

COURSE: Spring 2011, FISH 5320/6320, Limnology and Limnology Laboratory, 4 credit hours

LECTURE: TR, 9:30am-10:45am, Comer 307, 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://kermit.acesag.auburn.edu:444/fisheries/>

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://kermit.acesag.auburn.edu:444/fisheries/>):

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. Springer-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 website.

Brooks, J. L. and S. I. Dodson. 1965. Predation, body size, and composition of plankton. *Science* **150**:28-35.

Carpenter, S. R., J. F. Kitchell, J. R. Hodgson, P. A. Cochran, J. J. Elser, M. M. Elser, D. M. Lodge, D. Kretchmer, X. He, and C. N. von Ende. 1987. Regulation of lake primary productivity by food web structure. *Ecology* **68**:1863-1876.

Elser, J. J., T. Andersen, J. S. Baron, A. K. Bergstrom, M. Jansson, M. Kyle, K. R. Nydick, L. Steger, and D. O. Hessen. 2009. Shifts in Lake N:P Stoichiometry and Nutrient Limitation Driven by Atmospheric Nitrogen Deposition. *Science* **326**:835-837.

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.

Forbes, S. A. 1887. The lake as a microcosm. *Bulletin of the Peoria Scientific Association*:77-87.

Hall, S. R., R. Smyth, C. R. Becker, M. A. Duffy, C. J. Knight, S. MacIntyre, A. J. Tessier, and C. E. Caceres. 2010. Why Are Daphnia in Some Lakes Sicker? Disease Ecology, Habitat Structure, and the Plankton. *Bioscience* **60**:363-375.

Heffernan, J. B., D. M. Leibowitz, T. K. Frazer, J. M. Evans, and M. J. Cohen. 2010. Algal blooms and the nitrogen-enrichment hypothesis in Florida springs: evidence, alternatives, and adaptive management. *Ecological Applications* **20**:816-829.

Porter, K. G. 1977. The plant-animal interface in freshwater ecosystems. *American Scientist* **65**:159-170.

Schindler, D. W., R. E. Hecky, D. L. Findlay, M. P. Stainton, B. R. Parker, M. J. Paterson, K. G. Beaty, M. Lyng, and S. E. M. Kasian. 2008. Eutrophication of lakes cannot be controlled by reducing nitrogen input: Results of a 37-year whole-ecosystem experiment. *Proceedings of the National Academy of Sciences of the United States of America* **105**:11254-11258.

- Smith, V. H. and D. W. Schindler. 2009. Eutrophication science: where do we go from here? *Trends in Ecology & Evolution* **24**:201-207.
- Titman, D. 1976. Ecological competition between algae - experimental confirmation of resource-based competition theory. *Science* **192**:463-465.
- Vaughn, C. C. 2010. Biodiversity Losses and Ecosystem Function in Freshwaters: Emerging Conclusions and Research Directions. *Bioscience* **60**:25-35.
- Verburg, P., R. E. Hecky, and H. Kling. 2003. Ecological consequences of a century of warming in Lake Tanganyika. *Science* **301**:505-507.
- Werner, E. E. and D. J. Hall. 1988. Ontogenetic habitat shifts in bluegill - the foraging rate predation risk trade-off. *Ecology* **69**:1352-1366.

GRADING:

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

<u>Activity</u>	<u>Points</u>	<u>Grading scale</u>
Lecture - Attendance and participation	5	A = 90-100%
Lecture - Research articles	5	B = 80-89%
Lecture - Quizzes	5	C = 70-79%
Lecture - Presentation	15	D = 60-69%
Lecture - Paper (graduate students only*)	15	F = 0-59%
Lecture - Midterm exams	50	
Lecture - Final exam	50	
Lab - Attendance and participation	5	
Lab - Secchi project presentation	5	
Lab - Final project presentation	15	
<u>Lab - Reports and final</u>	<u>5</u>	
Total points	160 (undergraduate students)	
	175 (graduate students*)	

UNDERGRADUATE PARTICIPATION & ASSIGNMENTS EXPECTATIONS:

The course grade will be based on participation in lecture and lab, research article evaluations, quizzes, several presentations, 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 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. Reports will be due via email before class on the due date. The instructor may use TurnItIn software to check for plagiarism.

(4) **LECTURE PRESENTATION**: All students will be required to give a 10 minute lecture reviewing a pre-defined limnological topic that the instructor provides. Each student will give a 5 minute lecture and provide an associated 1 page outline in the middle of the semester (see lecture calendar below) so that I can assist with the final presentation development. The students are expected to use the primary literature as references for this presentation.

(5) **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.

(6) **SECCHI DISK PROJECT PRESENTATION**: Each student will build their own Secchi disk during the first lab. Using this important limnological tool, each student will identify two different waterbodies in the Auburn area where they will measure Secchi depth weekly for the entire semester. During the final lab period, each student will present a short 5 minute lecture describing the Secchi depth patterns observed at their study sites highlighting possible mechanisms mediating changes in Secchi depth over time.

