FISH 404: RIVER ECOLOGY

SEMESTER IN THE WILD, APPROX. AUG 27-SEPT 19, 2015

INSTRUCTORS

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OVERVIEW

Streams are vital components of the landscape and have not just local, but regional and global significance in the way materials are processed, landscapes connected, and ecosystem services generated. In this class we will study the state of scientific understanding of river ecosystems.

Rivers and streams in the Frank Church River of No Return Wilderness provide the opportunity to investigate the structure and function of watersheds in the absence of anthropogenic effects. This class will explore how the geologic settings within the west and geomorphic processes determine the fundamental shapes and structures of rivers. We will discuss the physical and chemical properties of rivers and how these are affected by regional, landscape and local processes. We will investigate the biologic characteristics and communities of different organisms that live within these rivers. Lastly, we will observe wild Chinook salmon behaviors within Big Creek and how their life cycle becomes integrated into both the biological and physical aspects of these unique river and riparian systems.

DETAILS

This course offers a watershed perspective of rivers and streams. We will study the physical controls on stream environments, particularly catchment processes such as sediment transport, hydrology and nutrient cycling, as well as how biotic processes, such as primary production, decomposition, trophic interactions and ecosystem subsides, function in riparian systems. Most lessons will include a hike and activity accompanied by a short lecture in order for you to experience direct engagement with the concepts covered in the course.

Rivers are dynamic environments that provide 1) the foundation for our understanding of how fluid forces shape the earth, 2) essential habitats for aquatic organisms, 3) classic examples of ecological processes and organismal interactions, and 4) the manifestation of anthropogenic change across the landscape. This class is designed to provide students with the knowledge required to understand, evaluate and perform science within the broad fields that contribute to our knowledge of rivers. In the field, we will cover basic stream hydrology and fluvial geomorphology as it pertains to understanding natural flowing river ecosystems. We will examine material transport, nutrient dynamics and biogeochemistry with expressed goal of understanding stream energetics, biodiversity and the distribution of riparian and stream organisms.

COURSE OBJECTIVES:

1. Think like a dynamic system
2. Understand how a river system responds to change
3. Evaluate the condition of a stream ecosystem – learn data collection methods
4. Identify connections between the living and nonliving parts of a river
5. Improve your scientific observation and writing skills
6. Find your own personal value within rivers and their watersheds

READINGS:

Main course reading packet will be provided at the beginning of the program in the form of two reading packets with complied book chapters and articles that will be used in the upper basin and at Taylor, respectively. We will not travel with readings on the trail.

Supplementary materials will be provided upon arrival to Taylor Wilderness Research Station, (TWRS) and include the following textbooks. Note you are NOT required to purchase these as we will have a few copies available to share at the research station. However, they may be useful resources in the future if you continue on in this field.

1. Allan, J. D., and M. M. Castíllo. 2007. Stream Ecology: Structure and Function of Running Waters. 2 edition. Springer, Dordrecht, The Netherlands.
2. Giller, P. and Malmqvist, B. Biology of streams and rivers.
3. Leopold, L. B. 1994. A View of the River. First Harvard University Press

4. Ritter, D. F., Kochel, R. C., Miller, J. R. 2011. Process Geomorphology. 5 edition. Waveland Press, Long Grove, IL.

EVALUATION:

