UNIVERSITY of TORONTO SCARBOROUGH
September 2012
Department of Physical & Environmental Sciences

Environmental Science EES C18

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: SY 346 (Maria Dittrich)

The course consists of: **(a)** a 2-hour lecture each week; **(b)** a 2-hour tutorial class; **(c)** student seminars; and **(c)** designated readings. Each lecture will be accompanied by either a handout or the lectures will be posted on the web.

Lectures: Tuesday 1pm-3pm **Tutorial Seminar:** Tuesday 4pm-6pm
Room: BV 361 **Room:** BV361

Course Grade:

Assignment 1	**10 %**
Midterm Exam (in-class)	**30%**
Report and presentation	**30% (15% written and 15% oral)**
Final Examination	**30 %**

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
Sept-11	1	• Introduction: Great Lakes in a global context	MD
Sep-18	2	• Thermal structure of the Great Lakes	MD
Sep-25	3	• Structure and Productivity of Aquatic Ecosystems	MD
Oct-2	4*	• Carbon and Nitrogen Cycles/**Assignment 1**	MD
Oct-9	5	• Phosphorus Cycle	MD
Oct-16	6	• Food Web, Planktonic Communities	MD
Oct-23	7*	• Eutrophication in Great Lakes/**Midterm in Class**	MD
Oct-30	8	• Water-Land-Interfaces	MD
Nov-6	9	• Invasive species	MD
Nov-13	10	• Pollutants in Great Lakes	MD
Nov-20	11	• Students presentations	MD
Nov-27	12	• Students presentations	MD

Week 1 – September 11 ORIENTATION GREAT LAKES IN A GLOBAL CONTEXT
Course Outline; Lecture Schedule
Great Lakes in Global Context
Week 2 – September 18 THERMAL STRUCTURE OF THE GREAT LAKES
Thermal Layering & Lake Overturning
Thermocline Development
Thermal Classification of Lakes; Vertical Stability
Examples from the North American Great Lakes
Potential impacts of climate change
Week 3 - September 25 STRUCTURE AND PRODUCTIVITY OF GREAT LAKES
Lake Ecological Concept
Population growth and Regulation
Community Structure and Interrelationships
Ecosystem Interrelationships, Productivity
Week 4 - October 2 CARBON AND NITROGEN CYCLES
The Oxygen content of inland waters, distribution of oxygen in Lakes
The occurrence of inorganic carbon in freshwater systems, utilization of carbon by algae
Sources and transformation of nitrogen in water
Nitrogen Loading and Algal Productivity
Assignment I
Week 5 – October 9 PHOSPHORUS CYCLES
Phosphorus in freshwater systems
Phosphorus and the sediments, internal loading
Phosphorus Loading and Algal Productivity
Week 6 – October 16 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 7 –October 23 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.
Midterm in class
Week 8 – October 30 WATER-LAND-INTERFACES
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 9 – November 6 INVASIVE SPECIES
Stressors and Induced Ecological Changes
Invasive exotic Species: Definition and Mechanisms of Introduction
Week 10 – November 13 POLLUTANTS IN THE GREAT LAKES
Toxic Substancesp, 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,
Week 11 – November 20 STUDENT SEMINARS during tutorial hours
In the 11th (tutorial hours) and 12th weeks of class student will make a presentation. This presentation will be worth 15% and the report 20% of the total course grade.
Week 12 – November 27 **STUDENT SEMINARS and COURSE REVIEW**
Last Day of Classes December 2, final examination between December 7 and 18.

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.

A few Web Reference Sources:

http://www.epa.gov/glnpo/atlas/ The Great lakes Atlas

http://www.great-lakes.net/index.html Great Lakes Information Network (GLIN)

http://www.epa.gov/glnpo/index.html **U.S.** Environmental Protection Agency (EPA)

http://www.cciw.ca/nwri-e.html Environment Canada, National Water Research Institute (NWRI)

http://www.glc.org/ Great Lakes Commission (GLC)

http://www.ndbc.noaa.gov/index.shtml National Oceanic and Atmospheric Administration's (NOAA) National Data Buoy Center

http://www.glerl.noaa.gov/ National Oceanic and Atmospheric Administration (NOAA) Great Lakes Environmental Research laboratory (GLERL)

http://www.glerl.noaa.gov/res/Programs/ncrais/ National Oceanic and Atmospheric Administration (NOAA) National Center for Research on Aquatic Invasive Species

http://www.glfc.org/home.php Great Lakes Fisheries Commission (GLFC)

http://www.dfo-mpo.gc.ca/regions/central/pub/bayfield/01-eng.htm Fisheries and Oceans Canada (DFO), Bayfield Institute - Great Lakes Research

http://www.glsc.usgs.gov/ United States Geological Survey (USGS), Great lakes Science Center