

**COURSE:** Spring 2022, FISH 5320/6320, Limnology, 3 credit hours

**LECTURE:** Tuesday and Thursdays, 11:00am-12:15pm, Swingle 301, 3 credit hours

**OFFICE HOURS:** Fridays, 8:00-10:00am or by appointment

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

**INSTRUCTOR:** Dr. Alan Wilson, Swingle 321, [wilson@auburn.edu](mailto:wilson@auburn.edu), 334-246-1120

**TEACHING ASSISTANT:** Matt Gladfelter, Swingle 323, [mfg0017@auburn.edu](mailto:mfg0017@auburn.edu)

**ZOOM:** We will use Zoom for remote course participants. You can access Zoom via Canvas =

**COURSE WEBSITE:** available in Canvas

### **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.

- Belfiore, A., R. P. Buley, E. G. Fernandez-Figueroa, M. Gladfelter, and A. E. Wilson. 2021. Zooplankton as an alternative method for controlling phytoplankton in catfish pond aquaculture. *Aquaculture Reports* 21:100897.
- 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.
- Domis, L. N. D., J. J. Elser, A. S. Gsell, V. L. M. Huszar, B. W. Ibelings, E. Jeppesen, S. Kosten, W. M. Mooij, F. Roland, U. Sommer, E. Van Donk, M. Winder, and M. Lurling. 2013. Plankton dynamics under different climatic conditions in space and time. *Freshwater Biology* 58:463-482.
- 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.
- Glibert, P. M., F. P. Wilkerson, R. C. Dugdale, J. A. Raven, C. L. Dupont, P. R. Leavitt, A. E. Parker, J. M. Burkholder, and T. M. Kana. 2016. Pluses and minuses of ammonium and nitrate uptake and assimilation by phytoplankton and implications for productivity and community composition, with emphasis on nitrogen-enriched conditions. *Limnology and Oceanography* 61:165-197.
- 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.
- Orihel, D. M., H. M. Baulch, N. J. Casson, R. L. North, C. T. Parsons, D. C. M. Seckar, and J. J. Venkiteswaran. 2017. Internal phosphorus loading in Canadian fresh waters: a critical review and data analysis. *Canadian Journal of Fisheries and Aquatic Sciences* 74:2005-2029.

- 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.
- 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.
- Verburg, P., R. E. Hecky, and H. Kling. 2003. Ecological consequences of a century of warming in Lake Tanganyika. *Science* 301:505-507.
- Woolway, R. I., B. M. Kraemer, J. D. Lenters, C. J. Merchant, C. M. O'Reilly, and S. Sharma. 2020. Global lake responses to climate change. *Nature Reviews Earth & Environment* 1:388-403.

## 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> |
|--------------------------------------|------------------------------|----------------------|
| Research article reports (4 x 5 pts) | 20                           | A = 90-100%          |
| Presentation                         | 35                           | B = 80-89%           |
| Paper (graduate students only*)      | 25                           | C = 70-79%           |
| Midterm exams                        | 100                          | D = 60-69%           |
| <u>Final exam</u>                    | 50                           | F = 0-59%            |
| Total points                         | 205 (undergraduate students) |                      |
|                                      | 230 (graduate students*)     |                      |

## UNDERGRADUATE PARTICIPATION & ASSIGNMENTS EXPECTATIONS:

The course grade will be based on participation in lecture, research article evaluations, 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*, or *Freshwater Science* and concisely ( $\leq 1$  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 ( $\leq 5$  minutes) present their paper to the class. Reports will be uploaded to canvas 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 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-pages of text, 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 - <https://goo.gl/forms/ut92HzlhHOUtfxm62>

## **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/universypolicies/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.

