Name____________________

Superior watersheds: Investigating stream health

Featured Scientists: Emma Holtan and Will Kendall with community volunteers from Superior Rivers Watershed Association. Written with: Andrea Pokrzywinski from Ashland High School.

Research Background

Fresh water is one of our most important natural resources and an essential daily need for all people. Ten percent of the world's freshwater is in Lake Superior. It is the largest lake in the world by surface area. It is also one of the cleanest, clearest, and coldest lakes in the United States.

Left: Will demonstrating how to conduct water testing. Right: A volunteer picking macroinvertebrates out of a stream sample.

Watersheds are the network of rivers and streams, called **tributaries**, that flow into a single point and empty into a larger body of water. The water at the end of a watershed therefore reflects all the changes that happened across a large area. Thousands of tributaries flow through forests, wetlands, and farmland before reaching Lake Superior. These tributaries carry soil, nutrients, and any pollution from the land into the lake.

For a long time, people living near Lake Superior assumed that the tributaries had good water quality, but they didn't have data to support this. In 2002, some residents living along the lake's southern shore in Wisconsin came together to monitor the health of local tributaries themselves. They were already hearing how climate change, pollution, and land use were affecting water systems around the world. They formed an organization, now called Superior Rivers Watershed Association (SRWA) to collect long-term data so they could track changes in local tributaries.

Today, over 20 years later, SRWA has an established monitoring program. Members train volunteers to visit streams and rivers to collect data. Through these volunteers, SRWA has data on over 50 tributaries in the Lake Superior watershed. They collect data on both the water chemistry of the tributaries, as well as the life they find there. This helps them understand how water conditions affect organisms.

Name____________________

Left: Will sampling macroinvertebrates in a small stream. Right: A dragonfly larvae found in one of the samples.

Every spring and fall, volunteers visit their sites and sample **macroinvertebrates**, or small organisms that spend most or all their lives living on the stream bottoms. Many are larvae for insects you might know, such as dragonflies. After collecting samples, the volunteers identify each type of macroinvertebrate.

Each species has a different tolerance for stress, such as pollution, changes in temperature, low oxygen, or flooding. So, along with their biological data SRWA also collects data such as temperature, the amount of oxygen available in the water, and **turbidity**, or the amount of sediment in the water. Some species are **indicators** of good water quality because they need very clear, cold water, with a lot of oxygen, while others can survive in dirtier or harsher conditions. By seeing which macroinvertebrates live in each stream, scientists can learn about the health of the water.

Two scientists, Will and Emma, are now analyzing over 20 years of volunteer data to identify trends and patterns. They want to see whether the water quality variables of temperature, dissolved oxygen, and turbidity affect the types of macroinvertebrates that can live in the tributaries. If there are a lot of sensitive indicator species in the sample, that is a good sign because it means the water quality is high. If they only find tolerant species, the water quality is likely poor, because indicator species were unable to survive in the environmental conditions at that site.

To do so, they use a tool called the Hilsenhoff Biotic Index. This index looks at which macroinvertebrates are present and how tolerant they are to pollution. HBI uses the living organisms that live at a site to provide an assessment of stream health over time, unlike chemical water tests which provide a snapshot of conditions at the time of testing. The index assigns a number from 1 to 10 based on the number and type of species in the sample. Lower numbers mean excellent water quality, and higher numbers mean poor water quality.

Name____________________

A preserved specimen found while sorting a macroinvertebrate sample in the lab.

Scientific Question: What are the water conditions in streams that support macroinvertebrate communities with sensitive indicator species?

What is the hypothesis? Find the hypothesis in the Research Background and underline it. A hypothesis is a proposed explanation for an observation, which can then be tested with experimentation or other types of studies.

Scientific Data: **Use the data and HBI interpretation guide below to answer the scientific questions. The table shows averages from all data collected at these sites during spring sampling efforts.**

HBI Interpretation Guide

HBI Score	Water Quality	Ecosystem Condition
0.0–3.5	Excellent	Very clean water
3.6–4.5	Very Good	Slight pollution
4.6–5.5	Good	Some organic pollution
5.6–6.5	Fair	Moderate pollution
6.6–7.5	Poor	Significant pollution
7.6–10	Very Poor	Severe pollution

