BIOL 4650 – Freshwater Ecology

California State University Stanislaus
Fall 2019

I. General Information

Tues. 12:30-1:45pm (lecture)
Thurs. 9:30-12:15 (lab), 12:30-1:45pm (lecture)
Room: Naraghi Hall 210
Instructor: Dr. Matthew Cover
Office Hours: In N273: Tuesday 11:00-12:00, Thursday 2:30-3:30, or by appointment.
Email: mcover@csustan.edu
Email is the best way to reach me. I usually respond to email within 24 hours (except on weekends). Please include "BIOL 4650" or "Freshwater Ecology" in the subject line, otherwise your email may get mis-filed and I may not respond.
Personal Website: http://www.matthewrcover.com
Twitter: https://twitter.com/matthewrcover
Communication: Please check your csustan email on a regular basis, ideally every day.

II. Course Description

From the course catalog: (4 Units) The biota of fresh water with emphasis on the ecology, identification, physiology, and behavior of aquatic organisms. Prerequisites: BIOL 1050, BIOL 1150, CHEM 1100, and CHEM 1110, or equivalents. (Lecture, 3 hours; laboratory, 3 hours; field trips) (Fall)
This course will focus on the ecology of freshwater ecosystems, as opposed to marine or brackish water habitats (which are covered in marine biology courses). In particular, we will focus our time on lotic (flowing water) habitats, such as rivers and streams, but we will also compare lotic and lentic (still-water) habitats, such as lakes and ponds. Rivers and streams are among the most dynamic and heterogeneous of ecosystems on earth, making them very exciting habitats to study. Flowing water is the fundamental process structuring lotic ecosystems, and a large part of our time will be spent trying to understand the ways in which the movement of water (hydrology) affects the ecology and evolution of aquatic biota.

Does this course count for me?
If your catalog year is 2011-2017:

- Education Concentration: satisfies the Ecology requirement
- Molecular/Microbial Concentration: satisfies the Ecology requirement

- Organismal Concentration: satisfies the Ecology requirement
- Ecology Concentration: satisfies the Second Ecology course requirement
- General Biology Concentration: this course does not meet any requirements!

If your catalog year is 2018-2019:

- No Concentration: counts as elective units
- Organismal, Ecological, and Evolutionary Biology: satisfies the (second) Ecology requirement, or counts as elective units
- Molecular, Cellular, and Microbial Biology: this course does not count!

Because this course is focused on the particular biota, habitats, and ecological processes in freshwater ecosystems, we necessarily do not cover basic ecological concepts and terrestrial ecosystems in as much detail as Ecology (BIOL 3680). Thus, students interested in learning about general ecological concepts are encouraged to take BIOL 3680 as well. This course is designed for upper division biology majors and graduate students, although students from other science majors or related majors (e.g., geography, chemistry) will also be successful provided they have a background in general biology (e.g., BIOL 1050, BIOL 1150). This class also assumes that students have college-level writing skills. Proficiency in math/stats/quantitative skills and computer skills will also be useful, as we will be doing a variety of calculations and analyses during lab and as part of homework assignments. At a minimum, students should be comfortable manipulating and analyzing data in spreadsheets.

Why take this course? In a general sense, knowledge of ecology, including the ecology of organisms, communities, and ecosystems, helps to make you a well-rounded biologist. More specifically, freshwater ecosystems are one of the most intriguing ecosystems to study because of their tremendous complexity. At a more practical level, this class can help to prepare you for a career as a freshwater ecologist. California (and the world) will continue to have tremendous problems related to water supply, fisheries, environmental quality, and flood control. Among ecology-related fields, there is a large demand for scientists with expertise in aquatic ecology. Potential employers include a number of federal agencies (USFWS, NMFS, USEPA, USGS, USBR), state agencies (CDFW, SWRCB, CalEPA), engineering and scientific consulting firms, and non-profit organizations. This course is designed to give you a broad foundation in the science of freshwater science, as well as the research experience and communication skills to help you become a professional scientist. Once you complete this course, I can recommend grad programs, internships, jobs, and other experiences that will prepare you for a career in the field of aquatic ecology.

