COURSE: Spring 2010, FISH 5320/6320, Limnology and Limnology Laboratory, 4 credit hours

LECTURE: M-W-F, 11:00am-11:50am, Swingle 303, 3 credit hours

LABORATORY: T, 1:00pm-5:00pm, Swingle 301, 1 credit hour

OFFICE HOURS: F, 9:00am-11:00am, Swingle 321, or by appointment

REQUIRED PREREQUISITES: BIOL 1030/1037, CHEM 1040, FISH 2100, BIOL 3060, FISH 5220, or departmental approval (contact Tracy Cline (tjc0001@auburn.edu))

INSTRUCTOR: Dr. Alan Wilson, Swingle 321, wilson@auburn.edu, 334-844-9321

TEACHING ASSISTANT: Michael Chislock, Swingle 323, chislock@auburn.edu, 334-844-9255

COURSE WEBSITE: https://moodle.acesag.auburn.edu:444/

FIELD OF STUDY:
Limnology is the study of the chemical, physical, geological, biological, and ecological processes that influence the structure and function of aquatic communities. It is an important field of study because of increasing global demands on freshwater natural resources which require the effective management of freshwater habitats used for drinking water, fish production, recreation, aesthetics, etc.

COURSE OBJECTIVES & STUDENT LEARNING PHILOSOPHY:
The course objectives represent a variety of tasks and skills that I expect students to have developed and mastered by the end of the course. Through participating in this course, you will (1) practice and develop your critical thinking skills (through in-class group discussions, presentations, and laboratory exercises), (2) learn how to read and interpret the scientific literature, and (3) broaden your understanding of freshwater ecosystems (through lectures and lab). My role in this course is to encourage and facilitate your learning and critical thinking about the ecology of freshwater ecosystems in a learning and fun-filled environment. I hope to provide you with a solid foundation of concepts and skills with which you can understand the complexity of freshwater ecosystems.

REQUIRED READINGS (available under FILES at https://moodle.acesag.auburn.edu:444/):
1. Dodson, S. I. Introduction to Limnology. McGraw-Hill, 2004. Available at http://www.aubookstore.com/
2. Select chapters from Wetzel, R. G., and G. E. Likens. Limnological Analyses. Spring-Verlag, Berlin. 2000, and Welch, P. S. Limnological Methods. McGraw-Hill, New York. 1948, will be used for some laboratory exercises. These chapters will be made available to the students on the class site.
3. Articles from the peer-reviewed literature (see below) will be used in student-led classroom discussions to supplement the textbooks. These papers will be made available to the students on the class site.

1. Brooks, J. L., and S. I. Dodson. 1965. Predation, body size, and composition of plankton. Science 150:28-35.
2. Broussard, W. and R. E. Turner. 2009. A century of changing land-use and water-quality relationships in the continental US. Frontiers in Ecology and the Environment **7**:302-307.
3. Carpenter, S. R., J. K. Kitchell, and J. R. Hodgson. 1985. Cascading trophic interactions and lake productivity. Bioscience 35:634-639.
4. Chao, B. F., Y. H. Wu, and Y. S. Li. 2008. Impact of artificial reservoir water impoundment on global sea level. Science **320**:212-214.
5. Fee, E. J., R. E. Hecky, S. E. M. Kasian, and D. R. Cruikshank. 1996. Effects of lake size, water clarity, and climatic variability on mixing depths in Canadian Shield lakes. Limnology and Oceanography **41**:912-920.
6. Forbes, S. A. 1887. The lake as a microcosm. Bulletin of the Peoria Scientific Association:77-87.
7. Hutchinson, G. E. 1959. Homage to Santa Rosalia; or, Why are there so many kinds of animals? American Naturalist **93**:145-159.
8. Mohamed, M. N. and W. D. Taylor. 2009 Relative contribution of autochthonous and allochthonous carbon to limnetic zooplankton: a new cross-system approach. Fundamental and Applied Limnology **175**:113-124.
9. Porter, K. G. 1977. The plant-animal interface in freshwater ecosystems. American Scientist 65:159-170.

