



**E545: LAKE AND WATERSHED MANAGEMENT
Spring 2004**

Lecture: M & W 8:00 - 9:15 am SPEA 272

WEB Site: <http://www.spea.indiana.edu/e545-joneswi/>

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Office Hours: Mon. 11:00 - Noon
Mon. 2:00 - 5:00 pm
(other times by appointment)

(Secretary: Kathy Perry, SPEA 340, 855-4556)

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I. GENERAL COMMENTS AND COURSE GOALS

Limnology, the study of inland fresh waters, is a field of study rich in history, dating back to the 1800's. Principles of physics, chemistry, geology, and biology combine to form the basis for understanding how lakes and streams function. Lake management and restoration, on the other hand, is a rather new field that has been fully recognized only since the early 1970's. The objective of this course is to develop an understanding of the causes and processes involved in the eutrophication of lakes and of methods currently used in lake and watershed management. This will be accomplished by lectures, homework exercises, field trip(s), and readings as listed below.

In this course, students will learn to apply basic limnological principles to diagnose lake and watershed problems, to understand lake response to pollution, to identify appropriate management solutions, and to predict lake response to management. We will use case studies and a variety of mathematical models to assist us in this task. The models will be discussed in class and students will use the models in the homework exercises. For example, an empirical model used to predict the concentration of total phosphorus in a lake is:

$$[P] = \frac{0.89L}{qs + 0.18 \bar{z}}$$

Where: L = areal phosphorus loading (g/m²-yr)
qs = areal water loading (m/yr)
 \bar{z} = mean water depth (m)

Throughout the course, we will examine how federal, state, and local policies affect nearly all lake and watershed management decisions.

II. PREREQUISITES

Students should have previous courses in and an understanding of basic chemistry, biology/ecology, and mathematics.

III. TEXT (REQUIRED)

Holdren, C, W. Jones and J. Taggart. 2001. Managing Lakes and Reservoirs. North American Lake Management Society and Terrene Institute. Madison, WI. (available from Bill Jones at the NALMS member price of \$30.00. Please make out check to: NALMS)

IV. SUPPLEMENTARY READINGS (on reserve in SPEA Library and electronic reserves) - See attached list. Not all of these readings will be assigned; however, all will be very useful to your understanding of lake and watershed management, particularly with regard to your writing assignments. I have put them on reserve so they will be readily available to you should you decide to use them. Please see Section IX (below) for reading assignments.

V. STUDENT RESPONSIBILITIES

Your responsibilities are to attend all the lectures, ask questions, prepare ahead for class, complete assignments on time, and express yourself creatively and concisely in your work. I will do my best to be clear, organized and fair.

VI. COURSE EVALUATION AND GRADING

Your course grade will be based on examinations covering the lecture material and associated reading assignments, homework exercises and classroom participation. Undergraduate and graduate students will be evaluated on separate scales, if necessary. Final grades will be based on the following percentages:

Classroom participation/ attendance	+/-
Homework Exercises (5)	40%
Group Project	25%
Exam I (Mon., March 8)	20%
Exam II (Fri., May 7) 8:00 – 10:00 am	20%

• EXERCISES

There will be five homework exercises and one group project during the semester. All homework exercises **must be done individually**. Assignments turned in late will cause the grade to be lowered by 10 percent per day. The exercises will likely include:

- A watershed mapping/lake morphometry exercise in which students will delineate a watershed boundary, use a planimeter to determine watershed and lake contour areas, and prepare depth/volume and area/volume graphs for the lake in question (10%).
- Three exercises of story problems emphasizing mass balances, unit conversions, and model applications (5% each).
- One short (4-5 pages) paper/project on nonpoint source pollution (15%).
- The group project (25%) will be a lake analysis and management plan project in which students may work together in groups.

• EXAMS

Examinations are in-class and closed book. The exams will emphasize your understanding of concepts and your ability to synthesize and apply the lecture material. Exams are primarily short answer/essay and story problems. Students are strongly advised to review previous exams on the course web page to gain an appreciation of what is expected on the exams. No make-up examinations will be given in this course! Should you have an unexcused absence from an exam, your grade will be zero. Consult your Student Handbook for a description of the few circumstances for which incompletes or excused absences from tests are appropriate.

