Field sketching, geomorphic data, and the power of perspective

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Abstract

Sketching is a powerful tool to capture observations about the landscape and preserve a picture of a field site at a particular time. In the digital age it is all too easy to take a picture from a phone and keep moving, rather than slowing down and interrogating the landscape around us. At the same time, our perspectives, be they disciplinary, personal, or literally where we are standing when making observations, color the way that we see things. This lesson asks students to make sketches of a field site over progressively shorter windows of time (10 minutes, 4 minutes, 1 minute) before and after conducting geomorphic data collection at the site. The expected outcome is that students will see and focus on different aspects of the landscape after collecting data, helping them to see the way that disciplinary learning informs their perspective. The activity also encourages them to consider their sketches as data rather than focusing on artistic ability.

Students will also build skills in hypothesis generation and field data collection, as they collect basic geomorphic data that can be used in an assessment for this individual lesson or in subsequent lessons. I envision the lesson as an introductory activity in a course, perhaps the first time students are taken to the field. I also envision it as an introductory level activity, so that students are learning the power of observation early in their academic careers. The lesson is written for a particular set of data collection activities, but could easily be adapted to other disciplines or techniques.

Tags/Keywords: River Field Studies Network, drawing, sketching, geomorphology, discharge, data, grain size, perspective

Instructor Notes

This lesson can be used independently or in conjunction with the following:

Luke Ward - Using Survey123 to Map Physical Habitat Characteristics, Watershed Activities, and Disturbances

Danielle Hare - Consideration of Groundwater-Dependent Ecosystems: Including Groundwater Discharge Dynamics into Stream Habitat Assessments

Our recommended order for lessons is Jones, Hare, Ward

Target audience level

This lesson is geared towards students at the introductory level, and potentially as the first time students are taken into the field. That way, they are introduced to the power of observation early in their academic careers and can build on it as they continue in subsequent field trips. There is little formal background that students need, depending on the specific methodology (for example, they may need to review analytical techniques or a field manual beforehand if the data collection is complex).

Summary of the lesson

Students sketch a field site multiple times and collect basic geomorphic data at the site. They compare their sketches and hypotheses with their classmates to illustrate that prior knowledge and perspective informs the way that we see the world. The students do calculations based on the data they collected, and the data can be used for future activities as well.

Student context factors

- **Worldview.** The lesson explicitly engages with the notion of perspective and the way that it influences our understanding of the world around us. The initial sketch that students complete is done with little instruction beforehand, so that students are sketching the landscape *as they see it*. And then after repeating the drawing and reflecting on the differences between their initial and subsequent sketch, students will see the way that the data collection process (disciplinary learning) and perspective influences the way they interpret the landscape.
- **Interests.** This lesson is intended as an introductory activity in an introductory level class, meaning that students will likely have a range of interests in field work, ecology, geomorphology, and science in general. Beginning the activity with drawing before moving into data collection will engage more artistically inclined students and may challenge some. The hands-on portion engages students who are interested in real-world application of concepts. And the calculations at the end engage more mathematically inclined students.
- **Identity.** Similar to worldview, students bring their identities into every field experience. This may affect their sense of safety, belonging, or enjoyment in the lesson. As noted above, this lesson explicitly considers the way that students see the world and asks them to compare their perspective with others. The data collection portion of the lesson has multiple roles, including some that are in the channel and others that are recording data from the shore. This allows students to engage in ways that are comfortable for them.
- **Prior knowledge and skills.** Some students may be uncomfortable with field drawing, viewing it as an artistic task rather than a scientific one. Similarly some students may be more comfortable with being in water and collecting data. This lesson is meant to ease students into all these tasks so that they can enter with a low level of prior knowledge and feel more comfortable after the activity. To do this effectively, it is important to communicate the value of drawing as a method to make observations and communicate

scientific information. And it is important to provide students with proper equipment to feel safe and comfortable while wading to collect data.

- **Motivation and expectation.** The drawing activity at the beginning is meant to motivate students and draw their interest in a fun way, with the decreasing time limit causing more frantic attempts to capture what they see. Sharing their drawings with a partner and working in groups during the data collection phase are meant to motivate and support students as they build connections with others in the course.
- **Prior experiences.** As noted above, prior experiences, skills, and identities affect the way that students engage with the lesson. The explicit consideration of perspective and the flexible roles built into the lesson help to accommodate students with a variety of prior experiences.
- **Personal needs.** As noted above, students may enter with some apprehension about drawing, being in the water, and their scientific ability. Emphasizing that the drawing is meant to be about *their perspective* and about communicating information rather than artistic prowess may lower this barrier. Providing proper equipment (waders, water shoes, etc.) and clear instruction for the data collection can help to lower students' apprehension about the data collection.