10. Schindler, D. W. 1974. Eutrophication and recovery in experimental lakes: implications for lake management. Science 184: 897-899.
11. Smith, V. H. and D. W. Schindler. 2009. Eutrophicaton science: where do we go from here? Trends in Ecology & Evolution **24**:201-207.
12. Werner, E. E. and D. J. Hall. 1988. Ontogenetic habitat shifts in bluegill: The foraging rate-predation risk trade-off. Ecology **69**: 1352-1366.
13. Verburg, P., R. E. Hecky, and H. Kling. 2003. Ecological consequences of a century of warming in Lake Tanganyika. Science **301**:505-507.

GRADING:
Course grades are based on each student's cumulative performance for the following assignments:

Activity	**Points**	**Grading scale**
Lecture - Attendance and participation	10	A = 90-100%
Lecture - Research articles	10	B = 80-89%
Lecture - Quizzes	20	C = 70-79%
Lecture - Debate	10	D = 60-69%
Lecture - Presentation	10	F = 0-59%
Lecture - Paper (graduate students only*)	40	
Lecture - Midterm exams	30	
Lecture - Final exam	40	
Lab - Attendance and participation	10	
Lab - Project presentation	10	
Lab - Reports and final	10	
Total points	160 (undergraduate students) 200 (graduate students*)	

UNDERGRADUATE PARTICIPATION & ASSIGNMENTS EXPECTATIONS:
The course grade will be based on participation in lecture and lab, research article evaluations, quizzes, a presentation, lab reports, and midterm and final exams as described below:

(1) *ATTENDANCE*: Students are expected to attend and be prepared for all classes and labs. Students missing 4 classes or 2 labs without a valid excuse will receive an F for the course.

(2) *PARTICIPATION*: Discussion is vital to an effective learning environment and participation grades will reflect student attendance and involvement during classroom and laboratory activities. In order to participate, you need to be at class on-time, prepared (i.e., perused readings), and with your cell phones off. One or two randomly chosen undergraduate students will also assist with leading discussions of the peer-reviewed literature scheduled five times throughout the semester – so be prepared with paper overview and questions for class.

(3) *RESEARCH ARTICLES REPORTS*: To familiarize you with the primary limnological literature, students will be expected to survey articles in *Limnology and Oceanography* or *Ecology* and concisely (≤ 1 page) scientifically describe one article four times throughout the semester. Each student will be given their own year of papers to choose from to prevent duplication of presentations. Article reports should include an attached reprint, the article citation, description of why you chose paper, study objectives, methods, novel findings, and flaws. Reports not fitting these criteria will be given a 0. On each due date, one or two students may be randomly chosen to briefly (≤ 5 minutes) present their paper to the class.

(4) *STUDENT DEBATE*: The class will be divided in half with equal numbers of graduate students on each half, when possible, to debate a current topic in limnology. The instructor will provide the topic. Students are expected to meet outside of class, decide on group leaders, research the topic using the peer-reviewed literature, and come fully prepared to debate.

(5) *LECTURE PRESENTATION*: All students will be required to give a 10 minute lecture reviewing a pre-defined limnological topic that the instructor provides. Brief 1 page outlines will be due mid-semester (see

lecture calendar below) so that I can assist with presentation and paper (if applicable) development. The students are expected to use the primary literature as references for this presentation.

(6) *LABORATORY REPORTS*: The purpose of the lab reports is to give the students an opportunity to write concise and accurate scientific reports with original data and conclusions. Reports will be required for selected labs (see lab calendar below) and will be due the following lab.

(7) *LAB PROJECT PRESENTATION*: Students will develop and conduct a lab project where chlorophyll *a* is the response variable. One graduate student will work with 2 or 3 undergraduates. The instructors will assign groups. Students are encouraged to discuss their ideas with the instructor well before the end of the semester.

(8) *LECTURE AND LAB QUIZZES*: During many class and lab periods, you will be given a short unannounced quiz. Classroom quizzes will focus on information learned in class and laboratory quizzes will focus on information learned in lab. Also, these quizzes may be given at the start, during, or end of a class or lab period. The focus of these assignments will be (1) to test your preparation for each class or lab period and (2) on answering questions or synthesizing material from previous lectures or labs. These assignments will test your understanding of class material, allow you to synthesize information from class lectures and lab activities, to extrapolate the information you have learned to new situations. At times, questions may require you to work collaboratively with other students and to report your answers to the class. Many of the quiz questions may be similar to those that will be on the midterm and final exams. Students who are absent from class without a valid excuse and miss a quiz will be given a 0 for the quiz and that day's participation grade. Make-up quizzes will not be provided.