III. Required Texts and Materials

- All course readings will be available in the course **reader,** via class handouts, or distributed electronically.
- We will make extensive use of online resources, including google drive and associated apps. You will need regular (daily) **internet** and computer access. We will often use computers in class; I'll announce those days ahead of time, and encourage you to bring a laptop. If you don't have a laptop don't worry; we will have department laptops you can use during class.
- You will need a **notebook** devoted to this course to hold your class notes, notes taken on readings, notes taken during laboratory exercises, notes and data taken during field trips, etc. I may collect or ask to see your notebooks during the course in order to assess your learning, so please keep all of your notes and work in one place. Everything you do for this class will either be in your notebook or in your own google drive folder. I highly recommend a hardbound notebook that is a bit smaller than standard paper, 5-6" wide and 8-9" tall.
- Field attire: for field trips we will be entering streams and rivers (no further than knee deep). You can wear athletic shoes that you don't mind getting wet, or sport sandals that drain and dry quickly (flip flops are generally not recommended, because they don't have stability or support on slippery rocks), or rubber boots/waders if you have them. Shorts will usually be better than pants. Be prepared on field trips for a range of weather conditions, from hot and sunny (sun block, hats, breathable clothing) to cool and wet (jacket and possibly rain gear).

IV. Course Goals

This course has two main goals. Each goal has several learning objectives.

1. <u>Learning the Science of Freshwater Ecology</u>
    a. Describe major concepts from organismal, population, community, and ecosystem ecology, and apply these concepts to freshwater ecosystems and organisms.
    b. Describe how the physical and chemical processes of flowing water are related to the structure and function of river ecosystems and their biota. Predict the morphology and function of freshwater ecosystems based on the physical setting (climate, terrain, drainage area, land use, etc.), with a focus on California geography.
    c. Describe the ecology and basic biology (life cycles, morphology, feeding and metabolism) of the most common types of organisms that inhabit freshwater

habitats (bacteria, fungi, algae, invertebrates (especially insects), fish, amphibians…)

d. Understand and map the relations within the multidisciplinary field of freshwater science, in terms of the various disciplinary science perspectives and the connections with water resources management and societal relations to freshwater ecosystems.

2. Science and Society: Developing Research, Communication, and Collaboration Skills
    a. Analyze and interpret primary scientific research articles.
    b. Apply field and laboratory techniques for surveying the physical habitat, aquatic biota, and ecological processes of freshwater ecosystems.
    c. Analyze and display biological and environmental data using graphical (scatter plots, box and whisker plots) and statistical techniques (regression, t-tests/ANOVA).
    d. Synthesize and communicate existing and novel information from a variety of sources and types (quantitative, qualitative) to produce new understandings of freshwater ecosystems using multimedia (text, photo, video, audio, oral presentations).
    e. Share and revise your work in response to feedback from your peers, the instructor, and members of the local and scientific community.

V. Expectations

- Every day in class you will be:
    - Talking with your partner, with your group, and the class
    - Writing (free writes, notes, assignments and quizzes)
    - Collaborating and dialoguing with your classmates learn from each other
- Treat everyone in our class with respect and kindness. In order to create a thriving learning community it is important that we actively welcome each other to the classroom and show our appreciation for each other's contribution.
- We will frequently be using computers and internet resources in class, so you will often have your laptops, tablets, and phones out. However, please do not text, email, facebook, snapchat, etc. while we are actively engaged in class activities. Of course, you are more than welcome to do any of those things during breaks or down time, provided you can reorient to the class activities when it is time to refocus. If you have other responsibilities that can't wait until class is over, please discreetly step outside the classroom to do your business. You do not need to ask my permission to leave the classroom.
- This is a field, lab, and collaboration-intensive course that requires a high degree of maturity, self-sufficiency, and cooperation relative to many other classes you have

taken. Although you will be doing activities you have never done before, you should never feel scared or unsafe. If so, please let the instructor know immediately. You have a responsibility to others to act safely and not put others in harm.