VII. ADDITIONAL COURSE POLICIES

1. My office hours are set aside for your use -- use them! If you have any problems with the course come and see me right away so we can correct them before you fall too far behind. During office hours, I promise to be in my office (or lab) and drop anything else I'm doing to answer your questions.

2. If you don't understand something in class -- raise your hand and say so! Chances are that other students are having the same problem. There is no such thing as a dumb question. Comments, debate, and alternative views are encouraged in my class -- let me and your classmates know what you think of the topic at hand.
3. I expect you to complete the assigned readings (including the reserves) prior to the class in which we will cover them. This is essential to allow for class discussions.
4. Cheating and Plagiarism are forms of academic dishonesty that cannot be tolerated in university education. Taking material from a book or magazine without citing it and taking material from another student's paper are but two examples of plagiarism. Please refer to the *Code of Student Ethics* for other examples and a description of the University's policies for dealing with plagiarism. You should also understand that the Associate Instructor and I will follow procedures described in the *Code* in handling any case of academic dishonesty. The IU School of Education has an informative and comprehensive web site devoted to plagiarism at: <http://www.indiana.edu/~istd/definition.html>. I recommend that you visit this site.

VIII. COURSE TOPICAL OUTLINE

1. Fundamentals of Limnology
2. Eutrophication of Lakes
3. Conducting a Lake Study
 - A. planning
 - B. assessment
 - C. water budgets
 - D. nutrient budgets
4. Models Useful in Lake Management
 - A. runoff models
 - B. nutrient export models
 - C. lake response models
5. Watershed Management
 - A. urban point and nonpoint sources
 - o stormwater management (NPDES Phase II)
 - o septic systems
 - o construction site management (Clean Water Act 'Rule 5')
 - B. rural nonpoint sources
 - o agricultural best management practices and the 'players' (Clean Water Act, Farm Bill, SWCDs, NRCS, Regulated Drains, TMDLs)
 - o lakeshore and streambank management practices
 - C. zoning controls
6. In-Lake Methods to Control Algal Biomass
 - A. Dilution and Flushing
 - B. Hypolimnetic Withdrawal
 - C. Phosphorus Precipitation and Inactivation
 - D. Biomanipulation
7. Procedures to Control Macrophyte Biomass
 - A. Water Level Drawdown
 - B. Harvesting
 - C. Surface and Sediment Covers
 - D. Phytophagous Insects and Fish
 - E. Aquatic Herbicides
8. Multiple Benefit Treatments
 - A. Hypolimnetic Aeration
 - B. Artificial Circulation
 - C. Sediment Removal

- 9. Human Use Management
- 10. Special Issues in Lake Management
 - A. Algal toxins
 - B. Aesthetics
 - C. Recreational demand

IX. SCHEDULE AND READINGS

The following lecture schedule is one that I will try to adhere to; however, guest lecturers, field trips, etc. may require adjustment. I assume you will have the assigned readings completed **before** class and are prepared to discuss the material.

- WEEK I** READ: NALMS *Chap. 1 & 2*; FREY, 1980; SCHINDLER & FEE, 1973; HUTCHINSON, 1973
 Jan 12 & 14 - Fundamentals of limnology
 - Eutrophication
- WEEK II** READ: *Exercise #1 handout*
 Jan 19 - NO CLASS: Martin Luther King Day
 Jan 21 - Lake basin morphology exercise
- WEEK III** READ: NALMS *Chapter 3*; CORRELL, 1998);
 Jan 26 - Eutrophication
 Jan 28 - Planning
- WEEK IV** READ: NALMS *Chapter 4*; WELCH & COOKE, 1995;
 Feb 2 - Water and Nutrient budgets
 Feb 4 - Trophic State Indices
- WEEK V** READ: *Chapter 5*; RECKHOW & SIMPSON, 1980;
 Feb 9 & 11 - Modeling (runoff models, nutrient export models, lake response models)
- WEEK VI** READ: NALMS *Chapter 6*; MONROE COUNTY SEPTIC SYSTEM REGULATIONS;
 O'REILLY, 199_;
 Feb 16 - Watershed Management; Wastewater treatment and diversion
 Feb 18 - Urban point and non-point sources and their control
- WEEK VII** READ: CITY OF BLOOMINGTON SOIL EROSION CONTROL ORDINANCE, CHAP 20.20
 PIMENTAL *et al.*, 1995
 Feb 23 - Urban point and non-point sources and their control
 Feb 25 - Rural nonpoint sources and their control
- WEEK VIII** READ: WILLIAMSON *et al.*, 1996; McCOMAS, JANSEN *et al.*, 1986; LEE and LOVELL,
 1998; and LAKESHORE PROTECTION IN INDIANA – available as PDF file from
<http://www.ai.org/dnr/soilcons/pdfs/seawall.pdf>
 Mar 1 -Lakeshore and Streambank Management
 Mar 3 - Watershed Zoning Controls
- WEEK IX** READ: PLANNING TO PREVENT URBAN RUNOFF; SCHUELER, 1998; LAKE MONROE
 WATERSHED OVERLAY ZONE; NALMS *Chapter 7*
 Mar 8 -EXAM #1
 Mar 10 -Dilution and Flushing

