

Freshwater Indicator Species: Overview

Summary

This activity will place students in the position of a biologist who has been contracted by the Environment Protection Agency (EPA) to report on the quality of water samples. Students will have to identify different freshwater aquatic organisms from water samples, assign them SIGNAL scores, then draw conclusions on the quality of the different water samples.

Curriculum Outcomes: Victorian Curriculum F-10

Levels 9 and 10

Biological Sciences

- Ecosystems consist of communities of interdependent organisms and abiotic components of the environment; matter and energy flow through these systems (VCSSU121).

Recording and processing

- Construct and use a range of representations, including graphs, keys, models and formulas, to record and summarise data from students' own investigations and secondary sources, to represent qualitative and quantitative patterns or relationships, and distinguish between discrete and continuous data (VCSIS137).

Analysing and evaluating

- Analyse patterns and trends in data, including describing relationships between variables, identifying inconsistencies in data and sources of uncertainty, and drawing conclusions that are consistent with evidence (VCSIS138).

Communicating

- Communicate scientific ideas and information for a particular purpose, including constructing evidence-based arguments and using appropriate scientific language, conventions and representations (VCSIS140).

Freshwater Indicator Species

Introduction

In this activity, you are playing the role of a biologist in a water pollution consultancy business. You have been contracted by the Environment Protection Agency (EPA) to report on the quality of some water samples. While other scientists will be working on the physical and chemical qualities of the water, your job will be doing a biological analysis.

Small Freshwater Aquatic Organisms

Freshwater aquatic organisms vary greatly in size. Some are microscopic bacteria that are only visible with a powerful microscope, while other organisms that can be many kilograms in weight, such as fish.

In this activity, you will be concentrating on organisms that can be just seen with the naked eye but seen clearly with low power microscopes. These organisms will include invertebrates, algae and some tiny plants.

Invertebrates

Animals without a backbone

- Protists - single-celled organisms
- Ciliates – rotifers and stentors
- Worms
- Crustaceans
- Insects
- Molluscs

Algae

- Simple photosynthesising aquatic organisms
- Unicellular e.g. chlorella
- Multicellular e.g. spirogyra

Plants

Complex multicellular photosynthesising organisms with cellulose cell walls, e.g. duckweed.

Indicator Species

An indicator species is an organism whose presence, absence or abundance reflects a specific environmental condition. For example, some organisms will only grow in very clean unpolluted water while others will grow abundantly in polluted water.

Equipment and materials

- Microscope – compound and stereo
- Petri dishes
- Cavity slides
- Flat glass slides
- Cover slips
- Droppers

A good reference is *A Beginners Guide to Waterbugs* produced by Melbourne Water:

<https://www.melbournewater.com.au/media/117>.

Instructions/directions

1. Collect samples to be analysed.
2. Look carefully at each sample of water. Note its appearance. Make sure you look very carefully at each sample and describe it as accurately as you can.
3. Put the sample into a petri dish. Use a magnifying glass and/or a stereo microscope look for small organisms. If the organisms are very small place a drop of water containing them on a flat slide. If the organism is large place it with some water on a cavity slide.
4. To observe organisms more closely, use a plastic Pasteur pipette (dropper) to suck the organism up and transfer it to a microscope slide with water. Observe at low power and if necessary at high power. In each case cover with a coverslip trying to exclude air bubbles.
5. Bring the specimen/s into focus. Use the information provided in the table below and any other resources available to identify the organism. Some things you see might be debris, that is, just bits of dead and decaying plant matter.
6. Try to estimate the abundance of the organism. That is, the number of this type of organism in your sample. If you can count them that would that is best, but you may have to make a rough guess. In your sample is there 1, 10s, 100s, 1000s of the organism?
7. If the organism has a **Signal Number** record it. This scoring system allows us to use the organisms in your samples to very roughly measure the pollution level of the water.
 - Organisms that need **unpolluted water** are given a high Signal Number;
 - Organisms that can live in **polluted waters** get a low Signal Number.
8. Calculate the **Signal Score** from each sample, by adding up all the signal numbers of the organisms you have found and then dividing the total by the number of types of organisms in the sample. A Signal Score that is higher than six, indicates healthy water. A Signal Score that is lower than four, indicates pollution.

Results and Analysis

Sample			
Appearance of Sample			
Organism	Abundance	Signal Number	Comments
Signal Score			

