

# Biology 412.3.1, Limnology Syllabus

## Instructor:

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**Lectures (remote delivery):** Mon., Wed., & Fri., 12:30 - 1:20 pm

**Lab (remote delivery):** Friday 1:30 - 5:20 pm

**Calendar Course Description:** The biological, chemical and physical properties of lakes are examined at lake and watershed levels. Theoretical and applied topics, including human impacts (e.g., eutrophication, climate change, ultraviolet radiation, contaminants, and angling) are examined.

## General Course Description

Limnology is a multidisciplinary field that is broadly defined as the study of inland waters. The course is taught at the ecosystem level, i.e., ecosystem structure and function is emphasized. Human impacts will also be studied. Laboratories are designed to train students in field and laboratory techniques. This includes the use of sampling equipment and procedures to identify and quantify aquatic organisms, and for characterizing the physical and chemical properties of lakes (e.g., water quality). Laboratories will also emphasize experimental design. On completion of the course students will be prepared for advanced study in limnology (graduate level) or other aquatic disciplines. In addition, students will be better prepared for careers in the environment (e.g., water quality assessment, habitat assessment, and lake and fisheries management).



## Learning Outcomes

Through lectures, assigned readings, and laboratory exercises students will develop an understanding of:

- The diversity of biological, physical and chemical characteristics of lakes
- Lake ecosystem function (energy flow and biogeochemical cycling)
- The diversity and ecology of organisms in lakes
- The use of limnological equipment to characterize the biological, physical and chemical characteristics of lakes
- The influence of watershed characteristics on lake properties
- Human impacts on lakes (e.g., water quality) and remediation strategies
- Current and emerging scientific thinking in limnology
- Experimental design and the interpretation of scientific data.
- The role of ecosystem science in society

**Prerequisites:** Biol 121, Biol 228 and CHEM 112; or permission of the instructor. A course in statistics is recommended.

**Course e-Text:** Kalff, J. and J. Downing (2002). Limnology: Inland Water Ecosystems. Students will be assigned text reading throughout the course. **Link for e-text:** [https://www.amazon.com/Limnology-Inland-Ecosystems-Jacob-Kalff-ebook/dp/B01GFEPZT0/ref=mt\\_kindle?encoding=UTF8&me](https://www.amazon.com/Limnology-Inland-Ecosystems-Jacob-Kalff-ebook/dp/B01GFEPZT0/ref=mt_kindle?encoding=UTF8&me)

## Course Structure and Other Details

The course follows a weekly M, W, & F lecture schedule with a lab on Friday afternoon. Each lecture will be posted to Canvas on the date it is scheduled to be delivered. Each lecture will include slides with audio. Updates, and assigned readings from the scientific literature, or from your textbook will be listed in lectures (and in this syllabus). The salient points from the reading of the assigned scientific literature will be described in lectures; students are responsible for an in depth understanding of these readings; the final exam will include, among other content, essay questions on these scientific articles. Textbook readings are assigned to supplement lecture content. I will be available for questions on lecture and lab content. However, questions on lab content may also be best directed to your lab instructors. Send questions via email to your instructors within or outside of Canvas. Some questions may be brought to the class's attention via the canvas discussion board.

A series of laboratories have been designed based on field sampling that was conducted by a previous limnology class on Anglin and Emma (middle Emma) lakes in 2009, hence the data that the class will use is "real" field and lab data. The labs are broken into three categories that contrast both lakes: the first illustrates the use of equipment and the collection and interpretation of field data (profile lab); the second includes an experiment to determine the type and degree of nutrient limitation in these lakes (algal fertilization lab); and the third, aims to help you develop a knowledge of algal, zooplankton, and benthic invertebrate taxonomy. Lecture content will compliment lab content.

Please review carefully the course schedule presented in the table below, particularly dates (e.g., for lab assignments). Note that lab materials (e.g., instructional documents, photos and videos) will be provided in advance of the lab date. This permits students to review and start their labs in advance and post questions to the Canvas discussion board, or via direct email for further assistance. Hence labs are not synchronous and questions concerning the labs will be addressed between the release date of the materials to the class and the due date for the lab assignment. Friday afternoons will serve as a focal point for responses to questions via the Canvas discussion board. Assignments will be due at a later date after the Friday lab slot (see the course schedule below for exact dates).