- Much of your learning will take place outside of the classroom as you carefully read and analyze the assigned texts, and work with data and information. Class periods will be focused on reinforcing the concepts covered in readings through discussions and applying the concepts during activities. It is very important that you come to class properly prepared by doing the required readings. I expect for most students you will need to spend ~5 hours each week doing the readings and working on homework on your own.
- Part of being a good scientist is making good observations. Your success in this course will depend on how well you can make observations, efficiently and accurately record your data, and relate your observations to other physical, chemical, and biological information. This requires constantly switching your focus between different organisms and processes at a huge range of spatial (microns to kilometers) and temporal scales (milliseconds to millennia). The only way to gain these observational and critical thinking skills is through dedicated practice.
- One key to learning and growing as a scientist and human is being able to monitor and reflect on your own learning. In this class, I will frequently ask you to honestly reflect on how you have engaged with the class, and provide feedback to yourself and to me about what you have learned and what activities are most conducive to your learning. I expect you to take these reflections and self-assessments seriously, and to be honest about your efforts, challenges, and successes.

VI. Activities and Assessment

Throughout the semester you will be completing learning activities, tracking your progress, and reflecting upon your own learning. There are several required types of activities all students need to be engaged in to meet the learning goals; however, there is some flexibility and optional activities you will choose from to advance your learning and meet your own goals. I want you to feel like you have agency to design this course that will work for you, so please let me know if you have ideas for other activities you'd like to pursue.

1. *Core Readings*

Each week we will all read 1 or 2 assigned readings from the course reader. For each assigned reading, complete a Reading Response (RR). This can either be in your notebook or as a google doc in your google drive folder. Whichever option you choose, you need to be

able to access and add to your RR during class time. At a minimum, your RR will be comprised of responses to the following questions:

1. A mini-outline of the reading, based on your own understanding. How is the reading organized, and what are the major components, concepts, and themes? Your outline should have at least two hierarchical levels, and can be written in bullet-point style (not complete sentences).
2. What lingering questions do you have for the author(s) of the reading? This could be regarding anything from the concepts to the examples to the approaches/methodologies to the reasons for writing to the background of the author(s) to the organization…
3. What from this reading can you apply to your case study, or to your own learning and interests? It could be a method, an important concept or finding, a new way of looking at a freshwater ecosystem…
4. What from the reading is most impactful for you? For example, after you put the reading down and go for a walk, or the next day, what particular aspects do you remember? These may or may not be part of your outline of the main components (question 2); they may in fact be relatively minor methodological approaches, names, new terminology, how the reading was written, etc.

The reason for doing the RR is to help us make sense of, reinforce, and apply the ideas in the readings. Research shows that by writing about the information we have read it helps us to recall the information much more efficiently.

2. Mini Literature Review

In addition to the articles and chapters we read together as part of the Core Readings, you will select a specific topic within the field of freshwater ecology (broadly defined) and do a mini-literature review (LR) on that topic. This will involve finding and reading a minimum of four peer-reviewed journal articles that describe original research (not review papers). All four papers should be closely related to one topic. You will make an article outline for each paper (to be discussed in class), and then write a two page synthesis that analyzes and compares the four papers.

3. Learning Journal and Self Assessment

I strongly believe that learning is most impactful when we take the time to consciously reflect on what we have learned and experienced. Every ~~two~~ three weeks I will ask you to write a 1-page (single-spaced) narrative on a google doc that provides a reflection on your experience in this class (Learning Journal - LJ). Initially, your narrative will describe expectations and hopes for the class in relation to your academic and professional goals, as well as your proposed assignments, activities, and grading policy. Subsequent LJ entries will recount your activities for this class, and reflect upon your learning. At the end of the

semester, you will write a 3-page narrative that describes your progress on the course learning objectives, summarizes your intellectual and professional growth, and reflects on the course activities that have been the most impactful. As part of this essay you will assign yourself a letter grade for the course and discuss the evidence for your self-assessment, based on your progress on the learning objectives and completion of class activities.

