Choking our waterways

Key Learning Outcomes

Level 4 Science: Living together
Identify living and non-living things that affect the survival of organisms in an ecosystem.

Level 5 Science: Living together
Explain the effects of various environmental changes on living things in ecosystems

Aims

- to develop understandings about the impacts of sediment on waterways
- to develop understandings about how sediment enters waterways

Materials

For each student:

Student sheet 10: Choking our waterways.

Student information sheet 4: Turbidity.

For each group:

2 large clear jars of the same size, one with a lid

2 plastic aquarium plants or 2 pieces of a weed

several large dried beans (e.g lima beans)

macaroni noodles

white rice (about 10-15 grains)

styrofoam (reuse food trays)

plasticine (enough for 6 small lumps)

scissors

string

paper clips

hole punch

soil (about half a cup)

texta

Advanced preparation

1. Duplicate required numbers of Student sheet 10 and the Turbidity information sheet.

Activity instructions

1. Make sure students know these words before they undertake the activity.

   [sediment soil or dirt

   smother to suffocate or prevent from getting air

   spawning the process of laying eggs by fish and frogs

   submerge to sink beneath the surface of the water

   suspended solids soil suspended in water]
2. Organise student groups and distribute materials.
3. Explain that the dried beans, white rice and macaroni noodles are to represent aquatic animals.

   [*See step 3 in Student sheet 10.*]
4. Students make up their model 'lakes', add soil to one, and observe the result.

   [*Soil becomes suspended in the water as suspended solids which makes the water muddy looking. Eventually the suspended soil particles settle to the bottom.*]
5. Students complete the student sheet.
6. Explain that this is a representation of what goes on in lakes, creeks and rivers that are polluted by excessive erosion.
7. If you know of any, discuss a local example, that the students may be familiar with, of a waterway or lake affected by sediment.
8. After students have completed their sheets, summarize the findings as a class to reinforce the key concepts:

   [*Sediment clouds the water, affecting life within it.*

   Sediment settles on plants and some animals, suffocating them.]

For Level 5, ask students for more detailed answers.

Note
If the water is brown but clear this indicates there are tannins in the water rather than suspended solids. Tannins are dissolved chemicals which come from the native vegetation around the waterway. Tannins make the water look like weak black tea and are not harmful to aquatic life.

[Adapted from Sediment activity *Chesapeake Choices and Challanges*. Chesapeake Bay Foundation and Maryland State Dept Education. USA. 1995.]

Student sheet 10

Choking our waterways

This activity involves making up 2 identical jars to represent an aquatic environment. Soil is added to one of the model 'lakes' to see what effect sediment can have on waterways.

Materials

For each group:
2 large clear jars of the same size, one with a lid
2 plastic aquarium plants or 2 pieces of a weed
several large dried beans (e.g lima beans)
macaroni noodles
rice (about 10-15 grains)
styrofoam (reuse food trays)
plasticine (enough for 6 small lumps)
scissors
string
paper clips
hole punch
soil (about half a cup)
texta

Activity instructions

To make the model 'lakes':

1. Cut out several small fish from the styrofoam, punch a hole in each of them and attach a paper clip through the hole.
2. The plant represents an aquatic plant, the beans could represent aquatic animals such as mussels, the macaroni could represent free-swimming macro-invertebrates while the rice could represent fish or frog eggs. Use separate lumps of plasticine to anchor the 'plant', several beans and the rice to the bottom of the jar. Do not attach the macaroni.
3. Tie a loop of string around each jar, from top to bottom, placing it so the string loops over the top of the jar. By connecting several paper clips together, suspend the fish into each jar.
4. Once both jars have been set up, add water. Label the 'lake' with the lid 'Plus Sediment'.

To test the model 'lakes':

5. Draw a diagram for each of your model 'lakes'. Label the organisms you are representing in each of the jars. Describe what the water looks like in both 'lakes'.

Jar 1 **Jar 2**

6. Add the soil to the 'Plus Sediment' jar. Put the lid on firmly and shake the jar.

Choking our waterways

7. Compare the 2 jars. How does the water in each 'lake' looks now. Draw the 2 jars as a record.

Jar 1 **Jar 2**

8. Through which jar could sunlight pass most easily? To which organism(s) in your 'lake' is sunlight important and why?
9. Read the Turbidity information sheet.