In the rare instance that a synchronous conference meeting is deemed necessary (e.g., to elaborate on an assignment), then students will be notified in advance of a specified time for such a meeting (e.g., a Webex meeting). Although such meetings will be rare, meetings will be recorded. **Video recordings in the course** (e.g., via Webex) will only be made available to students in the course for viewing. This is done, in part, to ensure that students unable to join the session (due to, for example, issues with their internet connection) can view the session at a later time. This will also provide you the opportunity to review any material discussed. Please remember that course recordings belong to your instructor, the University, and/or others (like a guest lecturer) depending on the circumstance of each session, and are protected by copyright. Do not download, copy, or share recordings without the explicit permission of the instructor.

For questions about recording and use of sessions in which you have participated, including any concerns related to your privacy, please contact your instructor. More information on class recordings can be found in the Academic Courses Policy

<https://policies.usask.ca/policies/academic-affairs/academic-courses.php#5ClassRecordings>.

### Course Schedule (August, 2020\*)

| <b>Week Of</b> | <b>Lecture Topic (M, W, &amp; F, 12:30 to 1:20 pm)</b>                                | <b>Laboratory (Fridays 1:30 - 5:30 pm)</b>                            | <b>Lab Assignments &amp; Due Dates</b>               | <b>Readings</b>                            |
|----------------|---|---|--|--|
| Sept. 4        | -Course introduction  |   |  | -Running Dry News Article                  |
| Sept. 7        | -Properties of water<br>-Lake ontogeny  | <b>Field sampling and equipment for review</b> (Sept 11)              |  | -Aquatic Hotspots article                  |
| Sept. 14       | -Lake morphometry<br>-Assignment: lake trophic status as affected by lake morphometry | <b>Water column profile lab with sonde data</b> (Sept 18)             | Lake profile assignment due on <b>Oct 2</b>          | -Bev Clark. Measuring Chl <i>a</i> .       |
| Sept. 21       | -Light and the lake ecosystem -<br>Assignment: $k_d$ calculations                     | <b>Outline of algal fertilization experiment for review</b> (Sept 25) | -Algal fertilization assignment due on <b>Nov 16</b> | -Schindler et al. 1996. UV radiation & DOC |
| Sept. 28       | -Temperature, Heat, and Stratification<br>-Lake types: monomictic, polymictic         | <b>Algal fertilization experiment data</b> (Oct 2)                    |  | -Nürnberg 2001<br>-Alberta acid rain       |

