COURSE: Spring 2017, FISH 5320/6320, Limnology, 3 credit hours

LECTURE: TR, 11:00am-12:15pm, Swingle 301, 3 credit hours

OFFICE HOURS: F, 8-10am or by appointment

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

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

TEACHING ASSISTANT: Edna Fernandez, Swingle 323, egf0013@auburn.edu

COURSE WEBSITE: available at https://www.dropbox.com/ (I will give you access to the class folder)

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 and presentations), (2) learn how to read and interpret the scientific literature, and (3) broaden your understanding of freshwater ecosystems (through lectures). 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 at https://www.dropbox.com/**)**:
1. Dodson, S. I. Introduction to Limnology. McGraw-Hill, 2004. Available at http://www.aubookstore.com/
2. 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.

Chaney, P. L., C. E. Boyd, and E. Polioudakis. 2012. Number, size, distribution, and hydrologic role of small impoundments in Alabama. Journal of Soil and Water Conservation **67**(2):111-121

Chislock, M. F, E. Doster, R. A. Zitomer, and A. E. Wilson. 2013. Eutrophication: causes, consequences, and controls in aquatic ecosystems. Nature Education **4**(4):10.

Dodds, W. K. 2006. Eutrophication and trophic state in rivers and streams. Limnology and Oceanography **51**(1):671-680.

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.

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.

Kawaguchi, Y., Y. Taniguchi, and S. Nakano. 2003. Terrestrial invertebrate inputs determine the local abundance of stream fishes in a forested stream. Ecology **84**(3):701-708.

Maavara, T., C. T. Parsons, C. Ridenour, S. Stojanovic, H. H. Durr, H. R. Powley, and P. Van Cappellen. 2015. Global phosphorus retention by river damming. Proceedings of the National Academy of Sciences USA **112**(51): 15603-15608.

Mekonnen, M. M. and A. Y. Hoekstra. 2016. Four billion people facing sever water scarcity. Science Advances **2**: e1500323

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

Schindler, D. W. 1974. Eutrophication and recovery in experimental lakes: Implications for lake management. Science **184**:897-899.

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.
Stein, R. A., D. R. DeVries, and J. M. Dettmers. 1995. Food-web regulation by a planktivore: exploring the generality of the trophic cascade hypothesis. Canadian Journal of Fisheries and Aquatic Sciences **52**: 2518-2526.
Stoks, R. and M. A. McPeek. 2003. Predators and life histories shape *Lestes* damselfly assemblages along a freshwater habitat gradient. Ecology **84**(6):1576-1587.
Titman, D. 1976. Ecological competition between algae - experimental confirmation of resource-based competition theory. Science **192**:463-465.
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 - Research article reports	10	A = 90-100%
Lecture - Presentation	35	B = 80-89%
Lecture - Paper (graduate students only*)	25	C = 70-79%
Lecture - Midterm exams	75	D = 60-69%
Lecture - Final exam	50	F = 0-59%
Total points	170 (undergraduate students) 195 (graduate students*)	

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

(1) *RESEARCH ARTICLES REPORTS*: To familiarize you with the primary limnological literature, students will be expected to survey articles in *Limnology and Oceanography*, *Ecology, Canadian Journal of Fisheries and Aquatic Sciences, Freshwater Biology,* or *Freshwater Science* and concisely (≤ 1 page) scientifically describe a different 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, flaws, and hyperlink to paper. 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.

(2) *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.

(3) *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.

(4) *LECTURE EXAM*: The closed-book final exam will be similar to the midterm exams and will be comprehensive.

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 four or five 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:
It is recommended 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. Students will also 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. Finally, students are encouraged to use an anonymous online survey form - http://wilsonlab.com/survey.htm

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 Student Academic Honesty Code (available at https://sites.auburn.edu/admin/universitypolicies/Policies/AcademicHonestyCode.pdf) clearly defines the university's honesty code. I expect all students to conduct themselves in my class with this Code 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 (available at https://www.dropbox.com/**):**

Date	Lecture topic	Readings (pages)
12-Jan	Course introduction and overview	
17-Jan	What is limnology?, History	Dodson 1 (3-23); Forbes 1887
19-Jan	Lake bathymetry and morphometry	Dodson 11 (265-290), Fee et al. 1996
24-Jan	Origin of lakes; Lake types	Chaney et al. 2012
26-Jan	Water as an environment, Viscosity and Reynold's numbers	Dodson 2 (29-38, 50-51)
31-Jan	Lake mixing, waves, currents, light, heat (ALAN IN CA) https://auburn.zoom.us/j/9922610946	Dodson 2 (40-56)
02-Feb	Article discussion: Verburg et al. 2003 (ALAN IN CA) https://auburn.zoom.us/j/9922610946	Verburg et al. 2003
07-Feb	Seasonal mixing patterns, Oxygen cycle ***ARTICLE REPORT #1***	Dodson 2 (43-45, 237-239)
09-Feb	Exam review	
14-Feb	****MIDTERM EXAM #1****	None
16-Feb	Nutrient cycles; stoichiometry	Dodson 10 (231-251); Schindler 1974; Schindler et al. 2008
21-Feb	Article discussion: Maavara et al. 2015	Maavara et al. 2015
23-Feb	Single-celled and colonial organisms	Dodson 3 (65-80)
28-Feb	Aquatic invertebrates (ALAN/EDNA at ASLO) https://auburn.zoom.us/j/9922610946	Dodson 4 (85-124), Stoks and McPeek 2003
02-Mar	Aquatic invertebrates, vertebrates, (ALAN/EDNA at ASLO) https://auburn.zoom.us/j/9922610946	Dodson 5 (85-138)
07-Mar	Plankton population dynamics, ***ARTICLE REPORT #2***	Dodson 6 (143-157), Porter 1977
09-Mar	Community ecology: competition ***PROJECT OUTLINE DUE***, ***MIDTERM COURSE EVAL***	Dodson 7 (161-168)
14-Mar	SPRING BREAK – NO CLASS	Have fun!
16-Mar	SPRING BREAK – NO CLASS	Be careful!
21-Mar	Article discussion: Titman 1976	Titman 1976
23-Mar	Community ecology: predation	Dodson 7 (168-182)
28-Mar	Seasonal succession, trophic cascades, biomanipulation	Dodson 8 (189-205), Brooks and Dodson 1965