SPRING BREAK

- WEEK X** READ: NALMS *Chapter 7*
 Mar 22 -Hypolimnetic withdrawal
 Mar 24 -Phosphorus precipitation/inactivation
- WEEK XI** READ: SHAPIRO, 1982; NEY, 1996 and McCOMAS, BORONOW *et al.*, 1986
 Mar 29 -Biomaniipulation/Fisheries management
 Apr 30 -Water Level Drawdown
- WEEK XII** READ: MADSEN, 2000 (on Course Web Page at <http://www.spea.indiana.edu/e545-joneswi/homework.htm>); and www.epa.gov/owow/lakes/bomoseen.html)
 Apr 5 -Harvesting and bottom covers
 Apr 7 -Phytophagus Insects, Fish and other Biological Controls
- WEEK XIII** READ:
 Apr 12 -Hypolimnetic aeration
 -Artificial circulation
 Apr 14 -Sediment removal
- WEEK XIV** READ: MACBETH, 1992; KLESSIG, 1994; JONES, 1996; MARTIN & COOKE, 1994; KOTAK *et al.*, 1994; CHU & WEDEPOHL, 1994
 Apr 19 -Managing Humans
 Apr 21 -Special Considerations at Water Supply Reservoirs
- WEEK XV** READ: NALMS *Chapter 9*
 Apr 26 -Riparian rights and the basis of water controls
 Apr 28 -Successful implementation of projects

X. RESERVE READING LIST – Electronic Reserves

Eutrophication

1. Frey, David G. 1980. The heritage of our lakes, *The Key Reporter*, 45(4):2-4.
2. Schindler, D.W. and E.J. Fee. 1973. Experimental Lakes Area: Whole-Lake Experiments in Eutrophication. *J Fisheries Research Bd Canada*, 31(5):937-953.
3. Hutchinson, G. Evelyn. 1973. Eutrophication - The scientific background of a contemporary practical problem. *American Scientist*, 61:269-279.
4. Hasler, Arthur D. 1969. Cultural Eutrophication is Reversible. *BioScience*, 19(5):425-431.
5. Correll, David L. 1998. The role of phosphorus in the eutrophication of receiving waters: a review. *J. Environ. Qual.*, 27(2):261-266.
6. Welch, E.B. and G.D. Cooke. 1995. Internal phosphorus loading in shallow lakes: importance and control. *Lake and Reserv. Manage*, 11(3):273-281.

Modeling

7. Reckhow, K.H. and J.T. Simpson. 1980. A procedure using modeling and error analysis for the prediction of lake phosphorus concentrations from land use information. *Can. J. Fish. Aquat. Sci.*, 37:1439-1448.

E456/545 Reserve Reading List (cont.)

