Instructors:
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Lecture: Tues: 10-10:50; Th 10:00 – 10:50 am, SCRF 206
Laboratory: Tues, 1:00-4:00 pm, Biol 2029
Field trip: September 30-October 1, 2019, Whistler

Course description
Biology 402 (***Aquatic Ecology***) is an upper-level ecological sciences course that provides an overview of biodiversity in freshwater systems (strong emphasis on lakes), while also focusing on the research process. This course will emphasize using the scientific method to understand ecology of communities and ecosystems. Students will study, sample and identify some of the dominant biota of aquatic environments, and learn about how they are related to physical and chemical processes of the systems in which they reside. We will use standard limnology methods to sample natural and experimental aquatic systems, as well as biodiversity sampling methods to sample biodiversity, and use comparative analyses to learn how processes affect biotic patterns. A series of case studies and contemporary issues will also be presented to highlight the interdisciplinary nature of this science, and its application to environmental problem solving and conservation.

Course objectives
1. To understand fundamental principles of ecology, evolution and ecosystem function in terms of life in aquatic systems.

2. To understand principles of biodiversity, ecosystem function and conservation in Canada's freshwaters

3. To develop a research project using fundamental principles of ecology and pilot data

4. To learn how to collect and process samples for a suite of abiotic and biotic factors, including biodiversity, and how to critically assess and interpret the data from those samples.

5. To choose and implement appropriate statistical analyses

6. To practice and develop communication skills, including oral and written skills

Texts and resources

Textbook: *Ecology of Freshwaters: Earth's Bloodstream* by Brian Moss. There is an electronic version online through the UBC library that you can e-read, or you can buy the book at the bookstore.

Scientific literature: papers will be placed on course reserve; Canvas website will have assignments, announcements and materials for class

Course policies

ATTENDANCE AT LABS AND FIELD TRIPS IS MANDATORY! The field trip will be Sept 30-Oct 1st (Mon-Tues). Lab absence and tardiness will be penalized and any late assignments will be penalized at 5% per day. Furthermore, any academic dishonesty in any form will not be tolerated, this includes cheating and plagiarism.

Assessment

We will practice formative assessment. That means we will provide each other regular feedback in this course. *The overall aim for this course is to help you become good scientists*. That is a combination of skills and critical thinking, and those are honed through practice and feedback. So, I want you to argue, constructively criticize, praise, question and explore. In this course, it's ok to not know the answer at any given moment; but if you don't know something you should know, then I want you to learn it and report back. That's how science actually works.

Assessment activity	**% final grade**	**Date of exam or due date**
Intellectual contribution (participation)	15	ongoing
Laboratory assignments (4)	20	ongoing
Exams and Quizzes	[30]	
Quizzes (5)	10	ongoing
Midterm 1	10	October 15th / 17th
Midterm 2	10	November 14th
Research project (RP)	[35]	
Milestones (7)	14	ongoing
Presentation	6	Nov 26-28
Report	15	Dec 12th

Marks for **intellectual contribution** will be assessed through class participation, participation in labs and group activities. All students will begin with 20 marks, and points will be deducted for persistent tardiness, unexcused absences, lack of engagement in class discussions and lab activities.

Laboratory assignments will involve producing figures with data generated from the labs. We will use R and code for figures and analyses.

Quizzes will be on Canvas, and are designed to give you practice for midterms in terms of question style and content. Midterms will be in class and on paper. Guidelines and expectations for the presentations and research paper are given in the Guidelines for Research Projects document.

Course Plan [topics on each date are subject to change]

Wk/ Date	Class	Lab	Assignments
(1) Sep 3 - 5	[1] Course intro and overview, emphasis on biodiversity [2] aquatic environment; biodiversity; some research questions	No lab this week	***Read:*** *Moss Ch 1, Ch. 12.1-12.6; skim ch 2-3;* ***Quiz 1***
(2) Sep 10 – 12	[1] Why does diversity vary? diversity and diversification; diversity sampling; how to read a paper [2] Brooks and Dodson activity, and 1st assignment	ZP intro (w/ some live ones); sampling gear. **Quiz 2**	***Read:*** *Moss 14.11-14.12, How to read a paper; Brooks and Dodson 1965;* ***B&D activity***
(3) Sep 17 - 19	[1] Canadian lakes and lake types; Physical attributes of lakes: depth, thermocline, [2] Physical attributes of lakes: Oxygen in lakes, stratification. Research project guidelines.	equipment review; practice nutrients, data organization; practice making depth profiles?	***Read:*** *Mensch et al 2017; Research guidelines; Moss Ch 4 + CH 12.5-12.7, 13.5-13.7;* **LA 1**
(4) Sep 24 – 26	[1] Why does diversity vary: filtering and dispersal w/ zooplankton examples [2] review Milestone 1 in class; questions, ideas, etc. Lake Assignment review.	**Quiz 3** Ponds to sample ZP, plus quick looks in the lab? teams;	RP: **Milestone 1 due 9/26**; ***Read***: *Moss Ch 14.11-14.20,* lab manual & field trip guide
Sep 30-Oct 1: **Field trip: Mountain Lakes**			
(5) Oct 1 – Oct 3	[1] field trip [2] field trip debrief, phytoplankton, chlorophyll, productivity; midterm review;	Field trip; **(LA 2)**	***Read:*** *Moss CH 14.1-14.8*
6: Oct 8-10	[1] Seasonality and species interactions: PEG model. Species interactions: food, predation, competition, facilitation [2] **MIDTERM**	Zooplankton ID and sorting	RP: **Milestone 2 due 10/10**; ***Read:*** *Sommer et al 1980, 2012*
7: Oct 15-17	[1] local and regional dynamics and connections; insurance hypothesis; BEF [2] *Patrick Thompson* – metacommunities and reorganization	Zoobenthos **Quiz 4**	***Read:*** *Thompson and Shurin 2012* RP: **Milestone 3 due 10/17;**
8: Oct 22-24	[1] [2] Biodiversity/ecosystem functioning	Phytoplankton and chlorophyll (**LA 3**)	***Read:*** *TBD*
9: Oct 29 –	[1] *Sean Naman* – Fish-habitat, foraging [2] *Jordan Rosenfeld* - Fish biology lecture	Nutrient analyses; (**LA 4**)	***Read:*** Moss Ch16, first part?