## COVID-19 ADDITIONAL INFORMATION

- Health and Participation in Class
  - Your health and safety, and the health and safety of your peers, are our top priorities. If you are experiencing any symptoms of COVID-19, or if you discover that you have been in close contact with others who have symptoms or who have tested positive, you must follow University guidelines. If you are feeling ill or if you have been exposed to someone with the virus, stay home to protect others.
  - Please do the following in the event of an illness or COVID-related absence:
    - Notify me in advance of your absence, if possible
    - Provide me with medical documentation, if possible
    - Keep up with coursework as much as possible
    - Participate in class activities and submit assignments remotely as much as possible
    - Notify me if you require a modification to the deadline of an assignment or exam
    - Finally, if remaining in a class and fulfilling the necessary requirements becomes impossible due to illness or other COVID-related issues, please let me know as soon as possible so we can discuss your options.
  - Students with questions about COVID-related illnesses should reach out to the COVID Resource Center at (334) 844-6000 or at [ahealthieru@auburn.edu](mailto:ahealthieru@auburn.edu).
- Health and Well-Being Resources
  - COVID Response Team (<https://ahealthieru.auburn.edu/>)
  - Student Counseling and Psychological Services (<http://wp.auburn.edu/scs/>)
  - AU Medical Clinic (<https://cws.auburn.edu/aumc/>)
  - If you or someone you know are experiencing food, housing or financial insecurity, please visit the Auburn Cares Office (<http://aucares.auburn.edu/>)
- A Healthier U Campus Community Expectations
  - We are all responsible for protecting ourselves and our community. Please read about student expectations for spring semester (<https://ahealthieru.auburn.edu/>).
- Course Expectations Related to COVID-19:
  - **Face Coverings:** As a member of the Auburn University academic community you are required to follow all university guidelines for personal safety with face coverings, physical distancing, and sanitation. Face coverings are required in this class and in all campus buildings. Note that face coverings must meet safety specifications, be worn correctly, and be socially appropriate. You are required to wear your face coverings at all times when indoors (<https://sites.auburn.edu/admin/universitypolicies/Policies/UsageOfFaceCoveringsPolicy.pdf>). If you remove your face covering or are non-compliant with the university's policies, you will be instructed to leave the classroom and will be held to the protocols outlined in the [Auburn University Policy on Classroom Behavior](https://sites.auburn.edu/admin/universitypolicies/Policies/PolicyonClassroomBehavior.pdf) (<https://sites.auburn.edu/admin/universitypolicies/Policies/PolicyonClassroomBehavior.pdf>). Any student who willfully refuses to wear a face covering and does not have a noted accommodation may be subject to disciplinary action.
  - **Physical Distancing:** Students should observe appropriate physical distancing and follow all classroom signage/avoid congregating around doorways before or after class. If the instructional space has designated entrance and exit doors, you should use them. **Students should exit the**

**instructional space immediately after the end of instruction to help ensure social distancing and allow for the persons attending the next scheduled class session to enter.**

- **Course Attendance:** If you are quarantined or otherwise need to miss class because you have been advised that you may have been exposed to COVID-19, you will be expected to develop a plan to keep up with your coursework during any such absences.
- **Course Meeting Schedule:** This course might not have a traditional meeting schedule in spring 2022. Be sure to pay attention to any updates to the course schedule as the information in this syllabus may have changed. Please discuss any questions you have with me.
- **Technology Requirements:** This course may require particular technologies to complete coursework. If you need access to additional technological support, please contact the AU Bookstore at [aubookstore@auburn.edu](mailto:aubookstore@auburn.edu).

*Disruptive or concerning classroom behavior involving the failure to wear a face covering, as directed by Auburn University, represents a potential Code of Student Conduct violation and may be reported as a non-academic violation. Please consult the [Classroom Behavior Policy](https://sites.auburn.edu/admin/universitypolicies/Policies/PolicyonClassroomBehavior.pdf) (<https://sites.auburn.edu/admin/universitypolicies/Policies/PolicyonClassroomBehavior.pdf>).*

- Course Delivery Changes Related to COVID-19
  - Please be aware that the situation regarding COVID-19 is frequently changing, and the delivery mode of this course may adjust accordingly. In the event that the delivery method is altered, please be assured that the learning goals and outcomes of the course will not change; however, some aspects of the course will change in terms of the mode of delivery, participation, and testing methods. Those details will be shared via Canvas as soon as possible. Please be prepared for this contingency by ensuring that you have access to a computer and reliable Internet.

