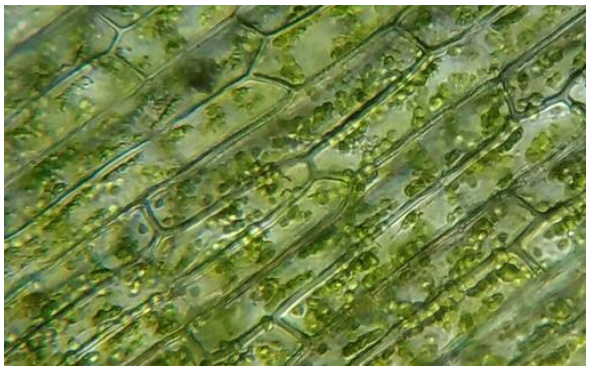
Freshwater Indicator Species – Worksheet

Adapted by: Louise Lopes, based on the workshop investigation by Ian Bently

Introduction:

Do you like creepy crawlies? A big concern for environmental scientists is the loss of biodiversity. Usually, a high variety of plant and animal life lets us know that an ecosystem is in a healthy and balanced state. It is when there is an overgrowth of one particular plant or animal that we can see that the environment is changing too fast to be sustainable. When an environment is not in a balanced state, it can degrade and become inhabitable for native flora and fauna.

Therefore, the animals and plants that we observe can be an indication of what state a particular environment is in. 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.

<table>
<tr><th colspan="2">Biodiversity of Water Systems</th></tr>
<tr><th>Algae</th><th>Plants</th></tr>
<tr><td>•Simple photosynthesising aquatic organisms
• Unicellular e.g. chlorella
• Multicellualar e.g. spirogyra
 
Figure 1</td><td>Complex multicellular photosynthesising organisms with cellulose cell walls
 
Figure 2</td></tr>
<tr><th>Invertebrates - animals without a backbone</th><th>Small Freshwater Aquatic Organisms</th></tr>
<tr><td>• Protists - single-celled organisms
• Ciliates – rotifers and stentors
• Worms
• Crustaceans
• Insects
• Molluscs
 
Figure 3</td><td>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.
 
Figure 4</td></tr>
</table>

Question:

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 Authority (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.

Using details about where your samples come from and the overall purpose of your research, write an Aim for your report:

Write a hypothesis by making predictions on what your samples will show. Consider the environment that your sample was collected from. Are they from waterways in an industrial zone or from a protected area like a State Park?

Plan:

Equipment and materials

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

Conduct:

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.

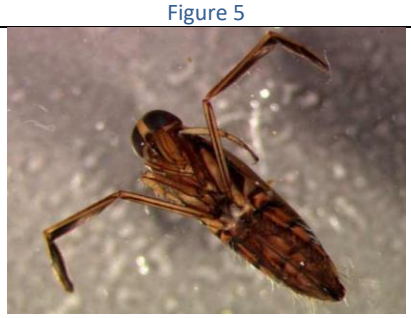
6. Try to estimate the abundance of the organism. That is, the number of this type of organism in your sample. If you can count them that would that is best, but you may have to make a rough guess. In your sample is there 1, 10s, 100s, 1000s of the organism?

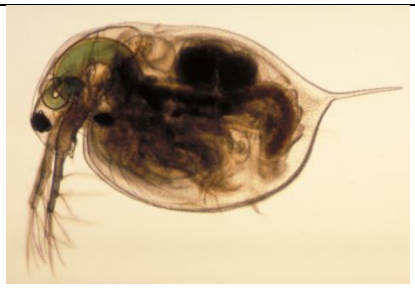
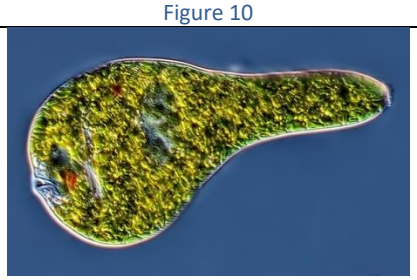
7. If the organism has a **Signal Number** record it. This scoring system allows us to use the organisms in your samples to very roughly measure the pollution level of the water.

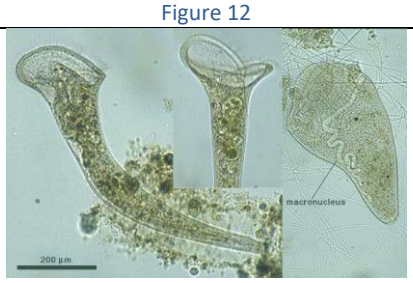
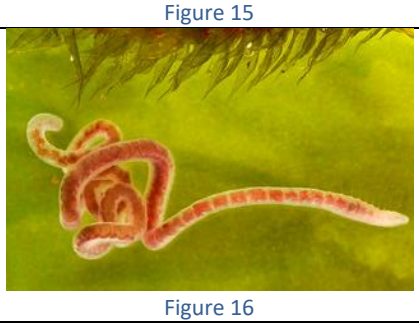
• Organisms that need **unpolluted water** are given a high Signal Number;

