Zoology 955
LIMNOLOGY SEMINAR: Aquatic ecosystem metabolism
Official Course Name

Spring Semester 2023
1 credit
Website: https://canvas.wisc.edu/courses/XXXXX

Course Designations and Attributes
Graduate 50%

Seminars: Tuesdays 2-3 or 1-3 pm in Hasler Laboratory of Limnology, Room 210.

Instructional Modes
All face-to-face.
This seminar will be tutorial-based and focused on developing a skill set that can be applied in graduate student research.

Credit Hours
This class meets one 50-minute class period each week over the spring semester and carries the expectation that students will work on course learning activities (reading, writing, problem sets, studying, etc) for about 2 hours out of the classroom for every class period. The syllabus includes additional information about meeting times and expectations for student work.

Instructor
Dr. Hilary Dugan, Assistant Professor, Center for Limnology, Rm 226E
Department of Integrative Biology
Office hours by appointment.
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Course Description and Overview
Ecosystem metabolism and is a fundamental functional characteristic of ecosystems. This class will explore the fundamentals of lake (and stream) metabolism by reading and discussing literature and analyzing data.

Requisites
Graduate or professional standing.

Additional Recommendations:
Students should bring laptops to class, with the latest version of R and RStudio installed.
Students should be familiar with the R programming language.

If you have never used R and would like to take this course, it does not take long to get acquainted. There are plenty of online courses (*e.g.* https://www.coursera.org/learn/r-programming), and meaty text documents, (*e.g.* https://cran.r-project.org/doc/manuals/R-intro.pdf).
I highly recommend using RStudio as a code editor. RStudio provides a wealth of learning resources, and handy desk cheatsheets.

Course Aim
After completion of this seminar, students will be familiar with ecosystem metabolism concepts, and be able to calculate NEP from dissolved oxygen data.

Course Learning Outcomes
- Understand fundamental ecosystem metabolism concepts.
- Identify applications for lake metabolism
- Organize and work with observational datasets
- Calculate NEP and interpret results
- Prepare well-written research papers

GRADING
Numerical grades are assigned as follows: 93-100 (A), 88-92 (AB), 82-87 (B), 78-81 (BC).

Grades will be based on:
- *Participating in class discussion (10%)*
- *Leading paper discussion (10%)*
- *Research paper review (10%)*
- *Research paper (30%)*
- *Data analysis and write-up (35%)*
- *Final presentation (5%)*

TIME COMMITMENT
A 1-credit class requires ~42 hours of committed time.

Expectations are:
- 10 hours – in class
- 10 hours – reading papers in preparation for class
- 11 hours – dedicated to research paper
- 11 hours – data analysis, write up and presentation

TIMETABLE

Week	Topic	Readings
Jan 24 **20 min**	Class introduction	
Jan 31 **1-3pm**	Background	Odum, H. T. 1956. Primary Production in Flowing Waters. Limnol. Oceanogr. 1: 102–117. doi:10.4319/lo.1956.1.2.0102 https://aslopubs.onlinelibrary.wiley.com/doi/abs/10.4319/lo.1956.1.2.0102 Hoellein, T. J., D. A. Bruesewitz, and D. C. Richardson. 2013. Revisiting Odum (1956): A synthesis of aquatic ecosystem metabolism. Limnol. Oceanogr. 58: 2089–2100. doi:10.4319/lo.2013.58.6.2089 https://aslopubs.onlinelibrary.wiley.com/doi/abs/10.4319/lo.2013.58.6.2089 Howarth and Michaels 2000 (Ch. 5). The Measurement of Primary Production in Aquatic Ecosystems. https://link.springer.com/chapter/10.1007/978-1-4612-1224-9_6 Pace and Lovett 2013. Primary Production: The Foundation of Ecosystems. (in Fundamentals of Ecosystem Science by Weathers et al.) https://www.sciencedirect.com/science/article/pii/B9780128127629000022 Williams and del Giorgio 2005 (Ch. 1). Respiration in aquatic ecosystems: history and background. https://www.uv.es/hegigui/Kasper/delGiorgio%202005.pdf Hotchkiss et al. 2018 https://aslopubs.onlinelibrary.wiley.com/doi/full/10.1002/lol2.10081
Feb 7	Streams 1	Demars et al. 2015 https://aslopubs.onlinelibrary.wiley.com/doi/full/10.1002/lom3.10030 Bernhardt et al. 2018 https://aslopubs.onlinelibrary.wiley.com/doi/full/10.1002/lno.10726
Feb 14	Streams 2	Holtgrieve et al. 2010

		https://aslopubs.onlinelibrary.wiley.com/doi/abs/10.4319/lo.2010.55.3.1047 Hotchkiss and Hall 2014 https://aslopubs.onlinelibrary.wiley.com/doi/abs/10.4319/lo.2014.59.3.0798
Feb 28 **1-3pm**	Lakes 1	Staehr et al. 2010 (state of science) https://aslopubs.onlinelibrary.wiley.com/doi/abs/10.4319/lom.2010.8.0628 Hanson et al. 2008 (comparison of modeling) https://aslopubs.onlinelibrary.wiley.com/doi/abs/10.4319/lom.2008.6.454 Bogard et al. 2017 (isotope methods) https://link.springer.com/article/10.1007/s10533-017-0338-5
	Lakes 2	Coloso et al. 2008 (depth integrated) https://cdnsciencepub.com/doi/abs/10.1139/f08-006 Van de Bogert et al. 2012 https://aslopubs.onlinelibrary.wiley.com/doi/abs/10.4319/lo.2012.57.6.1689 Sadro et al. 2011 https://link.springer.com/article/10.1007/s10021-011-9471-5
Mar 7	Metabolism Phenology w/ Robert Ladwig	Ladwig et al. (2021) https://aslopubs.onlinelibrary.wiley.com/doi/full/10.1002/lno.12098
Mar 21	*Working on Research Paper*	
Mar 28	*Editing week*	
Apr 4	Exploring data with Stream Metabolizer	Appling et al. 2018 https://agupubs.onlinelibrary.wiley.com/doi/full/10.1002/2017JG004140
Apr 11	Exploring data with Lake Metabolizer	Winslow et al. 2016 https://www.tandfonline.com/doi/abs/10.1080/IW-6.4.883 Dugan et al. 2016 https://www.tandfonline.com/doi/abs/10.1080/IW-6.4.836