**LECTURE SCHEDULE** (available in Canvas)

| <b>Date</b>   | <b>Lecture topic</b>   | <b>Readings (pages)</b>                                  |
|---------------|--|--|
| 13-Jan        | Course introduction and overview   | none   |
| 18-Jan        | What is limnology?, History  | Dodson 1 (3-23); Forbes 1887                             |
| 20-Jan        | Lake bathymetry and morphometry  | Dodson 11 (265-290); Fee et al. 1996                     |
| 25-Jan        | Origin of lakes; Lake types  | Chaney et al. 2012                                       |
| 27-Jan        | Water as an environment, Viscosity and Reynold's numbers   | Dodson 2 (29-38, 50-51)                                  |
| 01-Feb        | Lake mixing, waves, currents, light, heat  | Dodson 2 (40-56)   |
| 03-Feb        | Article discussion: Verburg et al. 2003 and Woolway et al. 2020  | Verburg et al. 2003; Woolway et al. 2020                 |
| 08-Feb        | Seasonal mixing patterns, Oxygen cycle<br><b>*ARTICLE REPORT #1*</b>   | Dodson 2 (43-45, 237-239)                                |
| 10-Feb        | Seasonal mixing patterns, Oxygen cycle continued   | Dodson 2 (43-45, 237-239)                                |
| 15-Feb        | Nutrient cycles; stoichiometry <b>(MATT LECTURE)</b>   | Dodson 10 (231-251); Schindler 1974; Glibert et al. 2015 |
| 17-Feb        | Single-celled and colonial organisms   | Dodson 3 (65-80)   |
| 22-Feb        | Article discussion: Orihel et al. 2017   | Orihel et al. 2017                                       |
| 24-Feb        | Aquatic invertebrates, exam review   | Dodson 4 (85-124)  |
| 01-Mar        | <b>**MIDTERM EXAM #1**</b> <b>ALAN AT WAS</b>  | none   |
| 03-Mar        | Aquatic invertebrates, vertebrates, <b>*PROJECT OUTLINE DUE*</b> ,<br><b>*MIDTERM COURSE EVAL*</b> <b>ALAN AT WAS</b><br><b>(MATT LECTURE)</b> | Dodson 5 (85-138)  |
| 08-Mar        | <b>SPRING BREAK – NO LAB</b>   | none   |
| 10-Mar        | <b>SPRING BREAK – NO LAB</b>   | none   |
| 15-Mar        | Plankton population dynamics   | Dodson 6 (143-157); Porter 1977; Domis et al. 2013       |
| 17-Mar        | Community ecology: competition, <b>*ARTICLE REPORT #2*</b><br><b>(MATT LECTURE)</b>  | Dodson 7 (161-168)                                       |
| 22-Mar        | Article discussion: Titman 1976  | Titman 1976  |
| 24-Mar        | Community ecology: predation   | Dodson 7 (168-182)                                       |
| 29-Mar        | Seasonal succession, trophic cascades, biomanipulation   | Dodson 8 (189-205); Brooks and Dodson 1965               |
| 31-Mar        | Article discussion: Belfiore et al. 2021, <b>*ARTICLE REPORT #3*</b>   | Belfiore et al. 2021                                     |
| 05-Apr        | Bottom-up regulation and energy flow   | Dodson 9 (209-219)                                       |
| 07-Apr        | Bottom-up regulation and energy flow continued   | Dodson 9 (209-219); Kawaguchi et al. 2003                |
| 12-Apr        | Eutrophication, exam review <b>(MATT LECTURE)</b>  | Dodson 10, 11 (201-202,244-245); Chislock et al. 2013    |
| 14-Apr        | <b>**MIDTERM EXAM #2**</b>   | none   |
| 19-Apr        | Eutrophication continued   | Smith and Schindler 2009                                 |
| 21-Apr        | Student presentations- <b>RECORDED</b> , <b>*ARTICLE REPORT #4*</b>  | none   |
| 26-Apr        | Student presentations- <b>RECORDED</b> , <b>*GRAD STUDENT FINAL PAPER DUE*</b>   | none   |
| <b>XX-Apr</b> | Final exam – TBD   | All readings   |