Logistics and materials needed

This activity is envisioned as a lesson for a wadeable stream, since students will be in the water collecting data.

Materials needed:

Measuring tapes

Jacob staffs (or some other depth measuring tool)

Velocity meter

Gravelometer

Waders or water-appropriate clothing including shoes that can get wet

Field notebook and/or sketchpad

Further reading

Ainsworth, S., Prain, V., & Tytler, R. (2011). Drawing to learn in science. Science, 333, 1096–1097, doi: 10.1126/science.1204153

Bobek, E. and Tversky, B. 2016. Creating visual explanations improves learning. Cognitive Research: Principles and Implications, 1, doi: 10.1186/s41235-016-0031-6

Garamonn Meckle, B., Barber, B.R., Carling, M.D. 2020. Drawn to natural history: Enhancing field courses with drawing and field journal instruction. Natural Science Education, v.49 (1), doi: 10.1002/nse2.20019

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Kondolf, M.G. 1997, Applications of the pebble count: notes on purpose, method, and variants. Journal of the American Water Resources Association, 33, doi: 10.1111/j.1752-1688.1997.tb04084.x

Wolman, M. G., 1954. A method of sampling coarse river-bed material. Transactions of the American Geophysical Union, 35(6), 951-956, doi: 10.1029/TR035i006p00951

Learning Outcomes

Students will be able to sketch the landscape around them, with a particular focus on biophysical characteristics.

Students will learn that different perspectives (disciplinary or personal) affect the way that we perceive the landscape.

Students will be able to collect basic geomorphic data

Students will be able to articulate the relationship between velocity and depth

Students will be able to calculate stream discharge and evaluate the consistency of their measurements

Students will recognize unique geomorphic features and collect data to describe them

Assessment of Learning Outcomes

There are a number of informal, formative assessment strategies embedded within the lesson: The think-pair-share activity after the first set of drawings is an opportunity for students to share their own drawings and to see how drawings differ based on student perspective. Similarly, creating and sharing hypotheses before collecting data and then comparing the data with their hypotheses allows students to reflect on their prior understanding. During the data collection process, the instructor circulates between groups to check in with them about their progress and answer any questions.

Several assessment questions that can be conducted during or after the lesson (depending on available time) are included, and cover calculating discharge for the measured cross-sections, analyzing the relationship between velocity and depth at points measured in the reach, and comparing the pre-data collection and post-data collection sketches for similarities and differences.

A follow-up for the sketching activity could have students complete a sketch based on a photograph, noting what may be missing because they are not able to physically visit the site.

Background information for students

Field sketching

This information should be delivered verbally by the instructor, ideally paired with field sketches that the instructor has done previously. Instructor can provide readings on field sketching to students if desired.

The natural sciences – biology, chemistry, physics, geology, and related disciplines, were born out of observation and measurement in nature. Early natural scientists sought to understand why the world around them operated the way it did. An important part of that quest was making observations in the natural world. These observations included writings and measurements, but also included drawings – of landscapes, animals, weather, and many other phenomena (Figure 1).