Date	**Lecture Topic**	**Readings (pages)**
30-Mar	Article discussion: Mekonnen and Hoekstra 2016**, *ARTICLE REPORT #3*** (ALAN IN PR)	Mekonnen and Hoekstra 2016
04-Apr	Bottom-up regulation and energy flow	Dodson 9 (209-219), Kawaguchi et al. 2003
06-Apr	Bottom-up continued, Exam review	None
11-Apr	****MIDTERM EXAM #2****	None
13-Apr	AU Student research symposium (AUHCC)	None
18-Apr	Eutrophication	Dodson 10, 11 (201-202,244-245); Chislock et al. 2013; Smith and Schindler 2009
20-Apr	Student presentations, ***ARTICLE REPORT #4***	None
25-Apr	Student presentations, ***GRAD STUDENT FINAL PAPER DUE***	None
27-Apr	Exam review	None
04-May	Final exam – 12:00pm-2:30pm	All readings

COURSE: Spring 2017, FISH 5321/6321, Limnology Laboratory, 1 credit hour

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

OFFICE HOURS: F, 8-10am or by appointment

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

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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 practice and develop your critical thinking skills (through in-class group discussions, presentations, and laboratory exercises) and broaden your understanding of freshwater ecosystems. 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.

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.

REQUIRED READINGS (available at https://www.dropbox.com/**)**:

1. Select chapters from Wetzel, R. G., and G. E. Likens. Limnological Analyses. Spring-Verlag, Berlin. 2000, will be used for some laboratory exercises. These chapters will be made available to the students on dropbox.

GRADING:

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

Activity	**Points**	**Grading scale**
Lab - Secchi disk project presentation	20	A = 90-100%
Lab - Final lab project presentation	40	B = 80-89%
Lab - Final lab project report (grads only)*	20	C = 70-79%
Lab - Lab reports	10	D = 60-69%
Lab - Final	10	F = 0-59%
Total points	80 (undergraduate students) 100 (graduate students*)	

UNDERGRADUATE PARTICIPATION & ASSIGNMENTS EXPECTATIONS:

The course grade will be based on participation in lab, several presentations, lab reports, and a final exam as described below:

(1) *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.

(2) *FINAL LAB PROJECT PRESENTATION*: Students will develop and conduct a lab project where chlorophyll *a* or another easily measured parameter is the response variable. Students will be required to provide a simple outline of their project idea midway through the semester. All students are encouraged to discuss their ideas with the me well before their outlines and projects are due.

(3) *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. 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.

Report format (≤ 2 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

(4) *LAB FINAL EXAM*: The comprehensive field final exam will cover all aspects of past lab activities. 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, and (4) write a 2-page, well-cited, single-spaced, paper supporting their final lab project presentation.

LAB ATTENDANCE & BEHAVIOR:
It is recommended to attend lab and engage in discussions and group projects. If you choose not to attend lab on any day, then you accept the responsibility to learn the material on your own. If you have a question during the lab 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 lab 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.

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ACADEMIC HONESTY:
The Auburn University Student Academic Honesty Code (available at https://sites.auburn.edu/admin/universitypolicies/Policies/AcademicHonestyCode.pdf) clearly defines the university's honesty code. I expect all students to conduct themselves in my class with this Code 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.

LABORATORY SCHEDULE:

Lab date	Report due	Field?	Laboratory activity	Readings*
17-Jan		Lab	Limnological equipment build day	handout
24-Jan		Field	Pond sampling (S1) - light, O_2, temp profiles	handout
31-Jan	04-Feb	Field	Opelika drinking water (2pm – George Sumrall) and wastewater (3pm – Derrick Askew) plants ALAN IN CA	
07-Feb	11-Feb	Field	Martin Hydropower Dam tour: **DEPART @ 12:15**	
14-Feb	18-Feb	Field	Chlorophyll analysis - extraction efficiencies test	handout
21-Feb		Lab	Zooplankton identification and enumeration	handout, W&L 11
28-Feb		Field	Electroshocking with Rusty Wright ALAN AND EDNA AT ASLO	
07-Mar		Lab	Phytoplankton identification and enumeration ***STUDENT PROJECT OUTLINES***	handout, W&L 10
14-Mar			SPRING BREAK - NO CLASS	
21-Mar	25-Mar	Lab	Guest lab by Dr. Arevik Minasyan	
28-Mar		Field	Pond sampling (S1) - light, O_2, temp profiles	handout
04-Apr		Field/Lab	Project preparation time	
11Apr		Field/Lab	Project preparation time	
18-Apr	22-Apr	Lab	ADEM tour with Chris Johnson	
25-Apr		Lab	***STUDENT PROJECT PRESENTATIONS*** **SECCHI DEPTH PRESENTATION** *FINAL COURSE EVALUATION*	

*Laboratory readings (available under FILES at https://www.dropbox.com/):
W&L = Wetzel, R. G., and G. E. Likens. Limnological Analyses. Spring-Verlag, Berlin. 2000.