UNIVERSITY of TORONTO SCARBOROUGH
December 2016
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** student seminars; and designated readings. Each lecture will be accompanied by either a handout or the lectures :will be posted on the web.

Lectures:	**Thursdays 2 pm – 4 pm**	**Room:**	**HW215**
Tutorials:	**Tuesdays 5 pm – 6 pm**	**Room:**	**MW130**
Office hours:	**Tuesdays 1 pm – 2 pm**	**Room:**	**ESCB452**

Course Grade:	**Assignment 1**	**15 %**
	Midterm Exam (in-class)	**30%**
	Report	**15%**
	Final Examination	**40 %**

Prerequisite: EESB03F **Recommended:** EESB02S

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.**

TENTATIVE COURSE OUTLINE

Date		Lecture Topic	Lecturer	Tutorial
Jan-5	1	• Introduction: Structure of Aquatic Ecosystems	MD	
Jan-12	2	• Thermal Structure of the Great Lakes	MD	Jan 10 **Zach**
Jan-19	3	• Productivity of Aquatic Ecosystems Carbon and Nitrogen Cycles • **Assignment 1**	MD	Jan 17 *Tim*
Jan-26	4	• Phosphorus Cycle	MD	Jan 24 **Zach**
Feb-2	5	• Food Web, Planktonic Communities	MD	Jan 30 *Tim*
Feb-9	6	• Case studies	MD	Feb 7 **Zach**
Feb-16	7	• **Midterm in class**	MD	
Mar-2	8	• Cycling of micronutrients: Iron, Sulfur and Silica Eutrophication in Great Lakes • **Due for the Topic title**	MD	No tut. Feb 28
Mar-9	9	• Water-Land-Interfaces	MD	March 7 *Tim*
Mar-16	10	• Invasive species	MD	March 14 **Zach**
Mar-23	11	• Pollutants in Great Lakes	MD	March 21 *Tim*
Mar-30	12	• Overview Due for the Report	MD	No tut March 28

Week 1 – Jan 5th 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 – Jan 12th 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 – Jan 19th PRODUCTIVITY OF GREAT LAKES CARBON CYCLE

The occurrence of inorganic carbon in freshwater systems, utilization of carbon by algae

Week 4 – Jan 26th PHOSPHORUS AND NITROGEN CYCLES

Phosphorus in freshwater systems Phosphorus and the sediments, internal loading, sediment demonstration Phosphorus Loading and Algal Productivity, Sources and transformation of nitrogen in water, Nitrogen Loading and Algal Productivity

Week 5 – Feb 2nd 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

Zooplankton, Food, Feeding and Food selectivity, Food-web Dynamics in Great Lakes

Week 6 – Feb 9th Case studies
Week 7 - Feb 16th MIDTERM
Week 8 – March 2th CYCLING OF MICRONUTRIENTS: IRON, SULFUR AND SILICA

Week 9 – March 9th 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 – March 16th 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 Sediments: general composition, re-suspension, aerobic and anaerobic decomposition
Week 11 – March 23th INVASIVE SPECIES
Stressors and Induced Ecological Changes
Invasive exotic Species: Definition and Mechanisms of Introduction
Week 12 – March 31st 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

The report will be worth 15% of the total course grade.

Last Day of Classes March 31st, the deadline for the reports is March 31st

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.