- Field Data Book (10%)
    - Students will keep a field data book (one of your Rite-in-the-Rain notebooks) to turn in at the end of the course. This should be used for taking legible, well-organized field notes and to record all data collected during activities, observations, the assignment projects, the longitudinal project and your independent research project.
      The data book will be evaluated based on the amount and quality of effort (as evidenced by extent, detail, and neatness of notes, drawings, objectivity, consistency, etc.).
- Journal (5%)
    - At various points throughout the course students will be provided with writing prompts for a journal entry. These will vary from explaining scientific concepts in writing, to personal reflections on your experience in a new watershed, to analytical responses to articles provided. Students are expected to engage fully in these assignments and develop different styles of writing for the different purposes presented.
- Assignments (15%)
    - Associated with several of the field/lab activities, a problem, worksheet or short task will be assigned. These will not be "lab reports," but be either quantitative problems (e.g., "graph a cross section of the channel") or a product from field work (e.g., "graph the data we collected on the invertebrate community in Logan Creek"). Due dates for activities will be announced – typically at the end of the day or the day following the activity
- Exam (15%)
    - One exam scheduled late in the course will serve to evaluate the students' understanding of material and provide personal feedback before students embark on their final projects. The exam will be essay-based, designed to give students an opportunity to explain learned concepts and research methods in their own words.
- Participation (15%)
    - This is an advanced undergraduate-level course and you are expected to conduct yourself accordingly. Students are expected to be present (physically and intellectually!), be on time, and be prepared. This will be a demanding, intensive course, with high expectations for fieldwork, reading, writing and discussions nearly every day. The more you immerse yourself, the more you will get out of it! Students are expected to ask questions and participate in regular discussions.
- Longitudinal River Projects (20%)
    - Physical portion: due September 13
    - Biological portion: due September 14
- Final Project (Planning, Paper and Presentation) (20% Total)
    - Students will conduct an independent or small group research project in the area and will choose the focus of their project. It may be hypothesis-driven or purely

descriptive. It may involve study of aquatic organisms (e.g., "The macroinvertebrate assemblages of Pioneer and Cliff Creek") or it may focus on aspects of the physical habitat (e.g., "Effect of stream gradient on substrate size in Big Creek"). This assignment is meant to afford students the opportunity to follow their own curiosity. Students should meet with one of the instructors to discuss their **study plans (5%)**, methods (including equipment needed, etc.), analysis, and write-up schedule. Groups may visit a site together and students are encouraged to help one another, but each student will be responsible for an individual report.

- The student will be responsible for a **written report (10%)** on their independent research project. The report should be written in the style of a journal article (use the journal *Ecology* as a guide), and will be evaluated based on detail, clarity and organization, conformation to scientific journal style, and evidence of independent effort.
- Students will also be responsible for a verbal **presentation (5%)** of the process, results and implications of their independent research projects. This may be done individually or in groups with instructor approval

SCHEDULE

Day	Plan & Location	Specific Themes	Activity – Reading - Assignments
Aug 27	**PM**: Pack, drive to Edwardsburg **PM**: Students arrive in Upper Big Creek, Intro to Big Creek Watershed and Plan for 5 days. Introduction to River Ecology and Class Expectations **CAMP**: Edwardsburg	"You never step in the same stream twice; Change is the only constant" – Heraclitus Systems Thinking and Feedback Loops Why Study Streams? Viewing a river through a watershed lens – scale in river ecology. Watershed delineation and watershed types (i.e. topographic, geologic influences on flow regime and sediment supply)	**Activity**: Concept map of stream ecosystem **Reading for today:** Allan & Castillo – Chaps. 1 and 2 Excerpts from Stream Channel Reference Sites and Guide to Field Technique
Aug 28	**AM**: Streams and Streamflow. Intro to inquiry project for the expedition and practice data collection methods **PM**: Activity: Stream exploration, Measuring	Physical foundations of rivers. Quantifying discharge, slope and mapping a stream reach. Mechanics of Field Notebooks. Making watershed hypotheses and sampling of velocity, channel	**Activity 1**: Fieldwork Methods Training: Discharge and Slope **Activity 2**: Conduct StreamWalk (record in Data Book) **Reading for today:** Giller & Malmqvist Chap. 3