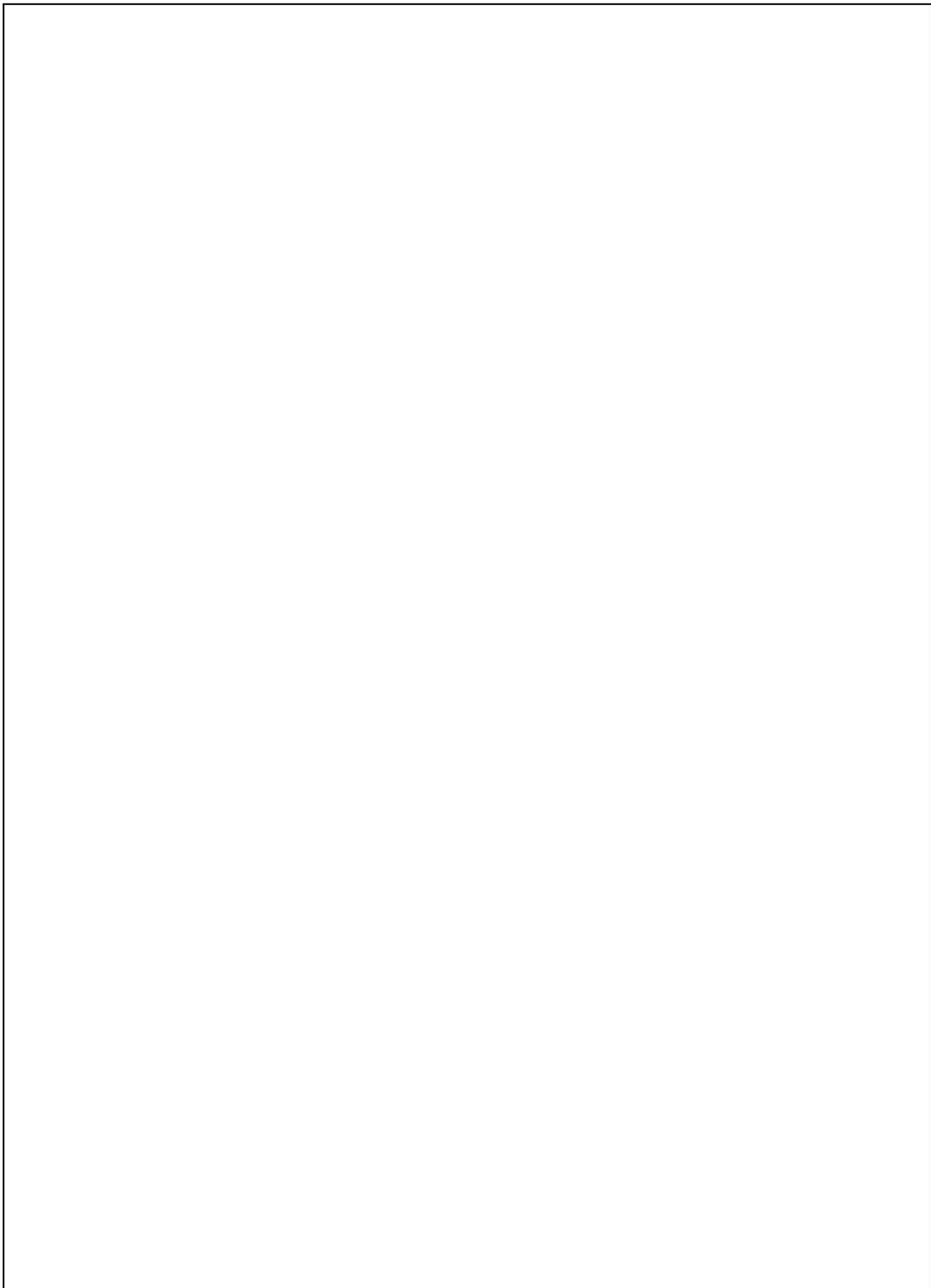
Sample			
Appearance of Sample			
Organism	Abundance	Signal Number	Comments
Signal Score			

Sample			
Appearance of Sample			
Organism	Abundance	Signal Number	Comments
Signal Score			

Sample			
Appearance of Sample			
Organism	Abundance	Signal Number	Comments
Score			

Drawing conclusions

Write your conclusions for each sample of water for inclusion in a report to the EPA. Be sure to write whether you think the water is polluted, in what way it might be polluted and indicate the evidence you are using to support you claims.



Further Questions

Question 1: What makes a good indicator species?

Question 2: What would an abundance of a certain species suggest?

Question 3: What could contribute to poor waterway health?

Question 4: Why is it important to monitor waterway health?

Question 5: Are there indicator species that are not aquatic?

Question 6: Would a stream with only 5 species of aquatic organisms be healthier than a stream with 50?

Short Guide to Small Freshwater Organisms

Name	Image	Where found	Signal Number
Planaria (flat worms)	 Footnote ¹	Found in a wide range of freshwater habitats, but can tolerate polluted water. Found on the under surfaces of leaves, branches and rocks. In low oxygen conditions, they will come to the surface.	2
Ostracods	 Footnote ²	Ostracods are found in a range of freshwater and saltwater habitats. They tend to be in abundance in warmer conditions.	5
Backswimmers	 Footnote ³	Maybe quite large. One of several types of aquatic insects with special paddle-like legs for swimming.	1
Daphnia	 Footnote ⁴	Small semi-transparent crustaceans visible under low power microscope.	5
Leeches	 Footnote ⁵	Leeches are segmented worms like earthworms but they tend to be predators. There are a few parasitic species	1

