Part 3: Macroinvertebrate Sampling Design Challenge

3.2 Lesson Sequence

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AT LEAST 30 DAYS PRIOR TO THE LESSON:

Apply for a joint permit. **See 3.1 Lesson Overview** for instructions.

This activity assumes that students have already done a habitat assessment and are familiar with macroinvertebrates as biological indicators. If they have not done the macroinvertebrate card sort, you may want the students to read **2.2b Indicators: Benthic Macroinvertebrates** in conjunction with this activity, or explore this video from PBS Learning Media on macros: https://ny.pbslearningmedia.org/resource/watsol.sci.ess.water.aquins/aquatic-insects/

Engage

Ask students how they would determine the water quality in a stream. Post their answers on the board and then have them identify some benefits and challenges to each these ideas. You might want to capture a few minutes of video of your stream or play a YouTube video like this one: https://www.youtube.com/watch?v=c2NmyoXBXmE to get students thinking about the physical and biological properties of their stream.

Next, in small groups, ask students to complete **3.2a What's the Problem?**

Explore

Research Hester Dendys **(**use **worksheet 3.2b Research Solutions**).

For this activity, students will learn about Hester-Dendy samplers and their use in streams. They will identify how the Hester-Dendy mimics the stream habitat and its limitations. They will also identify how they could alter/change the Hester-Dendy to better mimic the stream habitat

The 3.2b worksheet directs students to draw an image of a Hester-Dendy sampler and identify important parts. You may want to seed the idea of using a wingnut not a normal bolt and having washers on the top and bottom of the plates if you do not see students including this idea; or you may wish to allow this to be missed and address it when you evaluate your designs.

When researching, select the method that best suits your student ability level, time available, and access to the Internet. It would be best if you had a standard Hester-Dendy available for each student group to examine. Students can search the Internet for more information on Hester-Dendys and their use, or selected materials could be printed off and students could learn more by focusing on one article per group and summarizing it for the class.

Below is a list of suggested links to get the students started:

- How to make a Hester Dendy: https://streamsidescience.usu.edu/ou-files/ezplug/uploads/Who_lives_in_the_water/How_to_make_a_Hester-Dendy_-Who_Lives__in_the_Water.pdf

- YouTube videos:
  - Part 1: Install https://www.youtube.com/watch?v=haa29khmIa0,
  - Part 2: Removal https://www.youtube.com/watch?v=WTmVC70MXQg

- Hester-Dendys For Sale:
  - https://store.sciencefirst.com/hester-dendy-round-epa-each
    - Product Manual - https://wildco.com/wp-content/uploads/2017/05/150-A-Series-Hester-Dendy.pdf
  - http://www.hesterdendy.com/

- Indiana Department of Environmental Management Technical Standard Operating Procedure (TSOP) Hester-Dendy (H-D) Multiplate Artificial Substrate Macroinvertebrate Collection Procedure https://www.in.gov/idem/cleanwater/files/swm_sop_hd_multi_substrate_macro_collection.pdf

- Comparison of Three Macroinvertebrate Sampling Methods for Use in Assessment of Water Quality Changes in Flashy Urban Streams https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7490790/

Students are asked at the end of the worksheet to identify variables they can manipulate. Students might come up with:

- Plate materials
- Spacing between plates
- Size of plates
- Location in the stream
- Bolt length/number of plates (this might significantly increase the time for the teacher if you will be cutting/creating the plates that students will use)
- Putting material (food/debris between plates to attract organisms)

After groups have completed their **3.2b Research Solutions** worksheet, discuss as a class what variables will be appropriate for your class do change. This may be a good time to have students brainstorm possible materials. You might also want to have some on hand for them to examine.

The following activities will focus on manipulating the distance between plates and the type of material used for the plates. If your class decides to manipulate other variables, than you will need to adapt some of the worksheets to meet your needs.

Evaluate

3.2c Evaluate Building Materials & Design Layout

If you have the ability for students to use power tools (saws and drill press), you can have students attempt to make plates from several different materials as part of their evaluation. If students do not have access to tools, then you will want to have samples of materials available. You might want to include a fact sheet for each on how you have to cut it/price/time it took to make a plate from this material.

If students have to "buy" their materials they could purchase a 12" by 12" piece of the material from you and construct their plates from this. .

As a class, come up with a list of desired characteristics for your plates (or you can determine this ahead of time, depending on your class needs). Characteristics to be evaluated might include:

- Color: will insects be able to hide from predators, or will they stand out?
- Price: can you afford this as a class? This might require some math that students could work out, or you could provide them with an estimate. Remember when doing this to consider that you will lose some material when you make a cut.
- Durability in water: Will it last 4-6 weeks in the water? You might have students submerge the material in the water for a day or two, or prepare this ahead of time.
- Durability in general: does it break easily if dropped? Will it break if the water knocks it against the metal post/cement block?
- Surface: How rough or smooth is the surface? Will insects be able to attach to it?
- Ease to work - Do you need special equipment to cut it? Can you drill a hole in it?
- Thickness of material - if the material is too thick, it will reduce the number of plates/surface area for the insects.

Have students complete their material evaluation. At this point, you will need to determine what additional constraints you need to place on student designs. This will depend on individual class needs and limitations. Some classes might have the equipment and materials to allow for more flexibility, while others will be limited. If you have to purchase pre-made Hester-Dendy's, students can adjust distances between plates, number of plates, and add leaves or found materials in between layers.

Once students know what materials they want to use, they will need to design their layout. They should verify that their design will fit into the allowed thickness.

3.2d Build Prototype and Place in Stream

How this takes place will depend on the equipment and tools available to students. If you have time and equipment, students could cut and drill their plates, or these could be premade and students can assemble them. Be sure to label the Hester-Dendys by group. This can be done using tape around the eyebolt.

Having a good diagram of the prototype will assist in analyzing the results.

A standard Hester Dendy should be placed in the river at each sampling site to serve as a baseline for students to compare their designs to. When Hester Dendys are placed in the stream, it should be recorded where in the streambed they are placed. Students can determine the location and explain their reasoning for this if appropriate. Try to place Hester Dendys in a way that they will not attract attention from others. One challenge to Hester Dendy use is possible loss of samplers. Making them unobtrusive to the public will help reduce loss.

Wait 4-6 weeks

3.2e Evaluate Hester-Dendy & Suggest Improvements

Remember to have one group be in charge of taking apart and recording data on your standard Hester Dendy for each location.

Review with students that they need to be careful when taking apart their Hester Dendy to record where on the Hester Dendy they found the macroinvertebrates.

After students have had an opportunity to analyze their Hester Dendy, ask groups share out to each other what did and did not work before they create their suggestions for the next generation design.

Have students suggest improvements to your stream sampling. If there is time and interest, students can input their upgraded designs and run through the experiment again.

Extend

- Have students write a letter of advice to next year's class on the biggest challenges to completing the project, and advice they would give for designing a sampler.
- If you do more than one type of sampling, consider the results from each type and analyze benefits and limitations of each.
- If you used leaf packs in addition to the Hester-Dendy's, how could the two samplers be combined to make a super-sampler?
- Students can compare their findings to the closest Michigan DEQ macroinvertebrate sampling which can be found here: https://www.michigan.gov/documents/deq/wrd-monitoring-report-2014-lower-grand-watershed_606955_7.pdf