(9) *LECTURE MIDTERM EXAMS*: Four closed-book midterm exams will test your knowledge of basic facts and your understanding and synthesis of class concepts. The types of questions on the exam may be similar to the questions that are asked during quizzes. The textbook and primary literature readings reinforce the lecture material and will be used to develop exam questions. Exam questions may include true/false, multiple choice, short answer, and essays. Students who are absent from class and miss an exam will be given a 0. Make-up exams will not be provided.

(10) *LECTURE AND LAB FINAL EXAMS*: The closed-book final exams (classroom and laboratory) will be similar to the midterm exams and will be comprehensive. Make-up finals will not be provided.

GRADUATE PARTICIPATION & ASSIGNMENTS EXPECTATIONS:
Graduate students will be expected to (1) work above and beyond the expectations set forth for undergraduates (see above), (2) think critically about course topics, (3) be class leaders in discussions and actions, (4) to alternate discussion leading of five seminal limnological papers throughout the semester using creative teaching techniques, and (5) write a 5-page, single-spaced, paper supporting their final oral presentation.

CLASSROOM ATTENDANCE & BEHAVIOR:
To receive participation points, it is imperative to attend class and engage in classroom discussions and in-class group projects. If you choose not to attend class on any day, then you accept the responsibility to learn the material on your own. If you have a question during the class period, please do not hesitate to ask. In fact, other students probably have the same question. It is important to be on time for class since the first 5 minutes of each lecture will establish the direction for that day's session. Therefore, if you come in late, certain things may not make sense and you will miss important announcements. Throughout the semester, please be courteous to all of your fellow students and to me so we can create a positive learning environment. All cell phones should be turned off before entering the classroom and should not be used during class.

FEEDBACK & EVALUATION:
This course is for you to learn important fundamental concepts and ideas on which to build your understanding of freshwater ecosystems. I will do my best to create a positive learning environment. However, learning styles differ among students, so I may do some things that are not optimal for you. If this occurs, you can let me know through email or written comments turned in at the end of the class period, during office hours, or via email. Because I need to keep the interest of all students in mind, I cannot promise that I will change the course.

However, I do promise to listen and consider your suggestions. Moreover, course evaluations will be completed by students at the middle and end of the semester so that course changes can be made to enhance the learning experience for this class and future classes. Finally, students will be given an opportunity at the end of most lectures to ask questions about concepts not fully understood via one-minute papers. Some of these questions may be used on quizzes and/or exams.

COURSE CHANGES:
Although I expect to cover all the topics described in the syllabus, course changes will likely occur - especially based on feedback from the students. Consequently, I reserve the right to modify the course to enhance the learning experience where I deem appropriate. Course changes will be described verbally during class and/or in writing via email and/or handouts.

ACADEMIC HONESTY:
Title XII, Chapter 1200 of the SGA Code of Laws clearly defines the Auburn University student academic honesty code (available at http://auburn.edu/tigercub/) which states "*In accordance with those virtues of Honesty and Truthfulness set forth in the Auburn Creed, I, as a student and fellow member of the Auburn family, do hereby pledge that all work is my own, achieved through personal merit and without any unauthorized aid. In the promotion of integrity, and for the betterment of Auburn, I give honor to this, my oath and obligation."* I have a zero-tolerance policy for cheating. Cheating is not fair to you and to your colleagues. If you are not sure which activities constitute cheating, please ask me. Some examples of cheating include, but are not limited to the following activities: attempting to pass others' work as your own (i.e., plagiarism), using crib sheets, or providing exam answers to other students. Students who cheat will receive a 0 on the assignment in question and will most likely fail the course.

ACCOMMODATIONS FOR DISABILITIES:
If you have a disability and/or a special need that requires accommodations, please inform me immediately so that I can develop a plan to work with you and arrange an appointment with a campus disabilities counselor.