• Organisms that can live in **polluted waters** get a low Signal Number

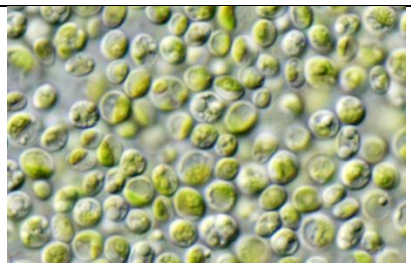
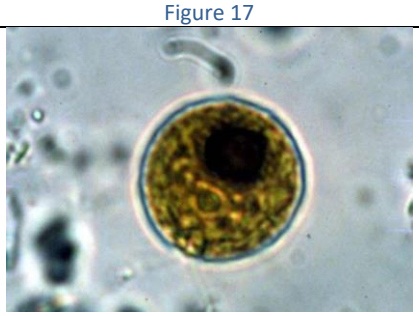
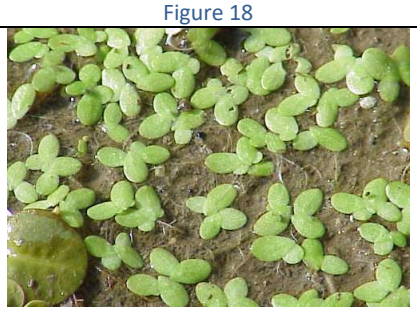
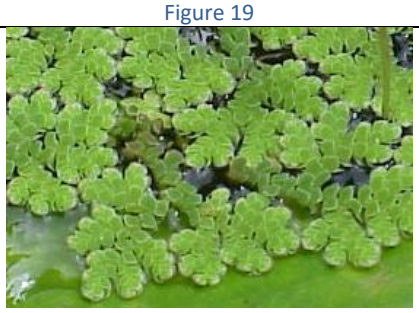
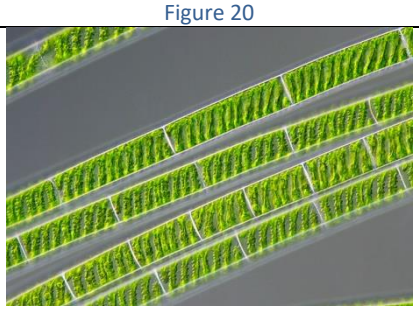
Short Guide to Small Freshwater Organisms

Name	Image	Where found	Signal Number
Planaria (flat worms)	 Figure 4	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	 Figure 5	Ostracods are found in a range of freshwater and saltwater habitats. They tend to be in abundance in warmer conditions.	5
Backswimmers	 Figure 6	Maybe quite large. One of several types of aquatic insects with special paddle-like legs for swimming.	1

Daphnia	 Figure 7	Small semi-transparent crustaceans visible under low power microscope.	5
Leeches	 Figure 8	Leeches are segmented worms like earthworms but they tend to be predators. There are a few parasitic species	1
Damselfly Nymphs	 Figure 9	An aquatic stage in the lifecycle of damselflies (like small dragon flies)	8
Paramecium	 Figure 10	Single-celled protists visible under low power compound microscope. Move rapidly.	N/A
Euglena	 Figure 11	A small single-celled prostist, which is only clearly visible at high power.	Varies

Rotifers	 Figure 12	Simple multicellular organism that uses beating cilia to move and to move food into its mouth	5
Stentor	 Figure 13	A filter feeding multicellular ciliate. Moves food into its trumpet-shaped mouth with beating cilia.	5
Amphipod	 Figure 14	There are many species of these small crustaceans. They feed on dead and decaying matter.	5
Vinegar eel	 Figure 15	Found in water with a low pH (acidic)	1
Segmented worms	 Figure 16	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

Short Guide to Plants and Algae

Name	Image	Where found	Signal Number
Chlorella	 Figure 17	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	 Figure 18	Microscopic algae with flagella found in many habitats including stagnant water. Clearly visible at high magnification.	5
Duckweed	 Figure 19	Flowering aquatic plants which float on or just beneath the surface of still or slow-moving bodies of fresh water and wetlands	N/A
Azolla	 Figure 20	A plant that floats on the surface of the water. In large amounts, it can suffocate a body of water preventing	N/A
Spirogyra	 Figure 21	Slimy green algae that grows near the edge of some waterways.	Varies

Sample			
Appearance of Sample			
Organism	Abun-dance	Signal Number	Comments

Sample			
Appearance of Sample			
Organism	Abun-dance	Signal Number	Comments

Sample			
Appearance of Sample			
Organism	Abun-dance	Signal Number	Comments

Sample			
Appearance of Sample			
Organism	Abun-dance	Signal Number	Comments

Sample			
Appearance of Sample			
Organism	Abun-dance	Signal Number	Comments

Sample			
Appearance of Sample			
Organism	Abun-dance	Signal Number	Comments

Analyse:

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. Record your results below:

- A Signal Score that is **higher than six** indicates healthy water;
- A Signal Score that is **lower than four** indicates pollution.

Problem-Solving:

Write a report to the EPA which includes your findings. 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 your claims.

Include in your report a discussion on the reliability of your findings. Where there any sources of error in your investigation? How could you improve your experimentation in the future?

Conclusion:

Provide a brief summary of your report here. Also include whether you achieved your Aim and if your predictions were correct.

References:

Figure 1 – aitoff, https://pixabay.com/en/seaweed-rock-round-beach-seaside-2205570/
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Figure 2 – Vierschilling, https://pixabay.com/en/waterweed-plant-cell-mikroskopieren-1582259/
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Figure 3 – ShirleyHoy, https://pixabay.com/en/crab-crustacean-pincer-1573088/
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Figure 4 – kkeung0506, https://pixabay.com/en/carp-freshwater-fish-fishes-2511700/
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Figure 4 - 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

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Figure 7 – 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

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Figure 12 – Image From Omegachysis, CC BY-SA 4.0 International
https://commons.wikimedia.org/wiki/File:Pair_of_Rotifers,_likely_Euchlanis,_from_Northeast_US_Pond_sample.jpg

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