.html
- E-Learning website http://www.dal.ca/dept/elearning.html
- Writing Centre https://www.dal.ca/campus_life/academic-support/writing-and-study-skills.html
- Faculty or Departmental Advising Support: Studying for Success Program http://www.dal.ca/campus_life/academic-support/study-skills-and-tutoring.html
- Student Finance page: https://www.dal.ca/admissions/money_matters.html