ENVR 413-001 (Class #3679)
Limnology
Fall 2016

Time and place:
0800-0915 Tu-Th
0004 Hooker Research Building

Instructor:
Steve Whalen (steve_whalen@unc.edu)
Office: 166A Rosenau Hall
Phone: 966-9895
Office hours vary-call first to be sure

Text: Wetzel, RG. 2001. Limnology, 3nd Edn., Saunders, Fort Worth, TX.
(Suggested) Horne, AJ & CR Goldman. 1994. Limnology, 2nd Edn., McGraw-Hill, NY.
Kalff, J. 2002. Limnology. Inland Water Ecosystems. Prentice Hall, NJ.

Objectives and Description: This is an intermediate level course targeted toward upper level undergraduate and beginning graduate students. The overall objective of this course is to gain an understanding of ecosystem structure and function in freshwater lakes and reservoirs. Limnology is a multidisciplinary science, requiring an understanding of physics, chemistry and biology as well as interactions and feedbacks. Although there are no prerequisites to enrolling in this course, familiarity with basic principles in these three disciplines is assumed. We will first examine the unique properties of water and physical phenomena that influence hydrodynamics of large and small water bodies. We will then explore the chemical environment in lake waters and sediments, microbial (bacteria/phytoplankton) influences on cycling of essential elements and link physical processes to chemical structure. Next, we will study trophic-level interactions (decomposers/producers/consumers) and integrate physical, chemical and biological principles for a holistic view of lake ecosystem dynamics. With this background, we will briefly discuss rivers and examine the unique ecosystem created by impoundment of large rivers. Finally, we will end the semester with a brief discussion of paleolimnology and lake ontogeny.

Reading assignments: Due to the multidisciplinary nature of Limnology, there is no text that is entirely adequate. In the past, I have used the books listed above (Wetzel, Horne and Goldman, Kalff) as required texts, with additional lecture material drawn from other sources. In recognition of the fact that many students will not embark on a career in the aquatic sciences, I suggest that any student interested in having a limnology text for his (her) personal library purchase any of these texts. However, none is required. Wetzel (2001) is certainly the most comprehensive, but is sometimes difficult to wade through. The other texts are easier reading and are general enough to be readily understood by the nonspecialist. Although it is not necessary to purchase a text to successfully complete the course, I have indicated the chapters in Wetzel that correspond to the material covered in each lecture. This course continuously builds on material from previous lectures, hence students are urged to regularly attend class. Students with spotty attendance records often perform poorly on exams.

Overheads: I will use figures and tables extensively in this course to reinforce the verbal presentation. These are frequently drawn from texts (particularly Wetzel) and journal articles Before each lecture I will pass out copies of the figures and tables that will be discussed that day.

Tests: Tests will be of the take-home variety and you will be allowed at least 5 days to *independently* work the problems. You may use your class notes, books, journal articles and internet sites when working the tests. You may not consult classmates, any other students or faculty at UNC or elsewhere or any materials from students that have previously enrolled in the course when completing the exams. Any deviation will result in an Honor Code violation (http://studentconduct.unc.edu/; http://www.unc.edu/gradrecord/front/univregulations.html).

On exams, students will be expected to: (a) perform calculations on a data set and explain the results; and (b) answer questions based on interpretation of figures drawn from the limnological literature. Calculations and figures used in test material will be similar to those shown in class, except that the student will now provide the interpretation. Tests are designed to be completed in six hours. You **must** turn in paper copies of your exam. I cannot accept electronically submitted exams due to issues with viruses.

Grading: Two midterm exams and a final exam will be given, worth a total of 100 points. Exams will be weighted as follows: Midterm #1, 30 points; Midterm #2, 30 points; Final Exam, 40 points. Your final grade will be determined by summing the scores of the three tests. The grading criterion follows: H (A)=90-100; P (B)=80-89;L (C)=70-79; F=<70 (grad); D=60-69 (undergrad); F=<60 (undergrad). Students are expected to turn in exams at the designated time and date unless prior permission is granted for an alternate time and date. Failure to pass in an exam at the designated hour of the due date will result in a one point penalty on the grade for that exam. Exams late by a day or more will result in a two point per day penalty on the grade for that exam.

Syllabus changes: I reserve the right to make changes to the syllabus, including lecture schedules and test dates when unforeseen circumstances arise. Any change will be announced as soon as possible to allow students to adjust schedules.

Course Evaluation: The University has implemented an online evaluation system. You will be notified by the Registrar late in the semester when the evaluation period is open. It coincides with the last two weeks of class.

Lecture Schedule

Lecture #	Date	Topic	Chapters
1	23 August	Hydrologic cycle, properties of water	2, 3, 4
2	25 August	Lake origins, morphometry and lacustrine zonation	3, 8
3	30 August	Light in lakes- electromagnetic spectrum, inputs, attenuation, transmission and quality	5
4	1 September	Thermal properties of lakes- vertical structure and seasonal cycles	6
5	6 September	Lake hydrodynamics- kinetic energy cascade, surface and internal waves	7
6	8 September	Lake hydrodynamics- surface and internal waves (cont.), Langmuir circulation	7
7	13 September	Lake hydrodynamics- surface drift, Ekman transport, geostrophic flow, thermal bars, stability	7
8	15 September	Dissolved gases - transfer at air-water interface Dissolved O_2- vertical structure and seasonal cycle	9
9	20 September	Dissolved gases- CO_2- dissolution and speciation, pH as master variable	11
10	22 September	Dissolved gases- CO_2-proton balance equations, closed and open systems	11
11	27 September	Dissolved gases- CO_2-determination of alkalinity, ΣCO2, CO_2 as a weathering agent	11
12	29 September	Dissolved gases- CO_2- ΣCO_2, $CaCO_3$ and buffering capacity	11
13	4 October	Geological weathering- common anions and cations	10

Take Home Exam #1, 4 October - 11 October (due 8 a.m.)- 30 pts.

Lecture #	Date	Topic	Chapters
14	6 October	Redox chemistry review, Nutrients: biogeochemical cycling of N	12
15	11 October	N cycle (continued)	12
16	13 October	Nutrients: Biogeochemical cycling of S, Fe/Mn and Si	14
17	18 October	Nutrients: Biogeochemical cycling of phosphorus	13
18	25 October	Phytoplankton- pigments, major algal groups, nutrient uptake, succession, competition	15
19	27 October	Phytoplankton-Photosynthesis and irradiance (P vs I), rates of primary production and relationship to underwater light climate	15
20	1 November	Phytoplankton- relationship with nutrients; Bacterioplankton - distribution and productivity Zooplankton- types, characteristics and population dynamics	16, 17
21	3 November	Zooplankton (continued); Fish- groups, life styles	17
Take Home Exam #2, 3 November - 10 November (due 8 a.m.) - 30 pts.			
22	8 November	Unifying concept- pelagic food webs, trophic cascade, microbial loop, new and regenerated primary production	16
23	10 November	Land-water interfaces and interactions- macrophytes, attached algae	18, 19
24	15 November	Littoral production and shallow lakes, detrital pathways	18, 19
25	17 November	Organic carbon cycling	23
26	22 November	Flowing waters- physical and chemical characteristics, productivity	
27	29 November	Reservoirs-a lake or a river? Unique characteristics	

Lecture #	Date	Topic	Chapters
28	1 December	Reservoirs (continued). Paleolimnology- historic record of a lake's past- dating sediment and interpreting biological and chemical markers	24
29	6 December	Paleolimnology (continued)	

Final Exam 6 December - 15 December (due 10 a.m.) - 40 points