Apr 18	*Working on lake data*	
Apr 25	*Working on lake data/* Final presentations	
May 2	Final presentations	

LEADING PAPER DISCUSSION
Each week we will read and discuss scientific literature that focuses on aquatic ecosystem metabolism. For each paper, one student will give a short synopsis of the paper (5-10 minutes). This overview should include: the research question(s), key findings, metabolism method(s), method assumptions, things that were interesting or difficult to understand, and the legacy of the paper. Any slides for the presentation should be uploaded to the course Google Drive folder prior to class.

RESEARCH PAPER TOPICS EXAMPLES [recommend choosing lakes or streams]
History of methods for measuring metabolism in lakes
History of methods for measuring metabolism in streams
History of methods for measuring metabolism in oceans
Oxygen isotopes for measuring metabolism
Eutrophication and lake/stream metabolism
Trophic status and lake metabolism
Climate change on lake/stream metabolism
Allochthonous carbon and lake metabolism
Spatial heterogeneity and lake metabolism
Global upscaling of lake/stream metabolism and the global carbon balance
Unknowns in lake/stream metabolism
(or another topic)

RESEARCH PAPER GUIDELINES
Each student will pick a topic. Research papers are to be written independently but discussion amongst class members is encouraged. Final papers should be ~ 3000 words, single spaced, TNR font. Use of a reference manager (e.g. Zotero) is encouraged.

Research paper outline due Mar 10th

- Prepare a short (1/2 page) outline of your research paper. This outline should include a title, any section headers, and topic sentences for your paragraphs.

Research paper due to class-mate March 27th. Return to author by March 31st.

- A final draft of your research paper should be given to a class-mate by Mar 27th for a first round of review. This editing should take ~1-2 hours and the paper should be returned to the author by Mar 31st. When the paper is returned, please cc' Dr. Dugan in the email to receive grades.

Research paper due April 7th.

- Incorporate suggests from editor. Upload essay on Canvas as a word doc.

DATA ASSIGNMENT
Each student will receive a dataset that includes high-frequency dissolved oxygen observations as well as ancillary data needed to calculate metabolism. The goal is to use the LakeMetabolizer package calculate NEP for your lake using a range of methods. The results of this assignment should be presented in manuscript form: Introduction, Methods, Results, Discussion.

RESEARCH PAPER PRESENTATIONS
Prepare a short 5-minute presentations on your research findings. 5 min will be given for Q&A. Upload your presentation to the Google Drive folder prior to class.

OTHER COURSE INFORMATION
Lake Metabolizer paper: https://www.tandfonline.com/doi/abs/10.1080/IW-6.4.883
https://github.com/GLEON/LakeMetabolizer
https://github.com/USGS-R/streamMetabolizer

RULES, RIGHTS & RESPONSIBILITIES

Refer to the Guide's Rules, Rights and Responsibilities

ACADEMIC INTEGRITY
By enrolling in this course, each student assumes the responsibilities of an active participant in UW-Madison's community of scholars in which everyone's academic work and behavior are held to the highest academic integrity standards. Academic misconduct compromises the integrity of the university. Cheating, fabrication, plagiarism, unauthorized collaboration, and helping others commit these acts are examples of academic misconduct, which can result in disciplinary action. This includes but is not limited to failure on the assignment/course, disciplinary probation, or suspension. Substantial or repeated cases of misconduct will be forwarded to the Office of Student Conduct & Community Standards for additional review. For more information, refer to studentconduct.wiscweb.wisc.edu/academic-integrity/.

ACCOMMODATIONS FOR STUDENTS WITH DISABILITIES
McBurney Disability Resource Center syllabus statement: "The University of Wisconsin-Madison supports the right of all enrolled students to a full and equal educational opportunity. The Americans with Disabilities Act (ADA), Wisconsin State Statute (36.12), and UW-Madison policy (Faculty Document 1071) require that students with disabilities be reasonably accommodated in instruction and campus life. Reasonable accommodations for students with disabilities is a shared faculty and student responsibility. Students are expected to inform faculty [me] of their need for instructional accommodations by the end of the third week of the semester, or as soon as possible after a disability has been incurred or recognized. Faculty [I], will work either directly with the student [you] or in coordination with the McBurney Center to identify and provide reasonable instructional accommodations. Disability information, including instructional accommodations as part of a student's educational record, is confidential and protected under FERPA." http://mcburney.wisc.edu/facstaffother/faculty/syllabus.php

DIVERSITY & INCLUSION
Institutional statement on diversity: "Diversity is a source of strength, creativity, and innovation for UW-Madison. We value the contributions of each person and respect the profound ways their identity, culture, background, experience, status, abilities, and opinion enrich the university community. We commit ourselves to the pursuit of excellence in teaching, research, outreach, and diversity as inextricably linked goals.

The University of Wisconsin-Madison fulfills its public mission by creating a welcoming and inclusive community for people from every background – people who as students, faculty, and staff serve Wisconsin and the world." https://diversity.wisc.edu/