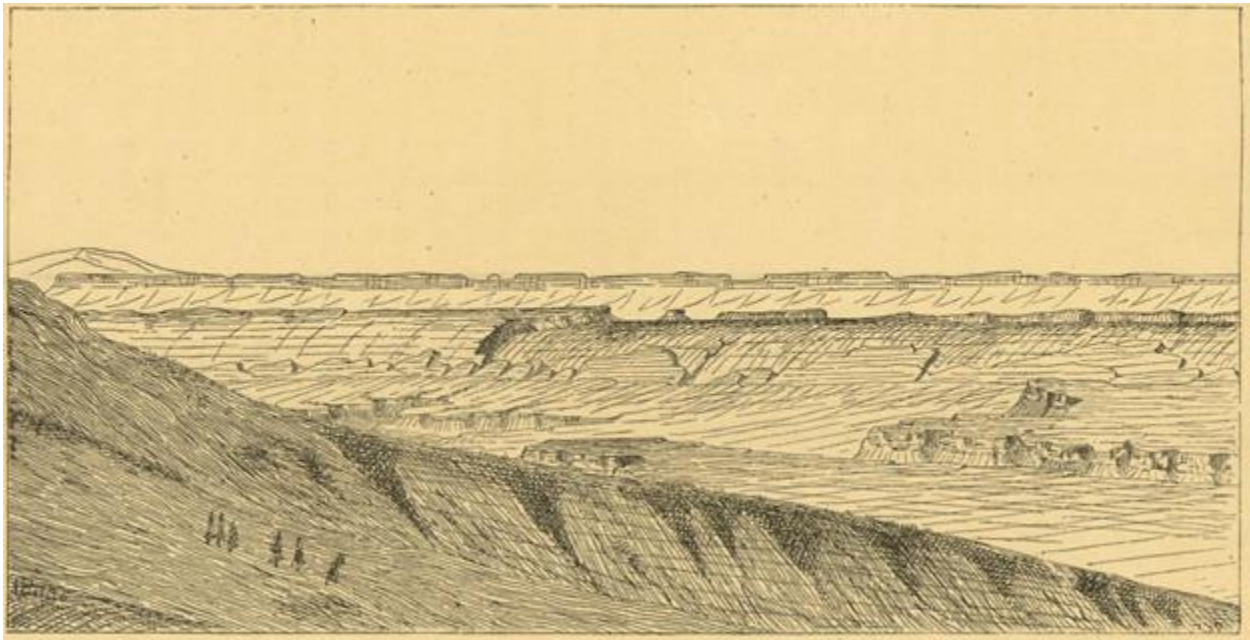

FIG. 4.—Waterpocket Flexure, as seen from the south end of Mount Ellen.

Figure 1. Illustration of Waterpocket Flexure, a geologic fold in the Henry Mountains, Utah. This illustration is from a USGS monograph written by G.K Gilbert, published in 1877.

This kind of field drawing has historical importance in the natural sciences, but research shows us that it can also help generate new ideas, increase spatial understanding, and improve information retention (e.g., Ainsworth et al. 2011). In the technological age, it is incredibly easy to take a high quality photograph of a field site. Smartphones allow us to collect a great deal of information incredibly quickly, but there are drawbacks to snapping pictures as well. Compared to photographs, drawing gives the observer an opportunity to make observations, add their own interpretations, and decide what to focus on.

While many historical field sketches that are preserved in museums or textbooks are aesthetically beautiful, scientific drawings do not need to be beautiful in order to serve their purpose. The main purpose of these drawings is to convey information. The field sketch is a data point, just like the other data we collect in this lab. It captures an image of the field site at a particular time, as seen by the observer.

Geomorphic data

This information would be best introduced prior to the lesson, so that students have a basic understanding of why they will be collecting the data in the lesson. These ideas should be re-visited prior to collecting data in the field.

Rivers are very heterogeneous landforms. Many elements of the riverine environment – velocity, grain size, channel dimension – are variable over small and large spatial and temporal scales. Over 10 meters, the depth in a river can change by an order of magnitude. And at the continental scale, rivers vary from small headwater streams running through a backyard up to channels draining entire continents. In terms of temporal change, a river can be frozen one day and be flooding over its banks the next.

In an environment with that much variability, the data that we collect represents a snapshot in time. Even though we are only getting snapshots, that data is important to understand what is happening in the river, and serves as a comparison for other times. In this lab, we are collecting four types of data in addition to our sketch: water depth, water velocity, discharge, and grain size.

Depth and velocity together are important habitat measures. Depth is the measurement of how deep the water is. The depth of the water column affects the velocity profile, the amount of light penetration, and the amount of force that is exerted on the bed; these attributes affect organisms in the water column as well as organisms and sediment on the bed of the stream. Flow velocity also affects organisms in the stream, as they experience the force of the moving water. Different organisms will respond differently to velocity; some organisms can swim at high velocity, others will be caught in drift, and others still will cling to the bed of the river (though they may be dislodged at high velocity).

Discharge is a fundamental measurement in hydrology, geomorphology, and riverine ecology. The term “discharge” refers to a volumetric flux, i.e., a volume per time. In rivers, discharge is the volume of water moving through a river cross-section at a given time. For example, a flood would have a larger discharge value than baseflow. Quantifying discharge is important to understand how much of the channel will be underwater, which determines the amount of wetted habitat available and where sediment can be eroded, transported, and deposited. In the United States, The United States Geological Survey maintains continuous measurements of discharge at more than 10,000 sites across the country: https://waterdata.usgs.gov/nwis/sw

Grain size is another fundamental measurement for geomorphology, hydrology, and riverine ecology. Typically we measure the distribution of grains on the bed of a river. We want to

understand how big the sediment is and how much variability there is in the size of the sediment. The grain size will determine the available habitat for macro-invertebrates, spawning fish, and any other benthic organisms. And because large grains weigh more, the grain size distribution is important to predict the amount of sediment that will be eroded and transported under a given flow regime.