4. Class and Lab activities

Every day in class and lab we will be doing a variety of activities. You should keep all of your notes from these activities in your class notebook.

5. Quizzes, Exams

We will periodically do quizzes and exams to assess our learning. These will include a range of question types, from recalling the names of organisms, to short answer questions and diagrams that ask you to explain or draw a concept in your own words, to longer essay questions that ask you to apply information to a research question.

- Midterm exam: covering concepts from core readings
- Bug Identification exam: identify 15 common taxa of freshwater invertebrates.

6. Field Study

You will work as part of a team to complete a field study of one particular freshwater ecosystem. I have devised several projects to choose from. The goals, activities, and schedule vary for each project. Alternatively, you can propose your own project, provided you can demonstrate that it is well conceived and feasible, and meets the same goals as the projects I have devised.

1. **Red Hills.** The Red Hills are about 1 hour north-east of Turlock, near the town of Jamestown. The team will conduct monthly surveys (Sept., Oct., Nov.) of habitat conditions, and population surveys of the Red Hills roach, an endemic fish. The team will complete a survey of the freshwater invertebrate community (sampling in class on Thursday, September 12), produce a species list, and compare the community to other streams. Expectations: three ~4 hour field trips. First trip will be led by Dr. Cover during the Thursday class time; subsequent trips will be organized by the team.

2. **Del Puerto Canyon.** Del Puerto Canyon is west of Paterson, about 45 minutes from Turlock. The team will survey habitat conditions and the freshwater invertebrate community at three sites. One field trip on Tuesday September 10 (meet in Paterson at 9am; return to campus by 1:30pm). The team will identify invertebrates and compare communities among three sites and two different sample dates: June and

September (6 samples total). Expectations: 1 four-hour field trip; additional lab time will likely be required during open lab hours (~2 hours/week).

3. **Lagunitas Creek.** Lagunitas Creek is in Marin County, north of San Francisco, and about 3 hours away from Turlock. Lagunitas Creek has one of the most important and most southerly populations of coho salmon in California. Just last month, an invasive species, the New Zealand mud snail, was discovered in Lagunitas Creek. This team will survey the extent of the invasion, and collect macroinvertebrate samples from throughout the watershed to determine the existing and potential impacts of the invasive species. One all-day field trip: Saturday, September 28, 7am-7pm. At the end of the semester, you will make a website and video conference presentation to scientists and managers who work in the Lagunitas Creek watershed.

4. **Tuolumne River.** The Tuolumne River begins in the mountains of the Sierra Nevada and flows into the valley through Modesto. We will visit a location in Waterford, 30 minutes from campus. This river has lots of human impacts, such as dams and agricultural and urban pollution, but remains an important habitat for chinook salmon and many other aquatic species. This team will make a field trip on Thursday, September 19, and make one more visit to the river to collect more data and observations, then will design and lead a ~2 hour field trip for local high school students, to teach them about the river and freshwater ecology. (This project combines the communication requirement, below). Trip dates TBD, but probably a Thursday during class time or a Saturday morning.

5. ~~**Mount Diablo.** Mount Diablo is a high peak in the eastern Bay Area, west of Tracy and near Concord and Walnut Creek. Most of the streams on Mount Diablo dry up in the summer, but we will visit one or two springs that have water most or all of the year. One field trip, probably the afternoon of Friday September 20 (leaving campus around 12 noon, getting back around 7pm). We will survey the stream invertebrates, and compare our samples to several years of collections I have made there. Participants should also be available to attend the Save Mount Diablo Science Colloquium, Thursday December 12, in Berkeley, to help share our results (this satisfies the Science communication portion of the class).~~