¹ Image by Holger Brandl, HongKee Moon, Miquel Vila-Farré, Shang-Yun Liu, Ian Henry, and Jochen C. Rink - PlanMine - a mineable resource of planarian biology and biodiversity. Nucleic Acids Res. 2016 Jan 4; 44(Database issue): D764–D773., CC BY 4.0, <https://commons.wikimedia.org/w/index.php?curid=47108231>

² Image by Anna33 at English Wikipedia, CC BY 2.5, <https://commons.wikimedia.org/w/index.php?curid=3414970>

³ Image in Public Domain, <https://commons.wikimedia.org/w/index.php?curid=378120>

⁴ Are We Underestimating Species Extinction Risk? PLoS Biology Vol. 3/7/2005, e253

doi:10.1371/journal.pbio.0030253, CC BY 2.5, <https://commons.wikimedia.org/w/index.php?curid=1430082>

⁵ Image by Karl Ragnar Gjertsen Own work, CC BY 2.5, <https://commons.wikimedia.org/w/index.php?curid=1614444>

Damselfly Nymphs	 Footnote ⁶	An aquatic stage in the lifecycle of damselflies (like small dragon flies)	8
Paramecium	 Footnote ⁷	Single-celled protists visible under low power compound microscope. Move rapidly.	N/A
Euglena	 Footnote ⁸	A small single-celled protist, which is only clearly visible at high power.	Varies
Rotifers	 Footnote ⁹	Simple multicellular organism that uses beating cilia to move and to move food into its mouth	5
Stentor	 Footnote ¹⁰	A filter feeding multicellular ciliate. Moves food into its trumpet-shaped mouth with beating cilia.	5
Amphipod	 Footnote ¹¹	There are many species of these small crustaceans. They feed on dead and decaying matter	5
Vinegar eel	 Footnote ¹²	Found in water with a low pH (acidic)	1

⁶ Image by Charlesjsharp - Own work, from Sharp Photography, sharpphotography, CC BY-SA 3.0, <https://commons.wikimedia.org/w/index.php?curid=33922101>

⁷ Image by Deuterostome - Own work, CC BY-SA 3.0, <https://commons.wikimedia.org/w/index.php?curid=25530266>

⁸ Image by Rogelio Moreno - Rogelio Moreno, CCO, <https://commons.wikimedia.org/w/index.php?curid=19389802>

⁹ Image From: <https://en.wikipedia.org/wiki/Cephalodella> CC-BY-SA-3.0

¹⁰ Image in: Public Domain, <https://commons.wikimedia.org/w/index.php?curid=57073>

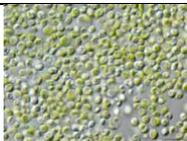
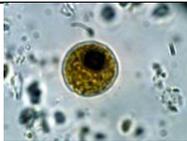
¹¹ Image by Uwe Kils - <https://commons.wikimedia.org/wiki/File:Hyperia.jpg>, CC BY-SA 3.0,

<https://commons.wikimedia.org/w/index.php?curid=50658752>

¹² Image: http://www.carolina.com/images/product/large/133266_la.jpg

Segmented worms	 Footnote ¹³	Usually found in the mud and decaying debris at the bottom. Found in most locations but abundantly in polluted water. Often have a red blood vessel running the length of the body	1
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Short Guide to Plants and Algae

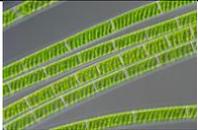
Name	Image	Where found	Signal Number
Chlorella	 Footnote ¹⁴	When found in large numbers can indicate an algal bloom because of pollution from fertilisers. Clearly visible at high magnification.	Varies In very large numbers, 1
Chlamydomonas	 Footnote ¹⁵	Microscopic algae with flagella found in many habitats including stagnant water. Clearly visible at high magnification.	5
Duckweed	 Footnote ¹⁶	A flowering aquatic plants which float on or just beneath the surface of still or slow-moving bodies of fresh water and wetlands.	N/A

¹³ Image by Michael Wigle <http://www.yorkshiredalesrivertrust.com/river-processes-secondary-school-resources/>

¹⁴ Image: Neon CC BY-SA 3.0 https://upload.wikimedia.org/wikipedia/commons/8/83/Chlorella_vulgaris_NIES2170.jpg

¹⁵ Image by Environmental Protection Agency - http://www.epa.gov/glnpo/image/viz_nat6.html, Public Domain, <https://commons.wikimedia.org/w/index.php?curid=2776712>

¹⁶ Image by Kurt Stüber [1] - caliban.mpiz-koeln.mpg.de/mavica/index.html part of www.biolib.de, CC BY-SA 3.0, <https://commons.wikimedia.org/w/index.php?curid=5225>

Name	Image	Where found	Signal Number
Azolla	 Footnote ¹⁷	A plant that floats on the surface of the water. In large amounts, it can suffocate a body of water preventing	N/A
Spirogyra	 Footnote ¹⁸	Slimy green algae that grows near the edge of some waterways.	Varies

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¹⁸ Image by Wiedehopf20 - Own work, CC BY-SA 4.0, <https://commons.wikimedia.org/w/index.php?curid=45272023>