|         |  |   |   |   |
|---------|--|---|---|---|
|         | etc.<br>-Meromictic lakes and paleolimnology   |   |   | -Acidification of the Oceans (DIC issue)                          |
| Oct. 5  | -Water movement, surface waves, seiches and circulation patterns - Dissolved inorganic carbon -Lake whittings and biota  | <b>Water Analysis</b> (Oct 9) - Analyze for TP, TN, Chl a and dry matter                                      |   |   |
| Oct. 12 | -Oxygen in lakes, profiles, seasonal effects, primary production, effect of DOC, BOD, winter & summer kill   | <b>Water Analysis</b> (Oct 16) - Analyze for TP, TN, Chl a and dry matter                                     |   |   |
| Oct. 19 | <b>Midterm EXAM (October 19, 12:30 to 1:20 pm)</b><br>-Oxygen in lakes, profiles, seasonal effects, primary production, effect of DOC, BOD, winter & summer kill | <b>Water Analysis</b> (Oct 23) - Analyze for TP, TN, Chl a and dry matter                                     | -Distribute algal taxonomy lab resources on <b>Oct 23</b> , students review for next week's lab.  |   |
| Oct. 26 | -Redox reactions in the water column and sediment  | <b>Algal taxonomy lab</b> (Oct 30) -Algal identification and lake comparison                                  | -Distribute zooplankton taxonomy lab resources on <b>Oct 30</b> , students review for next week's lab.<br>-Algal taxonomy Lab assignment due <b>Oct 26</b>  | -Hudson et al. 2000. Phosphate in lakes.                          |
| Nov. 2  | -Nutrients in lakes: P<br>-P management in lakes: successful and unsuccessful attempts - Nutrients in lakes: N   | <b>Zooplankton taxonomy lab</b> (Nov 6)<br>-Zooplankton identification and lake comparison                    | -Distribute benthic invertebrate taxonomy lab resources on <b>Nov 6</b> , students review for benthic lab held on <b>Nov 20</b> (after reading break)<br>-Zooplankton taxonomy lab assignment due <b>Nov 20</b> |   |
| Nov. 9  | <b>Fall Mid-Term Break</b>   | <b>Suggestions:</b> Use break to complete algal fertilization assignment, and text and paper readings.        |   | -Lawrence et al. 2007. Microbial loop                             |
| Nov. 16 | -Size spectrum of planktonic organisms<br>-Viruses, bacteria, bacterial production<br>-Algal Communities   | <b>Benthic invertebrate taxonomy lab</b> (Nov 20)<br>-Benthic invertebrate identification and lake comparison | -ALGAL FERTILIZATION ASSIGNMENT DUE ON <b>NOV 16</b><br>-Benthic taxonomy lab,  | -Watson and McCauley 1997. Chl. <i>a</i> along a trophic gradient |

|                       |  |  |                              |   |
|-----------------------|--|--|------------------------------|---|
|                       |  |  | assignment due <b>Nov 27</b> |   |
| Nov. 23               | -Algal succession and productivity -<br>Zooplankton communities<br>-Size efficiency hypothesis -<br>Determinants of Biodiversity and<br>Productivity         |  |                              | -Cyr and Pace 1993. Grazing<br>patterns in terrestrial vs<br>aquatic ecosystems<br>-Brooks and Dodson 1965.<br>Size efficiency hypothesis                           |
| Nov. 30               | -Resources vs. predation control of<br>food webs: top-down & bottom-up<br>control & trophic cascade hypothesis<br>-Humans and Angling<br>-Review & Questions |  |                              | -Food web dynamics.<br>Carpenter et al. 1985 -<br>Mazumder and Taylor 1990.<br>Algal particle size and heat -<br>Schindler 1976. The impact<br>statement Boondoggle |
| Dec. 7                | Last day. Catch up and Review  |  |                              |   |
| <b>Final<br/>Exam</b> | <b>Date to be determined</b>   |  |                              |   |

\* There will be minor changes to the schedule. I will provide advanced consultation with the class about such changes.

### Relevant Library Resources

#### Example of Journals with Limnological Content

- Canadian Journal of Fisheries and Aquatic Sciences
- Limnology and Oceanography
- Freshwater Biology
- Journal of Great Lakes Research
- Journal of Plankton Research
- Lake & Reservoir Management, and colloquial journal “Lakeline”
- Aquatic Sciences
- Water Research
- Ecology
- Hydrobiologia

#### Texts Resources:

- Bronmark, C. and L.A. Hansson. 2017. The biology of lakes and ponds. 3<sup>rd</sup> Edition. New York, Oxford University Press.
- Lampert, W. and U. Sommer. 2007. Limnoecology. 2<sup>nd</sup> Edition. Oxford University Press.
- Wetzel, R. G. (2001). Limnology: lake and river ecosystems. San Diego, Academic Press.
- Dodson, S. 2005. Introduction to Limnology. New York. McGraw-Hill.
- Moss, B. (1998). Ecology of fresh waters: man and medium, past to future. Oxford, Blackwell Science.