7. Communication Project

To meet the learning goals of practicing the communication of science to the public or a larger audience, everyone will engage in one science communication project. Choose from

one of these five options, or develop your own, with instructor permission. Requirement: communicating freshwater ecology to a wider audience than this class

1. **Tuolumne River** field trip and freshwater ecology lessons for high school students (described above). Only for Tuolumne River field study.
2. ~~**Save Mount Diablo** science colloquium (described above)- only for Mount Diablo field study.~~
3. **Lagunitas presentation** (described above)- only for Lagunitas field study
4. **Wikipedia article**: write an addition to an existing Wikipedia article related to freshwater ecology, or create a new article from scratch. Participants in this activity will go through learning modules developed by Wikipedia to help you learn how to best use and edit this resource, then do research (combined with your literature review) and synthesize information in order to make a unique and original contribution to this online, open-source encyclopedia.
5. **Conference attendance and poster:** Attend the California chapter of the Society for Freshwater Science meeting and present a poster on your field study. Leave campus Wednesday, October 23rd at noon, drive to UC Davis, attend the afternoon session, spend the night (hotel expenses paid), and attend the conference sessions on Thursday. Return to campus by 2pm on Thursday. Best for Red Hills or Del Puerto Canyon field study.

BIOL 4650 Freshwater Ecology- Fall 2019 Schedule- updated November 11

Date	Topic/Activity	Homework and Readings- date due
R 8/22	Introduction and syllabus Hierarchy of ecology Lab: California pathway observations Google drive setup	
T 8/27	Readers, grades, groups	HW #1 (due Mon 8/26 6pm)
R 8/29	Lab: Hydrology- USGS stream gages, interpret rain, snow, dams Lab: Freshwater Invertebrates	RR1: Natural state of streams (pgs 4-15)
T 9/3	Water in California	RR2: Water in California (pgs 16-33) HW#2 (due Mon 9/2 5pm)
R 9/5	Geomorphology. Elwha River, Queets River. Google earth analysis.	RR3: Fluvial Geomorphic Processes (pgs 45-55)
T 9/10	Del Puerto Canyon field trip (DPC group only) Meet in Paterson at 9am; back by 1:30pm Others: no class	LJ#1: A. How has your understanding of freshwater ecology changed thus far? B. How do you feel this class is going? Is there anything the instructor can do differently? C. What are you most excited about for this class?
R 9/12	Red Hills field trip (RH group only) Class time: 9:30am-1:30pm Others: no class	RR4: Chp 1: Introduction to fluvial ecosystems (pgs 33-44)
T 9/17	Synthesis: frameworks for understanding freshwater ecosystems	RR5: Chp6: Microorganisms and OM (pgs 64-88)

R 9/19	Tuolumne River field trip (Tuolumne group only) 9:30-1:30 Others: no class	RR6: Chp7: Primary production (pgs 88-113)
T 9/24	Microorganisms and algae	RR7: Chp20: Macroinvertebrates (pgs 113-132)
R 9/26	Macroinvertebrates BMI Lab: Ephemeroptera, Plecoptera, and Trichoptera	RR8: Inland Fishes- Ecology (pgs 141-167) Also: review Harrington and Born Chps 12, 14, 15, 16
Sat 9/28	Lagunitas Group Field Trip, 7am-7pm	
T 10/1	Freshwater food webs- putting it all together **Also: I will check RR's this week. If you are doing RR's in your notebook, I will collect your notebook today, and give it back Thursday.	LJ #2 A. How has your understanding of freshwater ecology changed thus far? Mention 3-5 specific concepts you have learned. B. What did you learn from your first field trip(s), and how do you envision the field project progressing? C. What are your plans for the communication project?
R 10/3	Taxa to know for quiz Study guide for exam BMI Lab: Diptera, Coleoptera, Odonata, Megaloptera, Hemiptera, other inverts	Review Harrington and Born Chps 13, 17, 18
T 10/8	NON-INSTRUCTIONAL DAY	NO CLASS
R 10/10	Quiz on BMI Review for Exam	
T 10/15	Exam 1	