(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**: Two 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 six seminal limnological papers throughout the semester using creative teaching techniques, and (5) write a 5-page, well-cited, 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:

The Auburn University Oath of Honor (available at <http://auburn.edu/tigercub/>) clearly 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 expect all students to conduct themselves in my class with the Oath of Honor in mind. 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 under FILES at <https://kermit.acesag.auburn.edu:444/fisheries/>):

<u>Date</u>	<u>Lecture topic</u>	<u>Readings (pages)</u>
10-Jan	Course introduction and overview	
12-Jan	What is limnology?, History (Michael Chislock)	Dodson 1 (3-23); Forbes 1887
17-Jan	Lake bathymetry and morphometry; Origin of lakes; Lake types	Dodson 11 (265-290), Fee et al. 1996
19-Jan	Article discussion: Hall et al. 2010	Hall et al. 2010
24-Jan	Water as an environment, Viscosity and Reynold's numbers	Dodson 2 (29-38, 50-51)
26-Jan	Lake mixing, waves, currents, light, heat (Michael Chislock)	Dodson 2 (40-56)
31-Jan	Article discussion: Verburg et al. 2003,	Verburg et al. 2003
02-Feb	Seasonal mixing patterns, Oxygen cycle *ARTICLE REPORT #1*	Dodson 2 (43-45, 237-239)
07-Feb	Exam review	
09-Feb	**MIDTERM EXAM #1** (Michael Chislock)	None
14-Feb	Nutrient cycles; stoichiometry, *ARTICLE REPORT #1*	Dodson 10 (231-251); Schindler et al. 2008
16-Feb	Article discussion: Elser et al. 2009	Elser et al. 2009
21-Feb	Single-celled and colonial organisms	Dodson 3 (65-80)
23-Feb	Aquatic invertebrates	Dodson 4 (85-124), Vaughn 2010
28-Feb	Aquatic invertebrates, vertebrates, *COURSE EVAL*	Dodson 5 (85-138)
01-Mar	Plankton population dynamics	Dodson 6 (143-157), Porter 1977
06-Mar	Community ecology: competition *PROJECT OUTLINE DUE*	Dodson 7 (161-168)
08-Mar	Article discussion: Titman 1976, *ARTICLE REPORT #2*	Titman 1976
13-Mar	<u>SPRING BREAK - NO CLASS</u>	None
15-Mar	<u>SPRING BREAK - NO CLASS</u>	None
20-Mar	Community ecology: predation	Dodson 7 (168-182)
22-Mar	Article discussion: Werner and Hall 1988, *ARTICLE REPORT #3*	Werner and Hall 1988
27-Mar	Seasonal succession, trophic cascades, biomanipulation	Dodson 8 (189-205), Brooks and Dodson 1965
29-Mar	Article discussion: Carpenter et al. 1987	Carpenter et al. 1987
03-Apr	Bottom-up regulation and energy flow, Exam review	Dodson 9 (209-219)
05-Apr	**MIDTERM EXAM #2**	None

<u>Date</u>	<u>Lecture Topic</u>	<u>Readings (pages)</u>
10-Apr	Eutrophication	Dodson 10, 11 (201-202,244-245); Smith and Schindler 2008
12-Apr	Article discussion: Heffernan et al. 2010	Heffernan et al. 2010
17-Apr	Student presentations, *ARTICLE REPORT #4*	None
19-Apr	Student presentations, *GRAD STUDENT FINAL PAPER DUE*	None
24-Apr	Exam review	None
26-Apr	Reading day (no class)	None
xx-May	Final exam	All readings

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:

<u>Lab date</u>	<u>Report due</u>	<u>Field?</u>	<u>Laboratory activity</u>	<u>Readings*</u>
10-Jan		Lab	Limnological equipment build day	
17-Jan		Field	Pond sampling (S1) - light, O ₂ , temp profiles	handout, D lab 1
24-Jan	31-Jan	Field	Drinking water and Wastewater Treatment plants <u>DEPART @ 12:45</u>	
31-Jan		Field	Liming of S1 (Rusty Wright)	
07-Feb		Field	Chlorophyll analysis - extraction efficiencies test	
14-Feb	21-Feb	Lab	Martin Hydropower Dam tour: <u>DEPART @ 12:15</u>	
21-Feb		Lab	Zooplankton identification and enumeration	handout, W&L 11
28-Feb		Lab	Phytoplankton identification and enumeration *STUDENT PROJECT OUTLINES*	handout, W&L 10
06-Mar	20-Mar	Field	Primary productivity lab (24 hour lab)	
13-Mar			<u>SPRING BREAK - NO CLASS</u>	
20-Mar		Field	Stream lab; fish and macroinvertebrate sampling	
27-Mar		Field	Student projects – fieldwork/labwork	
03-Apr	10-Apr	Lab	AU Research Graduate Research Forum - AUHCC	
10-Apr		Field	Pond S1 limnological sampling	handout
17-Apr		Lab	*STUDENT PROJECT PRESENTATIONS*	
24-Apr		Lab	***LABORATORY FINAL EXAM***, **SECCHI DEPTH PRESENTATION**, *FINAL COURSE EVALUATION*	

*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.