After 5 minutes have passed (while you were reading the sheet), observe the 2 jars again. What happened to the suspended soil in the water? Draw and label a diagram for each of your model 'lakes' to show any changes that have occurred.

Jar 1 **Jar 2**

10. Write a sentence to summarise your conclusions from this experiment.
11. Summarize how sediment affects each type of aquatic life represented in your jar. Does the sediment affect the organism when the sediment is suspended in the water or when it settles, or both?

Aquatic plant/animal **Effects of sediment**

Turbidity

Turbidity

Turbidity is the name for the clarity or clearness of a waterway. Soil particles can causes the water to look muddy or murky. Rivers usually turn brown after heavy rain. That is because the runoff picks up soil particles when it flows over exposed soil and carries this to the river. In the river these soil particles become mixed with the water and when in this state they are called 'suspended solids'. Over time if the water is calm these suspended solids slowly sink to the bottom and the water becomes clearer.

Turbidity can also be caused by some algae. Millions of very tiny floating algae cause the same effects as soil particles in the water.

High levels of salt can also increase turbidity levels. High turbidity usually means poor water quality.

How does turbidity affect water quality?

The suspended soil particles (or algae) cloud the water and block sunlight from reaching the bottom of a shallow lake or waterway.

Soil particles floating in the water absorb heat from the sun and raise the water's temperature This lowers the oxygen levels in the water (because warm water holds less oxygen than cold water).

Floating particles can clog the gills of insects and fish, making it hard for these animals to breathe.

When the floating particles sink, they can smother and kill the eggs of aquatic insects and fish that have been laid on the lake bed or river bed. This sediment can also remove habitat. It can fill in the small holes and cover rocks on the lake or river bed that are used by small animals.

Plant growth is reduced because less sunlight is able to reach the leaves of plants growing on the lake or river bed. This vegetation is very important food and habitat for many aquatic animals.

Every time there is a storm, these settled sediments are stirred up again into the waterway.

How humans affect turbidity

Any human activity that increases erosion on land, especially land nearby lakes and waterways, leads to increased turbidity in their water.

[Adapted from *Water Studies for Younger Folk.* GREEN. 1992.]

Complete these sentences

1. If the soil is muddy it is because _____particles from erosion are present.
2. If the water looks green it is because of _____.
3. Turbidity in water makes it harder for insects and fish to survive because there is less _____in muddy water.
4. In general, high turbidity means good / poor water quality. [cross out the wrong word]

Please don't feed the river

Conduct this experiment as a demonstration or organise students to conduct it in small groups.

Key Learning Outcomes

Level 4 Science: Living together
Identify living and non-living things that affect the survival of organisms in an ecosystem.

Level 5 Science: Living together
Explain the effects of various environmental changes on living things in ecosystems.

Aims

- to understand that phosphorus and nitrogen are major ingredients of fertilisers (natural and manufactured)
- to understand that phosphorus and nitrogen also occur in many other substances
- to observe the effects of fertiliser on water
- to draw conclusions about the relationship between fertilisers and water quality

Materials

Per group:

2 one litre glass jars or clear containers of the same size

2 teaspoons of fertiliser

3 litres of pond or creek water

Student Information sheet 5: Phosphorus

Student sheet 12B: Effects of nutrients on the river

[If a demonstration, use 2 two litre containers and double the quantity of fertiliser].

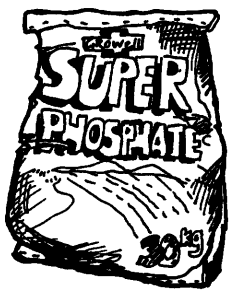
Advanced preparation

1. Plan this activity for a Monday so that you have 5 days to record the results. Alternatively, do not monitor every day.
2. Collect the pond or creek water.
3. Duplicate required numbers of the above Student and information sheets
4. Organise space on a sunny window sill for the jars.

Activity instructions

1. As a class discuss and list how fertilisers are used in the community.

   [*On farms and gardens to make plants grow.*]



2. Explain that Phosphorus and Nitrogen are two natural ingredients of many materials. When these materials break down (decompose) they release these nutrients. Discuss and list some of these.