- Wilderer, P. 2011. Treatise on water science. Volumes 1-4. Amsterdam, Elsevier.
- Likens, G. 2009. Encyclopedia of inland waters. Volumes 1-3. Boston, Elsevier.
- Lynn, K and Cech, T. (2010). Introduction to Water Resources and Environmental Issues. Cambridge, Cambridge University Press.
- Carpenter, S. R. and J. F. Kitchell (1993). The trophic cascade in lakes. Cambridge, Cambridge University Press.
- O’Sullivan and C. Reynolds. 2004. The Lakes Handbook. Volumes 1-2. Malden, MA, Blackwell.
- Fassett, N. C. (1957). A manual of aquatic plants. Madison, University of Wisconsin Press.
- Cooke, G., E. Welch, S. Peterson, and S. Nichols. 2005. Restoration & management of lakes & reservoirs, 3rd Ed. Boca Raton. Taylor and Francis,
- Kerr, S. R. and L. M. Dickie (2001). The biomass spectrum: a predator-prey theory of aquatic production. New York, Columbia University Press.
- Smol, J. P. (2002). Pollution of lakes and rivers: a paleoenvironmental perspective. London, Arnold.
- North American Lake Management Society and the Terrene Institute. (2001). Managing lakes and reservoirs. Madison, WI
- Thorp, J. H. and Covich, A. P. 2001. Ecology and classification of North American freshwater invertebrates. San Diego, Academic Press.
- Reynolds, C.S.2007. Ecology of Phytoplankton. Cambridge, Cambridge University Press.

| <b>Course Evaluation*</b> | <b>Mark</b> | <b>Lab Assignments: Mark Breakdown</b> | <b>Mark</b> |
|---------------------------|-------------|--|-------------|
| Final exam                | 40%         | Lake profiles assignment               | 10%         |
| Mid-term exam             | 20%         | Algal fertilization assignment         | 20%         |
| Lab assignments           | 40%         | Algal taxonomy assignment              | 3.33%       |
|                           |             | Zooplankton taxonomy assignment        | 3.33%       |
| <b>Total</b>              | <b>100%</b> | Benthos taxonomy assignment            | 3.33%       |

\*Late assignment policy: 3% deduction per day. Late assignments may not be returned to a student until the end of term

## Midterm and Final Exam

### Midterm Exam

**Date:** Held on October 19 in lecture slot (12:30 to 1:20 pm)

**Length:** 50 minutes

**Format:** Multiple choice questions (40 to 45 questions).

**Description:** Focus will be on lecture material with a minor emphasis on general lab material. Will cover all material up to the date of the mid-term exam. The exam will be delivered through Canvas (synchronous timed exam).

### Final Exam

**Date:** Consult the Final Exam Schedule when it is released.

**Length:** 180 minutes

**Format:** Essay questions

**Description:** The exam will consist of essay questions that are based on lecture content and scientific readings. Students will be provided with choice in the selection of essay questions. The exam will be delivered through Canvas (synchronous timed exam)

### **Final Examination Schedules**

Midterm and final examinations must be written on the date scheduled. Final examinations may be scheduled at any time during the examination period; therefore, students should avoid making prior travel, employment, or other commitments during the examination period. If a student is unable to write an exam through no fault of his or her own for medical or other valid reasons, documentation must be provided and an opportunity to write the missed exam may be given. Students who miss the final exam must contact the College of Arts & Science and apply for a deferred final exam promptly. Deferred exams may utilize a different format than the regular exam, at the sole discretion of the course instructors. Students are encouraged to review all University examination policies and procedures: <http://students.usask.ca/academics/exams.php>

If you experience internet connectivity issues during the midterm, or final exam, you must phone the course instructor immediately to advise them of the situation (Jeff Hudson: 306-966-4412)

### **Copyright**

Course materials are provided to you based on your registration in the class, and anything created by your professors and instructors is their intellectual property, unless materials are designated as open education resources. Copyright-protected material includes exams, PowerPoint/PDF slides and other course notes. Additionally, other copyright-protected materials created by textbook publishers and authors may be provided to you based on license terms and educational exceptions in the Canadian Copyright Act (see <http://laws-lois.justice.gc.ca/eng/acts/C-42/index.html>).

Before you copy or distribute others' copyright-protected materials, please ensure that your use of the materials is covered under the University's Fair Dealing Copyright Guidelines available at <https://library.usask.ca/copyright/general-information/fair-dealing-guidelines.php>. For example, posting others' copyright-protected materials on the open web is not covered under the University's Fair Dealing Copyright Guidelines, and doing so requires permission from the copyright holder.