Watershed Management

8. Septic System Regulations. Monroe County Code Chapter 365.
9. "Planning to Prevent Urban Runoff", Chapter 3 in Guide to Protecting the Urban Environment.
10. Williamson, R.B., C.M. Smith, and A.B. Cooper. 1996. Watershed riparian management and its benefits to a eutrophic lake. *J. Water Resour Plan and Manage.*, 122(1):24-32.
11. O'Reilly, N. 199_. Bio-Filtration: Using Natural Systems to Manage Urban Stormwater.
12. Schueler, T. 1998. Better Site Design: Changing the Rules to Protect the Environment. Nonpoint Source News-Notes newsletter.
13. McComas, S., D. Jansen, J. Marter and D. Rosenboom. 1986. Shoreline Protection Workshop. *Lake and Reservoir Management*, 2: 421-423.
14. City of Bloomington Soil Erosion Control Ordinance, (Chapter 20.20)
15. Lake Monroe Watershed Overlay Zone
16. Lee, David and J. Lovell. 1998. Urban trout stream gets a second chance. *Land and Water*, pp 16-19.
17. Pimentel, D. et al. 1995. Environmental and economic costs of soil erosion and conservation benefits. *Science*, 267:1117-1123.

Fisheries/Biological Management

18. Shapiro, Joseph. 1982. Experiments and experiences in biomanipulation - Studies of biological ways to reduce algal abundance and eliminate Blue-Greens. R803870. Corvallis Environmental Research Laboratory, U.S. Environmental Protection Agency, Corvallis, Oregon.
19. Mazumder, A. and D.S. Lean. 1994. Consumer-dependent responses of lake ecosystems to nutrient loading. *J Plankton Res.*, 16(11):1567-1580.
20. Ney, J.J. 1996. Oligotrophication and its discontents: effects of reduced nutrient loading on reservoir fisheries. *Am Fisheries Soc Symp.*, 16:285-295.
21. McComas, S.R., G. Boronow, D. Shodean and J. Schilling. 1986. Fisheries Management. *Lake and Reservoir Management*, 2:447-450.

Lake Management Policy

22. Clean Lakes Program Guidance. 1986. Code of Federal Regulation. 40 CFR Ch. 1, Sec. 35.

Special Lake Management Issues

23. Martin, A. and G.D. Cooke. 1994. Health risks in eutrophic water supplies. *LakeLine*, 14(2):24-26.

E456/545 Reserve Reading List (cont.)

24. Kotak, B.G., E.E. Prepas and S.E. Hrudey. 1994. Blue-green algal toxins in drinking water supplies - Research in Alberta. *LakeLine*, 14(2): 37-40.
25. Chu, F.S. and R. Wedepohl. 1994. Algal toxins in drinking water? Research in Wisconsin. *LakeLine*, 14(2): 41-42.
26. Macbeth, E.J. 1992. Protecting aesthetics and the visual resource quality of lakes. In, Proceedings of a National Conference on Enhancing the States' Lake Management Programs, U.S. Environmental Protection Agency, Washington, D.C.
27. Klessig, L.L. 1994. Load limits for lakes. *Lake and Reserv. Manage.*, 10(1):69-73.
28. Jones, W.W. 1996. Balancing recreational user demands and conflicts on multiple use public waters. *Am. Fisheries Soc Symp.*, 16:179-185.

Paper Reserves (SPEA Library)

1. HHRC&DC. 1985. *Urban Development Planning Guide*. Hoosier Heartland RC&D Council, Inc. Indianapolis, IN.
2. Jones, W.W., M.A. Pfister, R. Harris, P. Felling and M. Lincoln. 1992. *Indiana Volunteer Lake Monitoring Program Results for 1990 and 1991*. Indiana Department of Environmental Management, Indianapolis, Indiana.
3. Jones, W.W., C. Czarniecki, J. Joerke and R. Price. 1994. *Indiana Volunteer Lake Monitoring Program Results for 1992 and 1993*. Indiana Department of Environmental Management, Indianapolis, Indiana.
4. IDEM. 1986. *Indiana Lake Classification System and Management Plan*. Indiana Department of Environmental Management, Indianapolis, Indiana.
5. Jones, W.W. et al. 1996. *Indiana Lake Water Quality Update for 1989 - 1993*. Indiana Department of Environmental Management, Indianapolis, Indiana.
6. Cooke, G.D., E.B. Welch, S.A. Peterson and P.R. Newroth. 1993. *Restoration and Management of Lakes and Reservoirs, Second Edition*. Lewis Publishers, Boca Raton, Florida.