Collecting all this data provides a useful snapshot of what the river looks like at a specific time and under specific circumstances. This shows us what habitat is available at a given time and can serve as a baseline for future measurements.

Lesson Procedure

- Introduction on river bank:
    - Start with brief introduction to field drawing: tell students that the drawing doesn't need to be pretty or perfect, it's meant to convey information rather than art, for example "in what I see in front of me, what is important?") – 5-10 min
- Explain the scientific content of the lesson –
    - When you meet a person for the first time, you would ask questions to get to know them. We can do the same when we come to a field site for the first time.
    - Prompt students for questions they would ask when coming to a place for the first time.
    - Eventually introduce students to these questions: what does it look like, how much water is there, how fast is the water flowing, what size sediment is on the bed – 5 min
- 10 min, 4 min, 1 min sketch
    - To answer the question of what the river looks like, students complete the drawing activity.
    - Students should approach the drawing as a form of data rather than a form of art - the sketches are meant to convey information about what they see rather than trying to be a perfect, beautiful representation.
    - The students should draw what they see and highlight what they think is important. Given that students will have different backgrounds, they will likely focus on different elements in their drawings.
    - In the 10 minute, 4 minute, and 1 minute drawing, students should try to communicate the same information.
    - The instructor sets a timer for 10 minutes, and students begin sketching what they see. They must spend all 10 minutes drawing and notating their sketch. After 10 minutes elapses, instructor sets a 4 minute timer and again, students draw. After 4 minute timer elapses, instructor sets timer for 1 minute, and students draw. – 15 min
- Partner sharing – Students find a partner and show/discuss their drawings with each other. The older student (or some other way to designate a reporter) will report back to the class They focus on the following questions: - 5 min
    - What elements are present in both drawings?
    - Any features that one person noticed and the other did not?

- Class sharing – Each partner group reports back to the class, highlighting similarities and differences between their sketches. Ask students to ponder why these differences might be there and to think about that as we go through the rest of the lesson. – 10 min
- Break into groups – students split into groups of 3-5
- Before groups separate, instructor walks through data collection procedure (also included in the handout) – 15-20 minutes
    - Explain how to collect grain size data, depending on available equipment
    - Explain how to use velocimeter, depending on available equipment
    - Explain how to collect cross-sectional data for discharge, depending on available equipment
    - Remind students that all the instructions are included in the handout, and that instructor will circulate between groups to answer questions
- Groups split off and find a location for their measurements (5 min)
- Before collecting data, students hypothesize about what the grain size will be, how velocity will vary across the channel, how those attributes might be different in different places along the channel
- Students collect field data (1 hour)
    - Students should rotate through different tasks
- Full group comes back together, gather equipment
- Re-do the 10 minute sketch –
    - As before, instructor sets timers and students sketch what they see. Again, students are not told to focus on anything in particular, but to capture what they think is important in the site.
    - Students will likely pay more attention to geomorphic features in their post-sketches, given that they have spent 1+ hour focusing on geomorphic data.
    - Ideally students return to the exact spot they sketched from at the beginning of the period so that they can analyze their sketches as part of the lab report.
- Lesson wrap-up (10 minutes)
    - See if students have questions
    - Go over the assignment/calculations to be done

Total time: 2 hours, 30 minutes

Data Sheets: Included at the end of the lesson

Reflection:

Within the lesson itself, there are multiple opportunities for reflection, including the think-pair-share after the first set of drawings and the opportunity to evaluate hypotheses in real time as the students collect data.

There are also questions in the assignment that ask students to reflect on the activity: They compare their pre- and post-data collection drawings, and they answer a question about whether their hypotheses matched the data that they collected.

Links to Other Lessons and Concepts:

As noted, this lesson pairs with:

Luke Ward - Using Survey123 to Map Physical Habitat Characteristics, Watershed Activities, and Disturbances

Danielle Hare - Consideration of Groundwater-Dependent Ecosystems: Including Groundwater Discharge Dynamics into Stream Habitat Assessments

This lesson is intended as an introduction to field drawing and field data collection, and therefore should easily link into other lessons. The data collected in this lesson (velocities, grain size, discharge) can be used to describe habitat characteristics in ecology-focused activities, can be linked into hydraulic modeling, and can be compared to remotely collected or routinely collected data (e.g. from satellites or USGS gage data).

Additionally, this lesson is designed to be modular, so that the geomorphic data component could be substituted for a different data collection activity.

Field sketches and drawing should be incorporated in subsequent field lessons and in assessments. If sketching is only used once, students will not see it as an important component of their studies. But, as referenced above, sketching is a valuable technique that can enhance learning and foster scientific creativity.