For more information about copyright, please visit <https://library.usask.ca/copyright/index.php> where there is information for students available at <https://library.usask.ca/copyright/students/rights.php>, or contact the University's Copyright Coordinator at <mailto:copyright.coordinator@usask.ca> or 306-966-8817.

### **Student Feedback**

The Department of Biology or the instructors may survey students regarding the course. This is generally done through an assessment near the end of term.

## University of Saskatchewan Grading System

Students in BIOL 412 are reminded that the University has established a grading system to be used in all of its courses. Information on literal descriptors for grading at the University of Saskatchewan (reproduced below) can be found at:

<http://students.usask.ca/academics/grading/grading-system.php>

**Exceptional (90-100)** A superior performance with consistent evidence of

- a comprehensive, incisive grasp of the subject matter;
- an ability to make insightful critical evaluation of the material given;
- an exceptional capacity for original, creative and/or logical thinking;
- an excellent ability to organize, to analyze, to synthesize, to integrate ideas, and to express thoughts fluently.

**Excellent (80-90)** An excellent performance with strong evidence of

- a comprehensive grasp of the subject matter;
- an ability to make sound critical evaluation of the material given;
- a very good capacity for original, creative and/or logical thinking;
- an excellent ability to organize, to analyze, to synthesize, to integrate ideas, and to express thoughts fluently.

**Good (70-79)** A good performance with evidence of

- a substantial knowledge of the subject matter;
- a good understanding of the relevant issues and a good familiarity with the relevant literature and techniques;
- some capacity for original, creative and/or logical thinking;
- a good ability to organize, to analyze and to examine the subject material in a critical and constructive manner.

**Satisfactory (60-69)** A generally satisfactory and intellectually adequate performance with evidence of

- an acceptable basic grasp of the subject material;
- a fair understanding of the relevant issues;
- a general familiarity with the relevant literature and techniques;
- an ability to develop solutions to moderately difficult problems related to the subject material;
- a moderate ability to examine the material in a critical and analytical manner.

**Minimal Pass (50-59)** A barely acceptable performance with evidence of

- a familiarity with the subject material;
- some evidence that analytical skills have been developed;
- some understanding of relevant issues;
- some familiarity with the relevant literature and techniques;
- attempts to solve moderately difficult problems related to the subject material and to examine the material in a critical and analytical manner which are only partially successful.

**Failure <50** An unacceptable performance

## Integrity in a Remote Learning Context

Although the face of teaching and learning has changed due to covid-19, the rules and principles governing academic integrity remain the same. If you ever have questions about what may or may not be permitted, ask your instructor. Students have found it especially important to clarify rules related to exams administered remotely and to follow these carefully and completely.



The University of Saskatchewan is committed to the highest standards of academic integrity and honesty. Students are expected to be familiar with these standards regarding academic honesty and to uphold the policies of the University in this respect. Students are particularly urged to familiarize themselves with the provisions of the Student Conduct & Appeals section of the University Secretary Website and avoid any behavior that could potentially result in suspicions of cheating, plagiarism, misrepresentation of facts and/or participation in an offence. Academic dishonesty is a serious offence and can result in suspension or expulsion from the University.

All students should read and be familiar with the Regulations on Academic Student Misconduct (<https://secretariat.usask.ca/student-conduct-appeals/academic-misconduct.php>) as well as the Standard of Student Conduct in Non-Academic Matters and Procedures for Resolution of Complaints and Appeals (<https://secretariat.usask.ca/student-conduct-appeals/academic-misconduct.php#IXXIIAPPEALS>)

For more information on what academic integrity means for students see the Academic Integrity section of the University Library Website at: <https://library.usask.ca/academic-integrity#AboutAcademicIntegrity>

### **Access and Equity Services (AES) for Students**

Students who have disabilities (learning, medical, physical, or mental health) are strongly encouraged to register with Access and Equity Services (AES) if they have not already done so. Students who suspect they may have disabilities should contact AES for advice and referrals at any time. Those students who are registered with AES with mental health disabilities and who anticipate that they may have responses to certain course materials or topics, should discuss course content with their instructors prior to course add / drop dates. In order to access AES programs and supports, students must follow AES policy and procedures. For more information or advice, visit <https://students.usask.ca/health/centres/access-equity-services.php>, or contact AES at 306-966-7273 or [aes@usask.ca](mailto:aes@usask.ca).