	discharge and slope at (3) sites **CAMP**: Edwardsburg	shape, Gradient, Substrate, Vegetation, and Inverts for Longitudinal River Survey Project.	**<u>Assignment 1:</u>** Plotting data and calculating discharge and slope.
Aug 29	**AM**: Fluvial Geomorphology discussion Lecture: How geomorphic processes shape the Earth's surface. **PM**: Activity: Stream exploration and quantifying salmon spawning (begin near Lick Creek Bridge) **PM**: Measuring cross-sectional areas, substrate sizes (at same 3 sites), considering substrates and habitat types in the context of river power and repeating measurements upstream. **CAMP**: Edwardsburg	Thinking of rivers as dynamic and variable systems in the dimensions of depth and width. Geomorphic driving and resisting forces – thresholds	**Activity 1**: Fieldwork Methods Training: Temperature variation and substrates – Intro to RiverNET. **Activity 2:** Developing hypotheses for watershed-scale variation – assigning stream orders and identifying sampling sites (~5 in upper basin) **Reading for today:** Allan & Castillo – Chap. 3 Leopold – Chap. 1 *Ritter et al pgs. 2-15* **<u>Assignment 2:</u>** Inferring bankfull width, plotting cross-sectional data and calculating shear stress.
Aug 30	**AM**: Hydrology, the temporal variation of rivers and flooding discussion. The riparian zone. **PM:** Lecture on temperatures in rivers and effects on stream organisms (Marius) **PM**: Measuring riparian vegetation at multiple sites. Hike to Lick Lake. **CAMP**: Edwardsburg	Thinking of rivers in the dimensions of length and time. Riparian Ecology	**Reading for today:** Poff et al. 1997 **Reading for today:** Gregory 1991 "An ecosystem Perspective of riparian zones" **Assignment:** Rating curve and flood frequency assignment.
Aug 31	**AM**: Lecture: The natural wonders of the Salmon life cycle and its relationship to river structure and geomorphology, challenges for local salmon populations. Activity: Explore and comparatively measure	Salmon Ecology (salmon life cycle, carcasses, cross ecosystem subsidies)	**Activity 1:** Search for spawning salmon, observe behavior, Field log entry **Activity 2:** Sample carcasses, sampling and redd measurements, **Reading for today:** Hamann & Kennedy 2012; Schindler et al. 2010; *Gende et al. 2002 "Pacific*

	spawning habitat **PM**: Activity: Carcass Lab **CAMP**: Edwardsburg		*Salmon in Aquatic and Terrestrial Ecosystems"* **Assignment:** Plotting data and calculating discharge and slope.
Sep 1	**AM**: Lecture: The River Continuum as one organizing model. **PM:** Sample inverts from sites for which we have longitudinal data – Upper Big, UBC above Logan Lo, walk stream and collect any remaining samples. **CAMP**: Edwardsburg	Stream Insects as the drivers of energy processing - functional feeding groups Outdoor Leadership overview and hike prospectus (Gary into Camp)	**Activity 1:** Longitudinal River Survey Project – Data entry, Quality control and archiving of sites 1, 2, 3 and 4. **Assignment:** Journal entries, hypothesis formulation and preparing for hike. **Reading for today:** Ritter et al pgs. 219-225, 230, Ritter et al pgs. 234-240 Vannote et al. 1980; and Benda et al. 2004 and *Allan Chap 14*
Sep 2	**AM**: Finalization of Longitudinal River Stream Project sampling **PM**: Hike to Copper Creek Camp (~6 mi) **CAMP**: Copper Creek approximately.	First hike day, Observe changes in channel form and surrounding landscape as we hike Geology as the river template Outdoor Leadership Overview	**Activity 1:** Field log entry – focusing specifically on geology and river channel structure. **Activity 2:** Discussion of day's observations **A possible reading for hike:** Collectively – Passages from *A River Runs Through It* or *Cabin Creek Chronicles*
Sep 3	**ALL DAY**: Hike to Monumental Creek (~6 mi) **CAMP**: Monumental	Hiking day, Observe changes in channel form and surrounding landscape as we hike Geology of the Basin Outdoor Leadership	**Activity 1:** Field log entry - focusing specifically on geology and river channel structure. **A possible reading for hike:** Collectively – Passages from *A River Runs Through It* or *Cabin Creek Chronicles*
Sep 4	**ALL DAY**: Hike to Coxey (~6mi) **CAMP**: Coxey Hole	Historical perspective of the basin Outdoor Leadership	**Activity 1:** Field log entry
Sep 5	**AM**: Hike to Cabin Creek (~6mi) **PM**: Lecture: Fluvial Geomorphology and	Fluvial geomorphology intro. (unique wide valley floodplain @ cabin) Alluvial Stratigraphy and	**Activity 1:** Describe and interpret fluvial stratigraphy; learn the story of a river's evolution and dynamics (may do this earlier

	Stratigraphic Chronology: deciphering the history of a river Activity: Fluvial Stratigraphy Project 1: Longitudinal River Survey **CAMP:** Upstream of Cabin Creek	Floodplains **Energy Inputs**. Vertical and lateral linkages – hyporheic and reciprocal subsides. Energy in streams, nitrogen dynamics, organic matter, basal trophic resources, whole stream ecosystem metabolism	along hike if stratigraphy exists) **Activity 2:** Continue Longitudinal River Survey Project (Samples 6, 7) **Activity 3:** Survey for carcasses and further measure redd characteristics. **Reading for today:** Collectively – passages from group reading
Sep 6	**AM**: Hike to TWRS (~7 mi) **PM:** Settle in, TWRS Orientation	**Welcome to Taylor Ranch!**	**Reading for tonight:** Giller & Malmqvist (Ch 3 – Overview and Review and Ch 6 – Energy and Nutrients)
Sep 7 to Sep 9	**Time split between exploring, orientation, reading, and river reflection assignments**		
Sep 10	**TWRS – Academic half day off** **PM**: Lecture: TWRS Research, Previous stream ecology research done out of Taylor Ranch and the population ecology of salmon in the basin	Ranch jobs and opportunities Discussion of final project ideas	**Reading for today:** Achord et al. 2004, Cromwell & Kennedy 2011
Sep 11	**AM: Tour of Screw trap facility,** Lecture on juvenile salmonids and MFSR (Bryce) **PM**: Lecture: Insect communities and Bug Identification	Population ecology of river fishes	**Activity 1:** Screw Trap visit **a**nd tour of RiverNet sites **Activity 2:** Planning for LBC, Rush and Pioneer longitudinal sampling **Reading for today:** Allan Ch 8, 9, 10 (over the next few days); and Quinn Ch 12
Sep 12	**AM**: Return to Screw trap to assess - Longitudinal River Survey **PM**: Fish PTAGIS exercise, measuring growth and survival in a population	Species Interactions: top-down/bottom-up controls, trophic cascades, invasive species	**Activity 1**: Continue Longitudinal River Survey Project (sites 8, 9, 10, 11). Calculate discharge of Big Creek **Activity 2:** Further bug identification **Activity 3:** PTAGS exercise

			Reading for today: Diana Ch 12 and Richter & Kolmes 2005 (read to page 32).
Sep 13	**AM:** Sampling river populations **PM:** Identifying independent research projects – what makes a good question?	Temperature and Energetics of a Stream Ectotherm – Climate Past and Climate future.	**Activity 1**: Continue and finalize Longitudinal River Survey Project **Activity 2:** Snorkeling mainstem Big Creek **Activity 3:** Finalize bug identification and data input.
Sep 14	**ALL DAY:** Hike to MFSR, discussion of Longitudinal Projects and Final projects **PM:** Lecture on stream nutrients and river resource subsidies.	River nutrients and cross system subsidies	**Activity 1**: Finalize Longitudinal River Survey Project – Hike to benches and MFSR (site 12) and sample. **Reading for today:** Allan Ch 11, Davis & Minshall 1999, Naiman et al. 2002, *Excerpts from Mitchell 2014*.
Sep 15	**AM:** Lecture Trophic interactions and community ecology. **PM:** Data from Projects and Synthesis Longitudinal River Projects due.	Community ecology of rivers	**Activity 1:** Data Analysis for final project, Coordinate Data Sharing from Longitudinal River Survey **Activity 2:** Brainstorm Final Project Ideas – develop study plans **Reading for today:** Power 1990; Baxter et al. 2004; Taylor et al. 2006 and Middleton et al. 2013
Sep 16	**AM:** Finalization of independent research projects **PM:** Brian to Leave Taylor	**EXAM - *tentatively*** Personal research – inquiry and exploration. Hypothesis formulation	**Activity 1:** Assignment
Sep 17		Research and final field data collection	**Activity 1:** Data collection, entry and analysis
Sep 18		Work on Presentations and Written Reports	**Activity 1:** Data collection, entry and analysis and research writeup.
Sep 19	**PM:** Final projects Due	Independent Research Projects and Presentations	