LECTURE SCHEDULE (lectures available under FILES at https://moodle.acesag.auburn.edu:444/):

Date	Lecture topic	Readings (pages)
11-Jan-10	Course introduction and overview, What is limnology?	
13-Jan-10	History of limnology, approaches for studying limnology	Dodson 1 (3-23)
15-Jan-10	Lake bathymetry and morphometry	Dodson 11 (265-277), Fee et al. 1996
18-Jan-10	MLK JR. HOLIDAY - NO CLASS	
20-Jan-10	Origin of lakes; lake types	Dodson 11 (277-290)
22-Jan-10	Article discussion: Forbes 1887	Forbes 1887
25-Jan-10	Water as an environment	Dodson 2 (29-38)
27-Jan-10	Viscosity and Reynolds numbers	Dodson 2 (30-31, 50-51)
29-Jan-10	Lake mixing, waves, currents	Dodson 2 (50-56)
01-Feb-10	Light in lakes, LAST DAY TO DROP W/OUT GRADE	Dodson 2 (46-47)
03-Feb-10	Heat in lakes and stratification, Exam review	Dodson 2 (40-43), Verburg et al. 2003
05-Feb-10	****MIDTERM EXAM #1****	
08-Feb-10	Seasonal mixing patterns (Chislock)	Dodson 2 (43-44)
10-Feb-10	Oxygen cycle (Chislock)	Dodson 10 (44-45, 237-239)
12-Feb-10	Carbon cycle	Dodson 10 (231-237)
15-Feb-10	Phosphorus and nitrogen cycles; stoichiometry	Dodson 10 (239-251), Schindler 1974
17-Feb-10	Article discussion: Broussard and Turner 2009 (Chislock)	Broussard and Turner 2009
19-Feb-10	Single-celled and colonial organisms (Chislock)	Dodson 3 (65-80)
22-Feb-10	Single-celled and colonial organisms continued…	Dodson 3 (65-80)
24-Feb-10	Exam review, ****ARTICLE REPORT #1 DUE****	
26-Feb-10	****MIDTERM EXAM #2****	
01-Mar-10	Aquatic invertebrates, ***MIDTERM COURSE EVALUATION***	Dodson 4 (85-124)
03-Mar-10	Aquatic invertebrates, LAST DAY TO DROP W/OUT PENALTY	Dodson 4 (85-124)
05-Mar-10	Vertebrates	Dodson 5 (124-138)
08-Mar-10	Population dynamics: phytoplankton	Dodson 6 (143-157)
10-Mar-10	Population dynamics: zooplankton	Dodson 6 (143-157)
12-Mar-10	Article discussion: Hutchinson 1959, ***TALK OUTLINES DUE***	Hutchinson 1959
15-Mar-10	SPRING BREAK - NO CLASS	
17-Mar-10	SPRING BREAK - NO CLASS	
19-Mar-10	SPRING BREAK - NO CLASS	

Date	Lecture topic	Readings
22-Mar-10	Community ecology: competition	Dodson 7 (161-168)
24-Mar-10	Community ecology: competition continued…	Dodson 7 (168-182)
26-Mar-10	Community ecology: predation, ***ARTICLE REPORT #2 DUE***	Dodson 7 (168-182), Werner and Hall 1988
29-Mar-10	Community ecology: predation continued…, ***Debate groups***	Porter 1977
31-Mar-10	Article discussion: Brooks and Dodson 1965	Brooks and Dodson 1965
02-Apr-10	Seasonal succession, trophic cascades, biomanipulation	Dodson 8 (189-205)
05-Apr-10	Article discussion: Carpenter et al. 1985	Carpenter et al. 1985
07-Apr-10	Exam review, ****ARTICLE REPORT #3 DUE****	
09-Apr-10	****MIDTERM EXAM #3****	
12-Apr-10	Bottom-up regulation and energy flow	Dodson 9 (209-219), Mohamed and Taylor 2009
14-Apr-10	Aquatic resource management (Rusty Wright lecture)	Dodson 12 (298-311), Chao et al. 2008
16-Apr-10	Eutrophication	Dodson 10, 11 (201-202,244-245)
19-Apr-10	Eutrophication continued….	Smith and Schindler 2009
21-Apr-10	***STUDENT DEBATE***, Exam review	
23-Apr-10	****MIDTERM EXAM #4****	
26-Apr-10	Student presentations	
28-Apr-10	Student presentations, ***ARTICLE REPORT #4 DUE***	
30-May-10	Student presentations	
03-May-10	Exam review, ***FINAL COURSE EVALUATION***	
xx-May-10	Final Exam	

LIMNOLOGY LABORATORY: Tuesdays, 1:00pm-5:00pm, Swingle 301

LABORATORY REQUIREMENTS:
Fieldwork is a common part of most labs. Students should be prepared for work in lakes and streams by wearing appropriate clothing and wading boots (or old tennis shoes). Sampling equipment and transportation to the sites will be provided. Full participation is essential in order to learn the methodological techniques used by limnologists. Short quizzes on the afternoon's lab may precede or follow each lab. Field and lab data will be compiled into four formal lab reports (described below) and/or data presentations for select labs (see schedule).

