Environmental Science EES C18

The Great Lakes: An Introduction to Physical and Chemical Limnology

North America is endowed with eight of the twelve largest fresh-water lakes in the world. The origin and geological history, the hydrodynamics and hydraulics, 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 physical and chemical 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), George Arhondtsis (GA), William Gough (BG)
Office: SY 346 (Maria Dittrich)

The course consists of: (a) a 2-hour lecture each week; (b) a 2-hour tutorial/practical class each week, where the assignments are given out and discussed; (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 1300-1500 h  Tutorial/Practical/Seminar: Tuesday 1600-1800 h
Room: BV 361  Room: MW 160

Course Grade: Assignment 1 10 %
Assignment 2 10 %
Report and presentation 35 % (20% written and 15% oral)
Final Examination 45 %

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 AccessAbility Services Office as soon as possible. The UTSC AccessAbility 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

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<tr>
<th>Date</th>
<th>Lecture Topic</th>
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<tr>
<td>Sept-13</td>
<td>• Introduction, Climatology</td>
<td>GA, BG, MD</td>
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<td>Sep-20</td>
<td>• Dynamics</td>
<td>BG</td>
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<td>Sep-27</td>
<td>• Circulation</td>
<td>BG</td>
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<td>Oct-4</td>
<td>• Structure and Productivity of Aquatic Ecosystems</td>
<td>MD</td>
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<td>Oct-11</td>
<td>• Carbon, Nitrogen and Phosphorus Cycles</td>
<td>MD</td>
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<td>Oct-18</td>
<td>• Food Web, Planktonic Communities: Algae and Cyanobacteria</td>
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<td>Oct-25</td>
<td>• Eutrophication</td>
<td>GA</td>
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<td>Nov-1</td>
<td>• Water Quality</td>
<td>GA</td>
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<td>Nov-8</td>
<td>• Water-Land-Interfaces</td>
<td>MD</td>
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<td>Nov-15</td>
<td>• Invasive species</td>
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<td>Nov-22</td>
<td>• Pollutants in Great Lakes</td>
<td>MD</td>
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<td>Nov-29</td>
<td>• Students presentations</td>
<td>GA, BG, MD</td>
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Week 1 – September 13
ORIENTATION
Course Outline; Lecture Schedule
Practical Schedule; Seminar Schedule
CLIMATOLOGY
Great Lakes in a global context

Week 2 – September 20- Dynamics
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

Assignment I

Week 3 - September 27
CIRCULATIONS
Dynamic Forcing of the Lakes
Coastal upwelling; Thermal bar revisited
Great Lakes Circulation

Week 4 - October 4
STRUCTURE AND PRODUCTIVITY OF GREAT LAKES
Lake Ecological Concept,
Population growth and Regulation
Community Structure and Interrelationships
Ecosystem Interrelationships, Productivity
Week 5 – October 11
CARBON, NITROGEN AND PHOSPHORUS 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
Phosphorus in freshwater systems
Phosphorus and the sediments, internal loading
Phosphorus and Nitrogen Loading and Algal Productivity

Week 6 – October 18
FOOD WEB, PLANKTONIC COMMUNITIES: ALGAE AND CYANOBACTERIA
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 25
WATER POLLUTION EUTROPHICATION
Basic Concepts of Eutrophication
Food Web Structure
Natural and Cultural Processes of Eutrophication
Relationships among Nutrients, Water Clarity, and Phytoplankton
Response Models for Trophic State – Eutrophication Models
Other Pollutants and Mitigation of Water Pollution
Assignment II

Week 8 – November 1
EUTROPHICATION PROBLEMS IN THE GREAT LAKES
Great Lakes Water Quality Agreement
Eutrophication Problems in: (i) Lake Erie; (ii) Lake Superior; (iii) Lake Michigan, (iv) Lake Huron; (v) Lake Ontario.
Eutrophication Risk Assessment and Adaptive Management Implementation in the Hamilton Harbour.

Week 9 – November 8
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 10 – November 17
INVASIVE SPECIES
Stressors and Induced Ecological Changes
Invasive exotic Species: Definition and Mechanisms of Introduction
Week 11 – November 24
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,

STUDENT SEMINARS during tutorial hours

Week 12 – December 1
STUDENT SEMINARS and COURSE REVIEW
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.

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:


This journal and the reference sources below will be used for course readings and as starting points for student seminars.

Books:

A few Web Reference Sources:
http://www.epa.gov/glntpo/atlas/ The Great lakes Atlas
http://www.great-lakes.net/index.html Great Lakes Information Network (GLIN)
http://www.epa.gov/glntpo/index.html U.S. Environmental Protection Agency (EPA)
http://www.cciw.ca/nwri-e.html Environment Canada, National Water Research Institute (NWRI)
http://www.ilec.or.jp/database/index/idx-lakes.html Basic Data on World Lakes

http://ri.ijc.org/ Great Lakes-St. Lawrence Research Inventory, The International Joint Commission’s Council of Great Lakes Research Managers (CGLRM)

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://coastwatch.glerl.noaa.gov/ NOAA Coastwatch, Great Lakes Node

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