Biodiversity

OBJECTIVES

- Practice calculating biodiversity metrics
- Learn techniques for sampling stream invertebrates
- Evaluate how pollution affects stream biodiversity

ROADMAP

Species richness and **diversity** are valuable indicators of environmental health. Higher diversity typically reflects a well-functioning ecosystem, while habitat degradation such as pollution or introduction of invasive species often decrease diversity, especially via loss of more sensitive species in the community. For evaluating stream health, benthic invertebrates are relatively easy to sample and can provide key insights into water quality.

In today's lab, we'll practice methods for sampling and calculating stream biodiversity, including gathering virtual invertebrates from a simulated stream.

Calculating Biodiversity

Learn about biodiversity metrics and practice calculating Simpson's Diversity Index.

↓

Stream Biodiversity

Explore the importance of invertebrates as indicators of stream health and learn methods for sampling them.

↓

Virtual Stream Simulation

Collect virtual invertebrate samples from a stream, then evaluate species richness and diversity at different pollution levels.

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Submit Completed Worksheet to Blackboard before next lab.

Calculating Biodiversity

Name:

DIVERSITY INDEX

The **diversity** of species in an area is a combination of the number of species, or species richness, and how abundant each of these species are. The highest diversity is achieved in communities with many species and relatively even distribution of abundance, rather than one or two species dominating.

The **Simpson's Diversity Index (SDI)** is a number that can be used to quantify the diversity of a community. A higher number indicates a higher level of diversity (but is always a decimal <1).

$$\text{Simpson's Diversity Index } (D_s) = 1 - \frac{\sum n_i (n_i - 1)}{N(N-1)}$$

Where:
n_i = the # of individuals in a species
N = the TOTAL # of individuals across all species
Σ = "sum"

WARMUP

Using the two Symbol Populations below, practice calculating the SDI. For each population, write out the full SDI equation by plugging in all numbers you would need to calculate it (i.e. show your work). Double check your final answer.

Population 1

! & *
$ @ @
@ * $!
! ! & &
& * * *

Population 2

& * $
& & * $
$ $ $ &
& & & &
* * *

Symbol	Pop. 1	Pop. 2
!	4	0
&	4	8
*	5	5
$	2	5
@	3	0
Total	**18**	**18**

Calculate SDI for Symbol Population 1. Final answer should be 0.83.

Calculate SDI for Symbol Population 2. Final answer should be 0.69.

Stream Biodiversity

Name:

STREAM DIVERSITY

Aquatic biodiversity – including invertebrates, fish, reptiles, and algae – is a common metric for assessing the ecological health of streams. Today, we will focus on benthic invertebrates, which include insects, worms, mollusks, and arthropods (i.e. crabs). That they are "benthic" means they are bottom dwelling, usually found on the streambed or under rocks.

Stream assessments often include measurements of **water quality** such as pH, temperature, dissolved oxygen, nitrate concentration, and phosphorous concentration. While water quality data are certainly a useful metric to measure stream health, data from biological communities can be even more informative. This is because researchers can ground truth the health of the stream by seeing what *actually* lives there.

Watch **this short video on the importance of invertebrate sampling**. Describe at least two examples from the video of how invertebrates can inform us about stream health. Be specific!

SAMPLING METHODS

The methods researchers use to collect data on aquatic biodiversity vary based on what taxa they are interested in. A common method for sampling benthic invertebrates involves using a **kicknet or seine**.

The net is placed or held in the middle of a stream. A researcher then kicks up the sediment upstream of the net, causing any invertebrates or fish disturbed from their resting place to flow with the stream current into the net. This method might be combined with rock flipping, where large rocks are picked up and any organic material brushed off, along with hiding invertebrates.

Watch **this short video on kicknet sampling**. Typically, researchers will collect several samples from a single river. Why is this important?

If you were sampling a stream using a kicknet, and you had time to take 15 samples, where would you place your samples to get the best measure of stream health? Justify your answer.

Virtual Stream Simulation

VIRTUAL STREAM

Navigate to the **Virtual Biology Lab stream diversity simulation**. This model is loosely based on the water quality monitoring procedure of the Save Our Streams project of the Izaac Walton League of America. Read below to get an overview of the model. More specific instructions for your lab activity are on page 5.