   [*E.g. animal manure, sewage*]
3. Explain that Phosphorus is also an ingredient of some detergents and laundry powders.
4. Organise student groups for the experiment.
5. Explain that tap water contains chlorine to kill organisms so we need to use untreated water.
6. Explain that one of the jars is the control, so no fertiliser is added to it. It is used for comparison with the test jar which has fertiliser added.
7. Students conduct the experiment and record the results for Day 1.
8. Put the uncovered jars in a sunny window for one week.
9. Students or teams inspect the jars each day for 5 days and record their observations (colour, odour).

   [*The green growth is algae.*]
10. Keep the remainder of the creek water in a separate jar for students to use to top up the experiment jars if the water evaporates below the lines on the jars.
11. Record observations each day.
12. As a class, discuss the results of the experiment. Which jar looks more polluted?

    [*The one with fertiliser added.*]
13. Summarize ways that excess levels of nutrients can get into waterways.

    [*See next page.*]

For Level 5, explain in more detail and require more detailed responses from students.

Extension

1. Draw a lake scene with a factory, house and lawn, farm, eroding site. Draw arrows and write labels to show how phosphorus can get into the lake.
2. Draw 2 lake scenes; one before and one after too much phosphorus has entered its water.
3. Conduct the experiment to compare the effects of manufactured fertiliser and cow manure.

   [*Manufactured fertiliser is more concentrated so will have more impact.*]

   Conduct the experiment to compare the control with tap water and distilled water.

   [*Distilled water has no impurities and tap water is treated so both will show limited changes.*]

Note
Algae can sometimes take 10 to 20 days to grow, so extend the experiment's running time if necessary.

Please don't feed the river cont.

Effects of nutrients on rivers

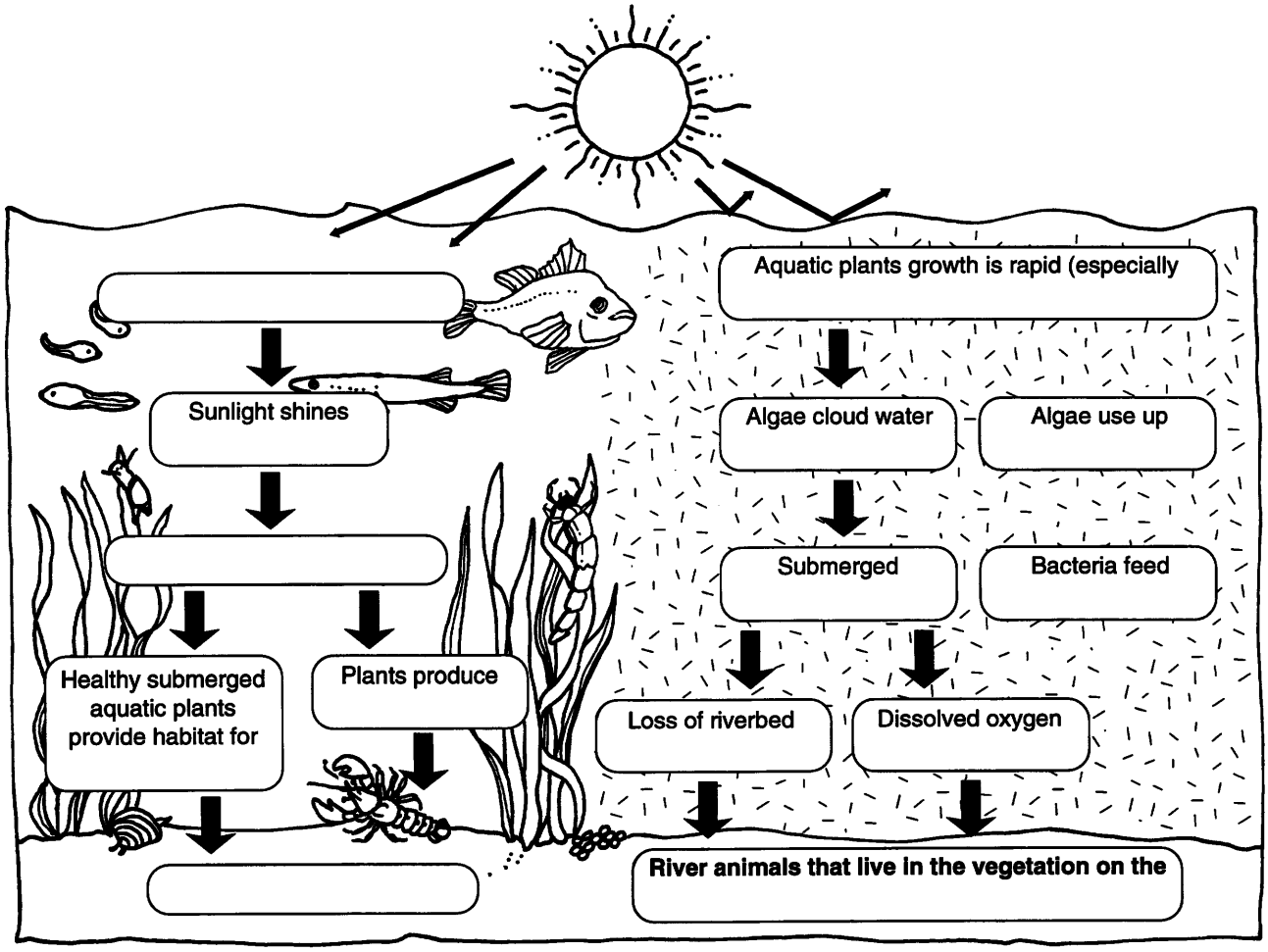
Higher than natural levels of nutrients (including phosphorus, nitrogen and potassium) are entering our waterways from urban stormwater and drainage but in particular from agricultural activity such as the application of fertilisers. Nutrients are absorbed by soil particles and are carried by run-off into waterways. The transport of these excess nutrients into streams is heaviest during storms.