SAFETY RULES & REGULATIONS FOR LIMNOLOGY:
Nothing can replace common sense and wise use of equipment, vehicles, and chemicals on the part of students to eliminate the chance of accidents. Students unsure of their ability to perform a task should not hesitate to ask for assistance from the instructor. Rules associated with limnology lab include…

- Life preservers will be provided and must be worn anytime you are on the water.
- Students should wear soled shoes (tennis shoes) or boots when they enter any waterbody.
- Transportation to the fisheries station or lake during class periods will be provided. Students should wear seat belts in the van.
- Students driving university vehicles must have a valid US driver's license and have successfully completed the AU van driving course.
- Spring electrical storms are common and can be dangerous. At the first sign of a thunderstorm, leave a waterbody and take refuge in your vehicle or the nearest building.
- Poisonous snakes and fire ants are occasionally encountered during field trips. Some people have an adverse reaction to bites by these animals. Symptoms may include: pain and swelling near the bites, dizziness, nausea, and difficulty breathing. Students bitten by a poisonous snake or that have an adverse reaction to ant bites should be taken immediately to the East Alabama Medical Center.
- It is difficult for the instructor to be aware of all equipment failures that require repairs. Students should alert the instructor to vehicles and equipment that need repair and should not use equipment if it is unsafe.
- Notify the instructor immediately of any accident resulting in damage to self, equipment, or vehicles.
- Exposure to the sun can result in skin cancer. Take appropriate precautions against sunburn by using sunscreen.

LAB REPORTS:
All lab reports should be turned in at the beginning of the following lab. The purpose of the lab reports is to give you practice in writing concise, accurate scientific reports with original conclusions and applications. Reference all sources of background information and methodological techniques. Reports incorrectly formatted will not be graded and will receive a 0.

Report format (≤ 4 pages total, 12 pt. font, double-spaced, 1" margins)

- Student name
- Laboratory title
- Introduction – background information and description of lab objectives and hypotheses
- Methods – include photos and diagrams, if needed
- Results – include figures and/or tables to present data, if needed
- Literature cited

LABORATORY SCHEDULE:

Lab date	Report due	Field?	Laboratory activity	Readings*
12-Jan-10		Field	Station tour; Pond sampling (S1) - light, O_2, temp profiles	handout, D lab 1
19-Jan-10	26-Jan-10	Field	Martin Hydropower Dam tour: **DEPART @ 12:15**	
26-Jan-10	02-Feb-10	Field	Drinking water and Wastewater Treatment plants **DEPART @ 12:45**	
02-Feb-10		Field	Tallapoosa reservoir sampling	
09-Feb-10		Lab	Chlorophyll analysis - extraction efficiencies test	handout
16-Feb-10		Lab	Zooplankton identification and enumeration	handout, W&L 11
23-Feb-10	02-Mar-10	Lab	Phytoplankton identification and enumeration	handout, W&L 10
02-Mar-10		Lab	Pond mapping and bathymetry- Fisheries pond S12	Welch 1
09-Mar-10		Field	Stream lab; fish and macroinvertebrate sampling	
16-Mar-10			SPRING BREAK - NO CLASS	
23-Mar-10		Field	Student projects – fieldwork	
30-Mar-10		Field	Student projects – fieldwork	
06-Apr-10		Lab	Student projects – labwork	
13-Apr-10	20-Apr-10	Field	Pond S1 limnological sampling	handout
20-Apr-10		Lab	***STUDENT PROJECT PRESENTATIONS***	
27-Apr-10		Lab	******LABORATORY FINAL EXAM******	

*Laboratory readings (available under FILES at https://moodle.acesag.auburn.edu:444/):
D lab = laboratory chapters (end of book) in Dodson, S. I. Introduction to Limnology. McGraw-Hill, 2004.
W&L = Wetzel, R. G., and G. E. Likens. Limnological Analyses. Spring-Verlag, Berlin. 2000.
Welch = Welch, P. S. Limnological Methods. McGraw-Hill, New York, 1948.