R 10/17	9:30-11. Suttle et al. 2004 (read in class, use as an example of how to read research articles) 11-1:45: Work on field projects, communication projects, and/or literature reviews in class. Cal-SFS presenters will work on posters. Others will begin ID of field samples, and/or plan communication projects.	LJ #3: due today, ~1 page google doc a) Describe two aspects of freshwater ecology that you would like to learn more about. For each, describe what you already know, and then give several questions you would like to investigate. b) Assess your performance on the learning objectives for this class at this point in the semester. Include your personal grading scheme (you can revise this if you like), and describe the progress you have made. Assign yourself a grade for the course based on the activities you have done thus far. For activities that we have not spent much time on yet, like the communication project and the literature review, describe your specific plans for what you plan on doing (topics, activities, etc.) in the next two months.
T 10/22	RCC Vannote et al. 1980. RCC (pgs 173-180)	RR#9: Vannote et al. River Continuum Concept
W 10/23	CABW/CalSFS meeting at UC Davis Leave campus at 12 noon	
R 10/24	CABW/CalSFS meeting at UC Davis Return by 2pm	For non-attendees: due at 2pm: Each field group: 1 page outline of question(s), methods, and plan for completing the study

	For non-attendees: meet with field groups to develop outlines of field study and communication plan	Each communication group: 1 page outline of your plans for how to communicate your science.
T 10/29	Bibliographic searches, literature review topics	
R 10/31	9-10:45: Literature review: paraphrasing and plagiarism 11-12: group work on communication and field projects 12:30: group share outs	HW due today: key words, topic for lit review. Pdf files of 4+ journal articles
T 11/5	Peer review of paragraph summaries	HW due today: 2 article summaries; 1 paragraph (paraphrased) summary of each article
R 11/7	RiverWebs Group work: lab ID, etc.	RR#10: Nakano et al.
T 11/12	Concept maps and outline for literature review. Bring all four article outlines.	Read and do article outlines for articles #3 and #4 LJ#4 (one page, single spaced) a. Status update on your group field/communication project. b. What are the remaining steps to achieve your goals? c. Assess your personal contribution to the group. d. How well is the group working together? e. What can you do to help your group achieve the overall goal?
R 11/14	9:30-11:30: group work on projects	Read: San Joaquin Valley Progressive Water Platform https://drive.google.com/open?id=1

	Dr. Cover meets individually with each group for 30 minutes to go over projects 11:30: pizza lunch 12:00-1:30 guest speaker, Dezaraye Bagalayos, on water management in the San Joaquin Valley	ZaQBlMRHydoq3oA7Y-FWdwqSWTjLQWF6
T 11/19	Tuolumne group: practice presentation to class	
R 11/21	8-noon Tuolumne Group: high school classroom presentations Others: Group work on projects	By 5pm LJ#5: make a copy of the self-evaluation google sheet in your own folder (only shared with me), and fill it out. Write a one page LJ response: how are you doing in the course? Is this preliminary evaluation indicative of your work and learning? What are your goals for the remainder of the course?
T 11/26	12:30: Peer review first draft of lit review	First draft of lit review due
R 11/28	Thanksgiving- No Class	Revise first draft (but keep a copy of your first draft as is)

T 12/3	Peer review second draft of lit review Rapid presentation by Tuolumne THS group	Second draft of lit review due
R 12/5	(Tuol group at Turlock HS) 9:30-noon: individual meetings (10 mins each) to discuss LJ#5 and class learning outcomes. Noon-1:45: individual meetings with Tuolumne Turlock	
T 12/10	Last day of class Three groups present their field/communication project Red Hills 12:35 Lagunitas 1pm Del Puerto 1:25 pizza party #2	
T 12/17	Final Exam Period 11:15-1:15 Submit via google docs	**Lit Review due **Final LJ due. 3 pages of text, single-spaced (see self-evaluation worksheet) Questions TBD: