Microhabitats and macroinvertebrates: Logjam influences on stream morphology and macroinvertebrate traits

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Abstract:

Logjams are important hydrologic features that shape stream channel morphology and create habitat for organisms. In this lesson, students learn about and measure logjams in a wadeable stream and predict how logjams affect macroinvertebrate communities. This lesson is geared toward undergraduates, and we recommend conducting field activities in groups of 3-5. We also recommend using a wadeable stream that contains both an area with a logjam and, some distance away (10-100m), an area without a logjam for comparison purposes. Necessary equipment includes writing supplies (paper, pencils), tape measure, datasheets, and macroinvertebrate identification (ID) keys with functional feeding group information. Students will begin the lesson by examining the riverscape, identifying channel morphology changes and major habitats in the stream, and discussing how these are influenced by logjams. Students will then examine macroinvertebrate ID keys and make a prediction about the functional feeding groups they will find in the different habitat zones. After this lesson, students will be able to identify how logjams influence channel morphology and predict how they affect macroinvertebrate habitat.

Tags/Keywords: wood, large wood, macroinvertebrate, habitat, riparian, functional feeding group, River Field Studies Network

Instructor Notes:

- <u>Target audience (who)</u> This lesson is geared towards undergraduate students and would be suitable for both lower division and upper division if they have some background in river channel features (pools, riffles, cutbanks, erosion and depositional surfaces, etc). A student's prior knowledge and skills may influence how much they engage with the material, but a brief explanation and identification of these features from the instructor would be helpful before the lesson begins. A student's interest may also influence how they experience this lesson.
- 2. Summary of the lesson (what, when, where, why) The students will first examine the different geomorphic features of a stream at two locations nearby each other: a channel cross section with a logjam and a channel cross section without a logjam. With the help of the instructor, students will learn about and identify various channel features (riffles, runs, and pools) and record differences in habitat composition between the two nearby sites. Students will also sketch the two sites, making note of the different habitats that might exist for macroinvertebrates. Students will then measure channel width and depth at both cross sections and conduct additional measurements of the logjam (log length, diameter, etc). After measuring the logjam, students will be prompted to reflect on the different habitats they observed in each channel cross section. Students will write a hypothesis and prediction about how macroinvertebrate traits (e.g., functional feeding groups, morphological adaptations, and movement strategies) may differ between habitats and sites. This hypothesis will be revisited in the optional part 2 of this lesson (Macroinvertebrates and BioAssessment).

3. Approach to engagement (how) -

- a. Discussion: Instructors can ask the students to verbally contrast the two sites and discuss what habitats exist within each cross section. Instructors can also prompt students to think about the types of macroinvertebrates that might inhabit each of the different habitat locations (e.g., riffles, runs, and pools). Instructors may also wish to discuss with the students how the stream today may differ from what it looked like in the past (prior to human modifications). For example, would more or fewer logjams likely be present? Why? These discussions can take place at the beginning and end of the lesson, but also during field measurements.
- b. Experiential learning: Students will engage in lesson content by learning and conducting field methods for measuring logjams and recording their own data. During this portion of the lesson, instructors can prompt students to note differences in habitats and stream channel characteristics and write any observations in their notebooks/on their datasheets. This will aid students in making predictions about how stream channel characteristics influence habitat, increase their familiarity with the site, and help them build confidence in making and recording observations.
 - i. Instructors and students may find it difficult to determine bankfull if not familiar with the area. To more easily identify bankfull at a specific site, we suggest the instructor search for any significant changes in slope from the floodplain into the channel. Bankfull typically occurs at this slope break. Above the slope break is the floodplain, which is typically a lower slope. Below the floodplain is typically the area of the channel that becomes inundated 50% of the time.
- c. Writing, sketching, and reflection: Instructors can provide an additional avenue for lesson engagement by giving students structured time to record observations, make field sketches, and reflect on/build their hypotheses and predictions. Instructors can also prompt students to think about the role of logjams in the stream reach section they are observing and the larger watershed.
- 4. Logistics and materials needed Students will need paper and drawing implements (at minimum, a pencil), at least one tape measure, a macroinvertebrate guide that includes information about traits, such as functional feeding groups, and the printed data sheet (1 for each student group of 2-4 that is conducting logiam measurements). The field site should be wadeable and accessible so that students can safely cross the stream channel and conduct the measurements at both the non-logiam and logiam sites. We recommend that the instructor scout the site for these requirements ahead of time.

5. Further reading for the instructor -

- a. WooDDAM (Wood Jam Dynamics Database and Assessment Model: <u>http://sites.warnercnr.colostate.edu/woodjam/#:~:text=WooDDAM%20is%20a%20collabo</u> <u>rative%20effort,both%20resource%20managers%20and%20researchers</u>.
- b. Table of data description for additional details on some measurements conducted: <u>https://sites.warnercnr.colostate.edu/woodjam/wp-</u> <u>content/uploads/sites/117/2021/01/Table-of-WooDDAM-V2.1-variables-1.pdf</u>
- c. <u>https://dep.wv.gov/WWE/getinvolved/sos/Pages/foodweb.aspx</u>
- d. Merritt, R.W., K.W. Cummins, and M.B. Berg. Chapters 5, 6, and 9 In: An introduction to the aquatic insects of North America. Fifth edition.
 - i. Chapter 5: Habitat, Life History, Secondary Production, and Behavioral Adaptations of Aquatic Insects
 - ii. Chapter 6: Ecology and Distribution of Aquatic Insects
 - iii. Chapter 9: Adaptations and Phylogeny of Aquatic Insects

- e. Wohl E. 2013. Floodplains and wood. Earth Science Reviews 123:194 212. Doi: 10.1016/j.earscirev.2013.04.009
- f. Wohl E.2017. Bridging the gaps: An overview of wood across time and space in diverse rivers . Geomorphology 279:3 26. d oi: 10.1016/j.geomorph.2016.04.014
- g. Wohl E. et al. 2019. The natural wood regime in rivers. BioScience 69:259 273. doi:10.1093/biosci/biz013
- h. Gregory SV, Gurnell A, Piégay H, Boyer K. 2017. Chapter 2 9 : Dynamics of Wood. p p. 113 126 in: Lamberti GA and Hauer FR, eds. Methods in Stream Ecology , Volume 2: Ecosystem Function , 3 rd ed. Academic Press, London, UK.

Learning Outcomes:

- Identify how logjams influence microhabitat locations.
- Map microhabitats (riffles, runs, and pools) as they relate to logjams and channel characteristics.
- **Conduct logjam measurements** (orientation, embeddedness, size, # of pieces, etc).
- **Predict** the traits of stream macroinvertebrates that might be found in different logjam-influenced stream habitats.
- Create, label, and interpret informative field sketches of stream characteristics and habitats.
- Be able to **discuss** how stream habitat is shaped by channel features such as log jams, as well as how these principles could apply to systems outside the study site.
- Gain **transferrable**, **field-based research skills**, including mapping and measuring channel features (including log jams)

Assessment of Learning Outcomes:

Pre-assessment:

- <u>Hypothesis question at the beginning of the data sheet:</u> Based on the introductory lecture and overview at the beginning of the field lesson, students will be asked to hypothesize how the logjam influences channel characteristics and habitat.
- <u>Q&A:</u> Instructors can use an introductory Q&A to gauge students' prior knowledge and understanding, as well as re-familiarize students with key concepts. Specifically, instructors can ask students to recall how logjams influence stream channel characteristics; how to identify riffles, runs, and pools; what functional traits may be present in a given macroinvertebrate community; and the effects of stream channel morphology on macroinvertebrate community traits.

Post-assessment:

- <u>Wrap-up question at the end of the data sheet:</u> Students will be asked what differences and similarities they noticed at the two sites. Students will also be asked to explain mechanisms or explanations for the differences and similarities they observed in the context of what they have learned about how log jams shape stream channels.
- <u>Macroinvertebrate traits hypothesis and prediction</u>: Students will be asked to predict which
 macroinvertebrate functional feeding groups (as well as other macroinvertebrate characteristics,
 such as mobility or breathing mode) will be most/least prevalent at each site. Hypotheses and
 predictions should indicate familiarity with different stream habitats (e.g., riffles, runs, pools) and
 their relative suitability for different types of macroinvertebrates.

Required Background Information for Students: Students should receive introductory lessons on wood in stream channels and macroinvertebrate adaptations/habitat prior to this field lesson (see videos). Students can also read Wellnitz et al. 2014 for more information on the importance of logjams in structuring macroinvertebrate communities:

https://www.sciencedirect.com/sdfe/reader/pii/S0075951114000590/pdf

Lesson Content:

To complete this lesson, the instructor will select a field location along a small stream that contains channel cross sections with and without logjams present so that the influence of logjams on stream channel characteristics and habitat heterogeneity can be determined. The two cross sections for comparison (logjam and non-logjam sites) should be close to each other (walking distance) so that they are undergoing the same channel processes and for logistical purposes. Large wood is defined as pieces larger than one meter in length and ten centimeters in diameter. Therefore, logs of this size or greater are measured for this portion and notes can be made of any additional smaller pieces. Students will be answering the general question: how do habitat and channel characteristics differ at logjam and non-logjam sites?

Lesson Procedure:

<u>Site Selection:</u> For this portion of the lesson, the stream should be wadeable and a significant portion of the logjam should be exposed (above the water) so that the logjam is easily measurable while keeping safety in mind. Some measurements will be dependent on orientation and placement of the logjam within the stream or along the stream banks. We also recommend selecting a logjam that has persisted for some time and has not been recently deposited so that it is clear how the logjam has influenced channel morphology. Studies on logjams have shown that they cause channel heterogeneity and therefore logjams that have persisted over longer time periods are surrounded by riffles and pools. We suggest choosing a cross section within the logjam span that has different habitats (depths of channel, etc) where differences can be observed.

The field portion of this lesson is designed to last 2 hours and will be conducted in two main parts, both of which will take place at the logjam and non-logjam sites.:

Part 1: Examining the riverscape, identifying habitats, and sketching

- 1. 5 minutes at each site (10 minutes total): walk to site location, unload and stage equipment.
- 2. 15 minutes at FIRST site only instructors conduct initial Q&A and discussion. Students will be asked to recall how logjams shape streams and rivers and how stream channel characteristics affect macroinvertebrate community traits (e.g., functional feeding groups). During this discussion, the instructor should remind students how to identify riffles, runs, and pools within a stream reach and point out examples of these habitats at the site.
- 3. 5 minutes at FIRST site only instructors distribute macroinvertebrate ID keys with functional feeding group information and datasheets. Instructors may also encourage students to download the "PocketMacros" app to facilitate macroinvertebrate ID. Students are instructed to get out their notebook or piece of paper. Students will hang on to keys/datasheets and keep their notebooks out for the rest of the lesson. Instructors direct students' attention to the stream reach.
- 4. 10 minutes at each site (20 minutes total) assignment in notebook/on datasheet:
 - a. Draw the stream reach. In your drawing, include:
 - i. The major stream channel characteristics in the reach (e.g., riffles, runs, pools). Make note of the approximate proportion (%) of the reach that is made up by different habitat types.
 - ii. Different potential habitats for macroinvertebrates
 - iii. A note about whether logjams are present or absent in the stream reach.
 - b. In your drawing, include some indication of scale and label any/all relevant parts of the sketch. The location of your measurements should also be indicated in your sketch.

Total time needed for Part 1: 50 minutes

- 15 minute introductory discussion at FIRST site only
- 10 minutes of sketching at each site (20 minutes total)
- 15 minutes of transition time

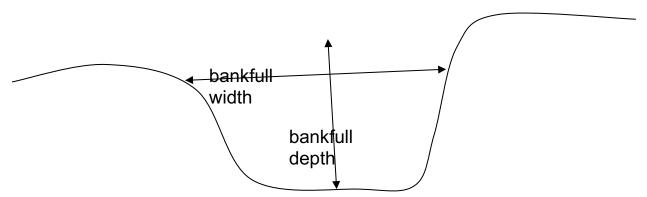
*Note: timing is also dependent on the size of the logjam. For example, if more time is needed for logjam measurements, the instructor may decrease time for introduction and sketching.

Part 2: Measuring the logjam

Total time needed for Part 2: 60 minutes (30 minutes of measuring at each site) Additional information and explanation of variables that can be measured provided here: <u>https://sites.warnercnr.colostate.edu/woodjam/wp-content/uploads/sites/117/2021/01/Table-of-WooDDAM-V2.1-variables-1.pdf</u>

Please refer to the attached data sheets for recording the variables described below. Instructors will direct students to conduct the following measurements at both locations:

1. Measure bankfull depth and width: Students will identify the tops of the banks of the channel outside of which lies the floodplain. The instructor will provide direction on how these can be identified. A sketch is provided below to identify approximate location measurements.

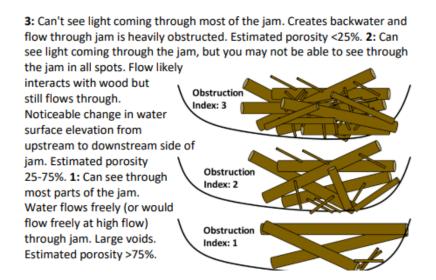


 Identify substrate sizes - Depending on student knowledge of sediment sizes students can identify general classes of sediment present at each site. It is recommended that students examine sediment at three locations within each habitat zone or channel feature. For example, examine three locations within a channel pool. Students can broadly identify if they see the following main sediment sizes:

Boulders & Cobbles	> 64mm
Pebbles	2-64mm
Sand	0.62mm-2mm
Silt/clay	< 0.62mm

The following measurements will take place at the logjam location:

3. Determine logjam obstruction index: Students will use the following figure (From WooDDAM) to identify how obstructed the channel is.



4. Determine decay index: Students will use the following figure to identify log decay index.

Scale paraphrased from Harmon et al. (2011). Most jams in rivers will be category 1-3, and it is nearly impossible for a jam to be 5. Applies to key pieces only.

1: Sound, freshly fallen, intact logs with no rot, fine twigs attached with tight bark. 2: Sound log sapwood partly soft but can't be pulled apart by hand, many fine twigs are gone and remaining fine twigs have peeling bark. 3: Heartwood is still sound with piece supporting its own weight, sapwood can be pulled apart by hand or is missing, wood color is reddishbrown or original color, only branch stubs are remaining which cannot be pulled out of log. 4: Heartwood is rotten with piece unable to support own weight, a metal pin can be pushed into heartwood, branch stubs can be pulled out. 5: There is no remaining structural integrity to the piece with a lack of circular shape as rot spreads out across ground, rotten texture is soft and can become powder when dry, wood color is red-brown to dark brown

- 5. Measure the key pieces within the logjam: Students will conduct the following measurements of all large wood present.
 - a. Length end to end or if it is buried the length to the furthest unburied point without disturbing the logjam
 - b. Diameter of the key pieces at each end
- 6. Document orientation of the log pieces with reference to streamflow: Students will describe the orientation of the logjam (perpendicular? At some angle?)
- 7. Note complexity of logjam: Students will describe the logjam in terms of number of pieces and other notable characteristics (presence of smaller wood pieces, etc).
- 8. Other questions to answer: Students will provide yes or no answers to the following questions.
 - a. Does the logjam touch the streambank?
 - b. Does it touch a floodplain surface?
 - c. Does it occupy the deepest part of the channel?
 - d. Is it buried or partially buried?

- e. Is the key piece above bankfull?
- f. Are rootwads present?
- g. Is the wood alive

Data Sheet: See attachment

Data Analysis and Interpretation: Data analysis will primarily be carried out in part 2 (Aquatic Invertebrates as Bioindicators) of this lesson, which focuses on macroinvertebrates as bioindicators (see below under "Links to Other Lessons and Concepts"). For the present lesson, students are qualitatively comparing channel features between logjam and non-logjam sites. One additional option, if this lesson is carried out over several years with subsequent courses, is to maintain the logjam information over time and examine changes in stream channel features, channel and logjam measurements, and habitat locations. Overall, students will discuss with the instructor and as a group the similarities and differences they found amongst the two sites and predict what this might mean for macroinvertebrate findings in the next lesson. Students can also update the predictions they formulated at the beginning of the lesson.

Reflection (10 minutes):

- The lesson will wrap up with a full group discussion of the features measured and how the students think the logjams are influencing habitat. Students can also discuss the potential source of the logs and what role they might be playing in the stream channel at locations other than the ones examined in the lesson (5 minutes). The instructor will reiterate the importance of logjams in influencing channel morphology and habitat.
- In preparation for part 2 of this 2-part field lesson (see below) students will spend 5 minutes writing a testable hypothesis and prediction about what macroinvertebrate functional feeding groups will be most prevalent in the different habitats they measured (see "Assessment questions" at the end of the datasheet below).
- Instructors may wish to discuss with students the current and historical conditions of the watershed and any recent events (e.g. fires, construction, log removal etc).

Links to Other Lessons and Concepts:

Link to lesson "Aquatic Invertebrates as Bioindicators" by Carissa Ganong and Ross Vander Vorste

Further Reading:

WooDDAM website:

http://sites.warnercnr.colostate.edu/woodjam/#:~:text=WooDDAM%20is%20a%20collaborative%20effort, both%20resource%20managers%20and%20researchers.