Name____________________

Sampling Site	Average water temperature (degrees Celsius)	Average dissolved oxygen (mg/L)	Average turbidity (NTU)	Average Hilsenhoff Biotic Index (HBI)
Bad River 1	5.9	10.3	7.2	3.7
Bad River 2	8.9	8.2	4.8	4.8
Barr Creek	7.4	10.4	5.8	2.6
Bono Creek	8.9	12.0		4.7
Brunsweiler River	7.8	10.2	4.9	2.9
Little Sioux River	6.7	10.8	18.1	3.0
Long Lake Brook	4.1	11.5	11.4	1.6
Marengo River 1	8.1	10.3	11.8	2.6
Marengo River 2	10.5	9.1	2.8	3.2
Montreal River	7.0	9.7	5.0	4.0
Onion River	5.3	11.2	10.5	3.2
Potato River	9.0	10.5	4.9	3.1
Tyler Forks	4.7	10.5	4.5	2.9
White River	8.4	10.2	21.8	3.2

Note: NTU is a unit for turbidity that is based on how much light scatters in water. If there are more sediments, algae, or other organic matter, the water is more turbid, and the NTU values will be higher.

What data will you graph to answer the question?

Independent variables: ____

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Dependent variable: ____

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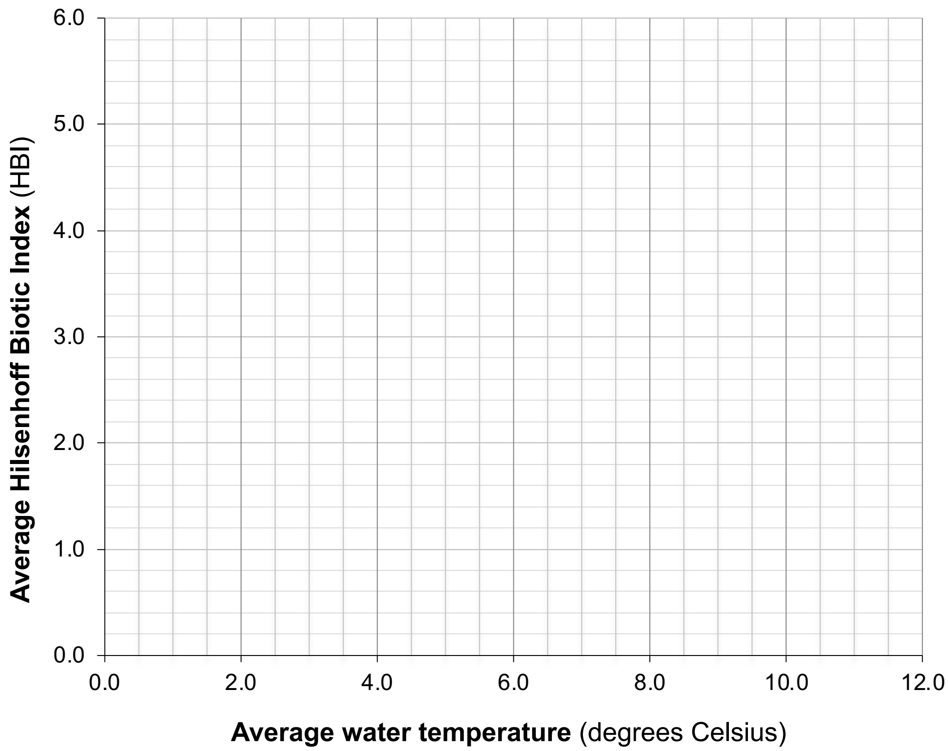
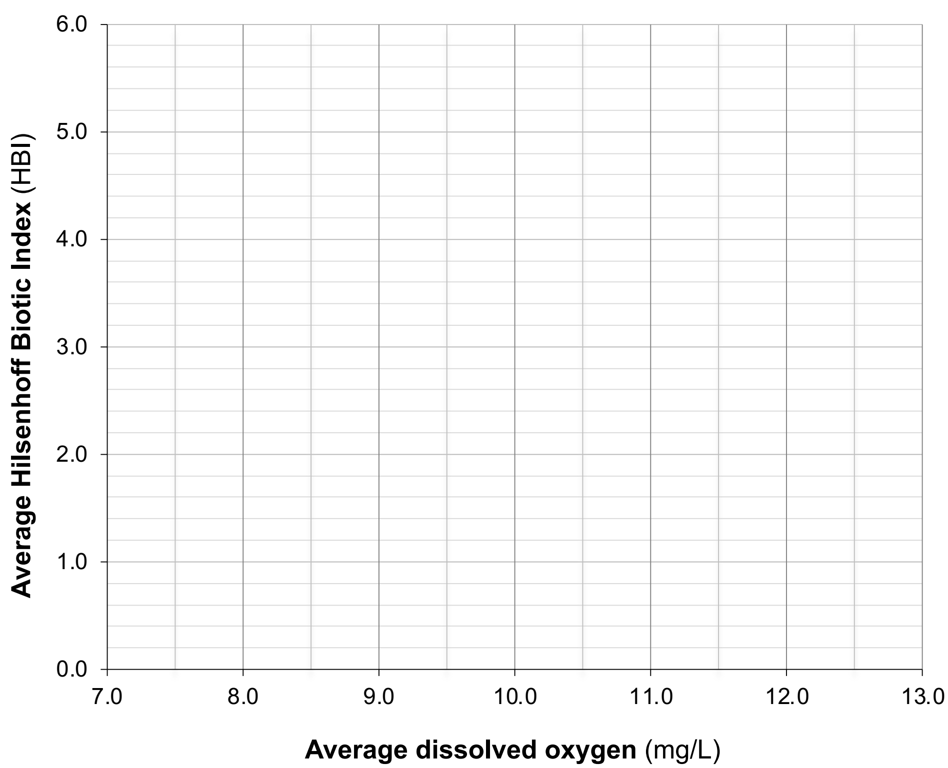
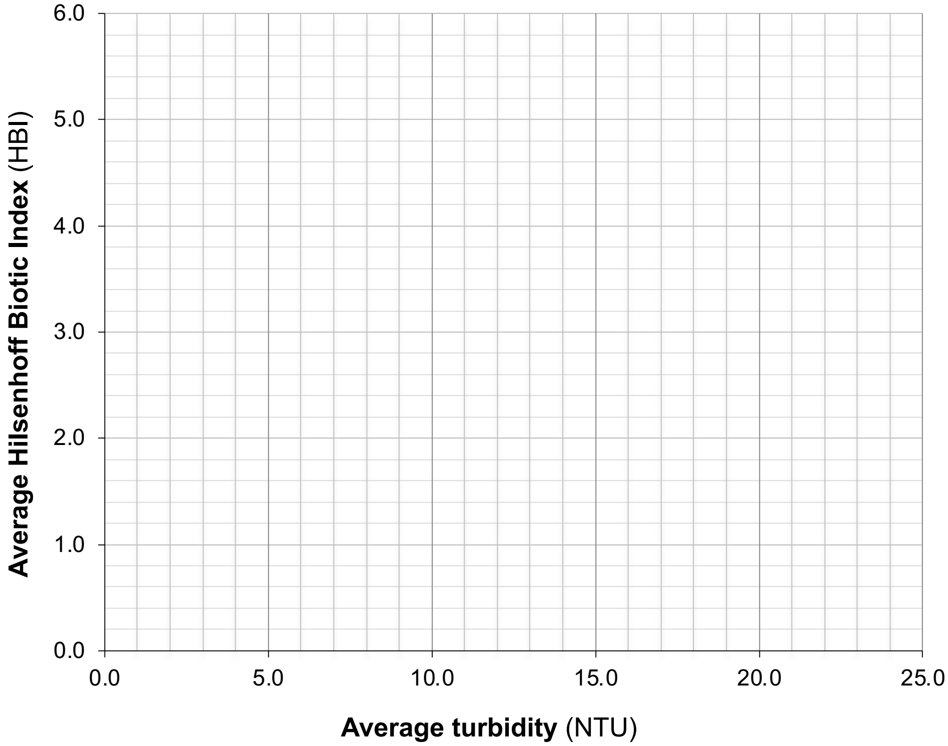
Name____________________

Below are graphs of the data: Identify any changes, trends, or differences you see in your graph. Draw arrows pointing out what you see and write one sentence describing what you see next to each arrow.





Name____________________



Interpret the data:

Make a claim that answers the scientific question - What are the water conditions in streams that support macroinvertebrate communities with sensitive indicator species?

What evidence was used to write your claim? Reference specific parts of the table or graph.

Name____________________

Explain your reasoning and why the evidence supports your claim. Connect the data back to what you learned about the sensitive and tolerant macroinvertebrates and the conditions they can live in.

Did the data support Emma and Will's hypothesis? Use evidence to explain why or why not. If you feel the data are inconclusive, explain why.

Your next steps as a scientist: Science is an ongoing process. What new question(s) should be investigated to build on Emma and Will's research? How do your questions build on the research that has already been done?