Students registered with AES may request alternative arrangements for mid-term and final examinations. Students must arrange such accommodations through AES by the stated deadlines. Instructors shall provide the examinations for students who are being accommodated by the deadlines established by AES.

For information on AES services and remote learning please visit <https://updates.usask.ca/info/current/accessibility.php#AccessandEquityServices>

## **Student Supports**

### **Academic Help for Students**

The University Library offers a range of learning and academic support to assist USask undergrad and graduate students. For information on specific services, please see the Learning page on the Library web site <https://library.usask.ca/support/learning.php>

Remote learning support information <https://students.usask.ca/remote-learning/index.php>

Class and study tips <https://students.usask.ca/remote-learning/class-and-study-tips.php>

Remote learning tutorial [https://libguides.usask.ca/remote\\_learning](https://libguides.usask.ca/remote_learning)

Study skills materials for online learning <https://libguides.usask.ca/studyskills>

A guide on netiquette, principles to guide respectful online learning interactions <https://teaching.usask.ca/remote-teaching/netiquette.php>

Writing Help <https://library.usask.ca/studentlearning/writing-help/>

Library Biology Research Guide <https://libguides.usask.ca/c.php?g=16523&p=91352>

### **Teaching, Learning and Student Experience**

Teaching, Learning and Student Experience (TLSE) provides developmental and support services and programs to students and the university community. For more information, see the students' web site <http://students.usask.ca>.

### **Financial Support**

Any student who faces challenges securing their food or housing and believes this may affect their performance in the course is urged to contact Student Central <https://students.usask.ca/student-central.php>.

### **Aboriginal Students' Centre**

The Aboriginal Students' Centre (ASC) is dedicated to supporting Aboriginal student academic and personal success. The centre offers personal, social, cultural and some academic supports to Métis, First Nations, and Inuit students. The centre is also dedicated to intercultural education, bringing Aboriginal and non-Aboriginal students together to learn from, with and about one another in a respectful, inclusive and safe environment. Students are encouraged to visit the ASC's Facebook page <https://www.facebook.com/aboriginalstudentscentre/> to learn more.

### **International Student and Study Abroad Centre**

The International Student and Study Abroad Centre (ISSAC) supports student success and facilitates international education experiences at USask and abroad. ISSAC is here to assist all international undergraduate, graduate, exchange and English as a Second Language students in their transition to the University of Saskatchewan and to life in Canada. ISSAC offers advising and support on matters that affect international students and their families and on matters related to studying abroad as University of Saskatchewan students. Please visit [students.usask.ca](https://students.usask.ca) or [updates.usask.ca](https://updates.usask.ca) for more information.

### **College Supports**

Students in Arts & Science are encouraged to contact the Undergraduate Student Office and/or the Trish Monture Centre for Success with any questions on how to choose a major; understand program requirements; choose courses; develop strategies to improve grades; understand university policies and procedures; overcome personal barriers; initiate pre-career inquiries; and identify career planning resources. Contact information is available at: <https://artsandscience.usask.ca/undergraduate/advising/>

## **Treaty Acknowledgement**

As we engage in Remote Teaching and Learning, we would like to acknowledge that the Saskatoon campus of the University of Saskatchewan is on *Treaty Six Territory* and the *Homeland of the Métis*. We pay our respect to the First Nation and Métis ancestors of this place and reaffirm our relationship with one another. We would also like to recognize that some may be attending this course from other traditional Indigenous lands. We ask that you take a moment to make your own Land Acknowledgement to the peoples of those lands. In doing so, we are actively participating in reconciliation as we navigate our time in this course, learning and supporting each other.