Oct 31			
10: Nov 5 - 7	[1] Nitrogen and the N-cycle; Stoichiometry [2] P cycle, eutrophication	No lab this week; **Quiz 5**	RP: Milestone 4 due 11/7 ***Read:*** *Schindler 1974, Elser et al 2010*
11: Nov 12-14	[1] *Chelsea Little* - Streams, River Continuum, and Biodiversity/EF [2] **Midterm 2**	Flex - projects	RP: Milestone 5 due 11/14; *Little and Altermatt 2018*
12: Nov 19 – 21	Climate change [*Michelle Tseng*], human activities, etc: habitat, species interactions, dispersal, etc. Phenology.	Flex - projects	RP: Milestone 6 due 11/19; ***Read:*** TBD
13: Nov 26 – Nov 28	Presentations and discussions of research findings; workshop rough drafts of papers	Presentations	RP: Milestone 7 due 11/26

Papers we will read throughout the course:

Brooks, J. L. and S. I. Dodson. 1965. Predation, Body Size, and Composition of Plankton. Science 150:28-34.

Carpenter, S. R., J. F. Kitchell, J. R. Hodgson. 1985. Cascading Trophic Interactions and Lake Productivity. Bioscience. 35(10): 634-639

Dolson, R., K. McCann, N. Rooney, M. Ridgway. 2009. Lake morphometry predicts the degree of habitat coupling by a mobile predator. Oikos 118:1230-1238

Elser, J. J., et al. 2009. Shifts in lake N:P stoichiometry and nutrient limitation driven by atmospheric nitrogen deposition. Science 326: 835-837.

Elser, J. J., et al. 2010. Atmospheric nitrogen deposition is associated with elevated phosphorus limitation of lake zooplankton. Ecology Letters 13: 1256-1261.

Hutchinson, G. E. 1961. The Paradox of the Plankton. The American Naturalist 95(882): 137- 145. Post, D. M., M. L. Pace, and N. G. Hairston, Jr. 2000.

Ecosystem size determines food chain length in lakes. Nature 405: 1047-1049 Scheffer, M., Hosper, S. H., M-L Heijer, B. Moss, E. Jeppesen. 1993. Alternative equilibria in shallow lakes. Trends in Ecology and Evolution 8(8): 275-279.

Tunney, T. D. K. S. McCann, N. P. Lester and B. J. Shuter. 2012. Food web expansion and contraction in response to changing environmental conditions. Nature Communications 3:1105

Schindler, D. W. 1974. Eutrophication and Recovery in Experimental Lakes: Implications for Lake Management. Science 184:897-898.

Vadeboncoeur, Y., M. J. Vander Zanden and D. M. Lodge. 2002. Putting the lake back together: Reintegrating benthic pathways into lake food web models. Bioscience 52(1): 44-54.

Other relevant papers (we might read them, or you might find them useful to your project):

Longmuir, A., J. B. Shurin, J. L. Clasen. 2007. Independent gradients of producer, consumer and microbial diversity in lake plankton. Ecology 88(7) 1663-1674.

Carpenter, S. R., J. F. Kitchell, J. R. Hodgson, P. A. Cochran, J. J. Elser, M. M. Elser, D. M. Lodge, D. Kretchmer, X. He, C. N. von Ende. Regulation of Lake Primary Productivity by Food Web Structure. Ecology 68(6): 1863-1876.

De Senerpont Domis, L., D. B. Van de Waal, N. R. Helmsing, E. Van Donk, W. M. Mooij. Community Stoichiometry in a Changing World: Combined Effects of Warming and Eutrophication on Phytoplankton Dynamics. Ecology 95(6): 1485-1495.

Ledger, M. E., L. E. Brown, F. K. Edwards, A. M. Milner, G. Woodward. 2013. Drought alters the structure and functioning of complex food webs. Nature Climate Change. 3: 223-227.

Gaedke, U. A. Seifried and R. Adrian. 2004. Biomass size spectra and phytoplankton diversity in a shallow lake. Internat. Rev. Hydrobiol. 89(1): 1-20.

Havel, J. E. and J. B. Shurin. 2004. Mechanisms, effects and scales of dispersal in freshwater zooplankton. Limnology and Oceanography 49(4): 1229-1238.

Hutchinson, G. E. et al, 1970. An account of the history and development of the Lago di Monterois, Latium, Italy. Transactions of the American Philosophical Society, New Series, 60(4): 1-178.

Lindeman, R. L. The trophic-dynamic aspect of ecology. Ecology 23(4): 339-417.

Sprules, W. G. and A. P. Goyke. 1994. Size-based structure and production in the pelagia of Lakes Ontario and Michigan. Can. J. Fish. Aquat. Sci., 51: 2603-2611