Setup

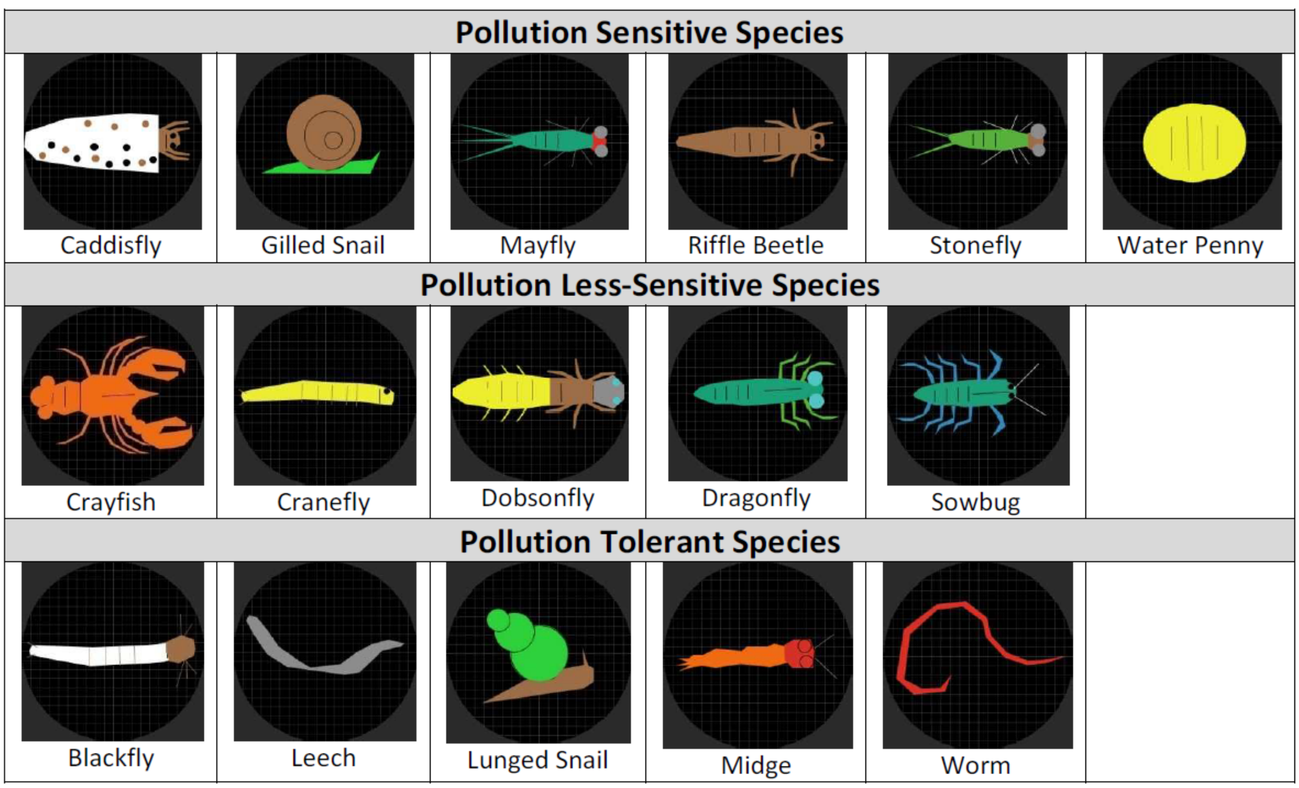
When the model opens, the world-view will show a section of stream with sixteen sample buckets below, one for each species of invertebrate (see figure at bottom of this page). On the top right is a “Pollution” drop down menu. We will start at “None,” then run additional simulations at increasing pollution levels. Leave the sampling time at the default (500).

Running

To set your net in the stream, click the “Open Seine” button. When you’re ready to begin your sample, click the “Go” button. As virtual invertebrates float by in the current, those caught in your net will automatically be sorted into their appropriate sampling bucket. You can also view statistics on the total number of species (“Total Species”) and individuals (“Total Catch”) caught. Sampling will automatically end when the specified sampling time has been reached.

Resetting

The “Reset” button clears all monitors and plots. Remember to reset your model in between each simulation you run, especially after changing the pollution level.



Simulated invertebrates. When “Pollution” is set to none, all species have similar probabilities of appearing. In the moderately polluted stream, the pollution sensitive species have low probabilities of appearing, the less-sensitive species have intermediate probabilities, and the tolerant species have high probabilities. When pollution is severe, sensitive species won’t appear, less-sensitive species have a low probability, and most species captured will be pollution tolerant.

Virtual Stream Simulation

Name:

STREAM SIMULATION

Following the model info on page 4, collect one virtual biodiversity sample each from a no pollution, moderate pollution, and high pollution steam. For each pollution level, record the # species caught, total species, and total catch in the tables below, then calculate the Simpson's Diversity Index (SDI). Keep sampling time constant at 500 for each simulation.

No Pollution

Pollution Sensitive	Caddisfly	Gilled Snail	Mayfly	Riffle Beetle	Stonefly	Water Penny
Count						
Pollution Less-Sensitive	Crayfish	Cranefly	Dobsonfly	Dragonfly	Sowbug	
Count						
Pollution Tolerant	Blackfly	Leech	Lunged Snail	Midge	Worm	
Count						

Total Species: **Total Catch:** **SDI:**

Moderate Pollution

Pollution Sensitive	Caddisfly	Gilled Snail	Mayfly	Riffle Beetle	Stonefly	Water Penny
Count						
Pollution Less-Sensitive	Crayfish	Cranefly	Dobsonfly	Dragonfly	Sowbug	
Count						
Pollution Tolerant	Blackfly	Leech	Lunged Snail	Midge	Worm	
Count						

Total Species: **Total Catch:** **SDI:**

Virtual Stream Simulation

Name:

High Pollution

Pollution Sensitive	Caddisfly	Gilled Snail	Mayfly	Riffle Beetle	Stonefly	Water Penny
Count						
Pollution Less-Sensitive	Crayfish	Cranefly	Dobsonfly	Dragonfly	Sowbug	
Count						
Pollution Tolerant	Blackfly	Leech	Lunged Snail	Midge	Worm	
Count						

Total Species: **Total Catch:** **SDI:**

Now that you've collected your samples, write 1-2 paragraphs evaluating how invertebrate biodiversity changes in response to stream pollution. At a minimum, include a comparison of species richness, species diversity, and prevalence of pollution sensitive versus tolerant species at different pollution levels, backing up your claims using data from your simulations.