UNIVERSITY of TORONTO SCARBOROUGH
December 2020
Department of Physical & Environmental Sciences

Environmental Science EESC18

The Great Lakes: An Introduction to Limnology

North America is endowed with eight of the twelve largest fresh-water lakes in the world. The origin and geological history, cycles of carbon, nitrogen and phosphorus, and structures of ecosystems of the North American Great Lakes will be used as examples of *large* lacustrine systems.
Fundamental concepts in limnology will be related to features found in the Great Lakes. Topics include: lake origins, lake classification, lake temperature structure and heat budgets, seasonal water circulations, productivity, plankton ecology, food-web dynamics, exotic species invasions, eutrophication-related phenomena and water quality/fisheries management. Specific anthropogenic influences will be illustrated using case studies from the local environment, and students will be allowed to pursue their own interests through a series of short seminars.

Instructors: Maria Dittrich (MD)
Office: ESCB452 (Maria Dittrich)
The course consists of a 2-hour lecture each week; and designated readings.
Each lecture will be accompanied by either a PPT file of the lectures, it will be posted on the web usually the day before the classes. lectures

Lectures: Thursdays 2 pm – 4 pm
Tutorials: Tuesdays 5 pm – 6 pm
Office hours: Tuesdays 2 pm – 3 pm please contact me per email for an appointment.

Course Grade:	**4 Assignment** late assignments will be penalized	**40 %**
	5 Quizzes	**30 %**
	Students video-presentations	**25%**
	Participation in the discussion of the presentations	**5%**

Prerequisite: EESB03F **Recommended:** EESB02S

TENTATIVE COURSE OUTLINE

Date		Lecture Topic	Lecturer	Tutorial
Jan-14	1	• Introduction: Structure of Aquatic Ecosystems	MD	No tutorial
Jan-21	2	• Thermal Structure of the Great Lakes **Assignment 1 due Week 4** **Quiz 1**	MD	Jan-19
Jan-28	3	• Productivity of Aquatic Ecosystems • Carbon and Nitrogen cycles	MD	Jan-26
Feb-4	4	• Phosphorus Cycle • **Assignment 2 due on Week 6** • **Quiz 2**	MD	Feb-2
Feb-11	5	• Case studies • **Discussion of the students presentations**	MD	Feb-9
Feb-18		• Reading week		
Feb-25	6	• Food Web / Planktonic Communities/Case studies • **Assignment 3 due on Week 8** • **Quiz 3**	MD	Feb-23
March-4	7	• Cycling of micronutrients: Iron, Sulfur and Silica	MD	March 1
March-11	8	• Eutrophication in Great Lakes **Assignment 4 due on Week 10** **Quiz 4**	MD	March-9
March-18	9	• Water-Land-Interfaces	MD	March-16
March-25	10	• Invasive species • **Quiz 5**	MD	March-23
Apr-1	11	• Pollutants in Great Lakes	MD	March-30
Apr-8	12	• **Examples of the students presentations**	MD	Apr-6

Week 1 ORIENTATION/GREAT LAKES IN A GLOBAL CONTEXT/ STRUCTURE OF GREAT LAKES

Course Outline; Lecture Schedule Thermal Layering & Lake Overturning Thermal Classification of Lakes; Vertical Stability. Examples from the North American Great Lakes, Dynamic Forcing of the Lakes, Coastal upwelling; Thermal bar revisited, Great Lakes Circulation, Thermocline Development

Lake Ecological Concept Ecosystem Interrelationships

Week 2 THERMAL STRUCTURE OF THE GREAT LAKES

Understanding the thermal structure of the Great Lakes. Conceptual understanding of mictic classification. Understand formation of the thermocline. Measures of vertical stability

Week 3 PRODUCTIVITY OF GREAT LAKES CARBON AND NITROGEN CYCLES

Algal Productivity. The occurrence of inorganic carbon in freshwater systems, utilization of carbon by algae. Sources and transformation of nitrogen in water, nitrogen loading

Week 4 PHOSPHORUS CYCLE

Phosphorus in freshwater systems, Phosphorus diagenesis, internal loading, sediment

Week 5 Case studies

Week 6 FOOD WEB, PLANKTONIC COMMUNITIES

Composition of the Algae of Phytoplankton, Importance of size
Phytoplanktonic Communities, Growth Characteristics and Mortality of Phytoplankton
Heterotrophy of organic carbon by algae and cyanobacteria
Seasonal succession of Phytoplankton

Week 7 MIDTERM

Week 8 CYCLING OF MICRONUTRIENTS: IRON, SULFUR AND SILICA

Week 9 EUTROPHICATION PROBLEMS IN THE GREAT LAKES

Basic Concepts of Eutrophication Natural and Cultural Processes of Eutrophication
Relationships among Nutrients, Water Clarity, and Phytoplankton
Eutrophication Problems in: (i) Lake Erie; (ii) Lake Superior; (iii) Lake Michigan, (iv) Lake Huron; (v) Lake Ontario.

Week 10 WATER-LAND-INTERFACES/ **REPORTS DEADLINE**

The littoral zone: aquatic macrophytes, their metabolism and primary production
Productivity of littoral algae Periphyton, littoral zooplankton communities
Importance of wetlands and estuaries

Week 11 INVASIVE SPECIES

Stressors and Induced Ecological Changes
Invasive exotic Species: Definition and Mechanisms of Introduction

Week 12 POLLUTANTS IN THE GREAT LAKES **/Course Overview**

Toxic Substances, Sources of Contaminants, The Fate of Contaminants, The Sediment Record Physical and Chemical Characteristics of Contaminants and Their Distribution in Nature, Toxicity and Its Prediction, Bioaccumulation and Biomagnification, Mercury and the Mercury Cycle, Toxic Chemicals, Environmental Health

N.B. **Students with diverse learning styles and needs are welcome in this course. In particular, if you have a disability/health consideration that may require accommodations, please feel free to approach me and/or the Access*Ability* Services Office as soon as possible. The UTSC Access*Ability* Services staff (located in S302) are available by appointment to assess specific needs, provide referrals and arrange appropriate accommodations (416) 287-7560 or ability@utsc.utoronto.ca. The sooner you let us know your needs the quicker we can assist you in achieving your learning goals in this course.**

READINGS

There is **no required text** for this course, since there is no book that covers all the course material, while several books cover much more material than is required. Thus, specific readings will be given out during each lecture and/or practical sessions; however, a number of texts cover the course material

in part and there is one journal devoted specifically to research on large lakes of the world, but with a dominance of papers on North American Great Lakes research:
Journal of Great Lakes Research, International Association for Great Lakes Research.
http://www.iaglr.org/jglr/journal.php
This journal and the reference sources below will be used for course readings and as starting points for student seminars.
Books:
Kalff, J., 2002. Limnology, Prentice-Hall, NJ, 592 pp.
Wetzel, R.G., 2001. Limnology: Lake and River Ecosystems. Third Edition, Academic Press, NY.
Lampert, W., Sommer, U., 2007, Limnoecology, Oxford ; New York : Oxford University Press Inc., 2007. 2nd ed.

HANDING IN ASSIGNMENT: You are responsible for making sure that your TA receives your work. Students who mail assignments in.
LOST OR MISPLACED ASSIGNMENT: It is your responsibility to keep a photocopy of your work, and to make more than one copy of your work. Excuses are not accepted in the case of lost or misplaced work.