These higher than natural nutrient levels in the water increase plant growth, especially of algae, potentially leading to the eutrophication of lakes and wetlands. In some cases these algae are toxic to animals such as fish and cattle, and can be a health risk to people.

Nitrogen can also enter the groundwater and effect its quality.

High levels of phosphorus (and salt) occur naturally in some rivers because of the types of rocks and hence the soil that occurs in the catchments. In these areas the plants and animals have evolved to live in conditions of high phosphorus (and salt). Problems only occur if additional phosphorus enter the river from non natural sources.

For further information on sources of phosphorus and nitrogen inputs into rivers, refer to pages 15-20 of the Physical and Chemical tests section of *A Community Water Quality Monitoring Manual for Victoria.*



[Adapted from Please don't feed the Bay activity, *Chesapeake Choices and Challanges.* Chesapeake Bay Foundation and Maryland State Dept Education. USA. 1995 and Too many nutrient activity, *Nonpoint Source Pollution Prevention. Grades 3-5.* Air and Waste Management Association. USA. 1993.]

Please don't feed the river

Activity instructions

1. Label the jars as follows: Control; Fertilised.
2. Add 1 litre of creek or pond water to each jar.
3. Add 2 teaspoons of fertiliser or 2 tablespoons of manure to the jar labelled 'Fertilised' and stir in until it is dissolved.
4. Draw a line on the jar to mark the water level.
5. Let the fertiliser settle then record your observation for Day 1.
6. Put the uncovered jars in a sunny window for one week.
7. Inspect your jars each day for the next 5 days and record their colour and odour in the results table below. Add more creek water to top up the experiment jars if the water level falls below the line as water evaporates.

Observations

	Day 1	Day 2	Day 3	Day 4	Day 5
Jar 1 (control)					
Jar 2 (fertilised)					

8. Explain your results.

_____

_____

_____

9. List some ways that nutrients can get into waterways.

_____

_____

_____

Oxygen and water quality

Conduct this experiment as a demonstration or organise students to conduct it in small groups. This activity is an advance on the *Please don't feed the river* activity.

Key Learning Outcomes

Level 5 Science: Living together
Explain the effects of various environmental changes on living things in ecosystems

Aims:

- to show the effects of organic wastes on dissolved oxygen (D.O.) levels in water.
- to provide practice in (or demonstrate) testing dissolved oxygen levels in water.
- to draw conclusions about the relationship between dissolved oxygen (D.O.) levels and water quality.

Materials

2 one litre glass jars or clear containers for each group (or if a demonstration use 2 two litre containers and double the quantity of fertiliser).

2 teaspoons (15 ml) of fertiliser.

Creek water (2 litres per group).

D.O. testing equipment; Waterwatch equipment kit.

Thermometer.

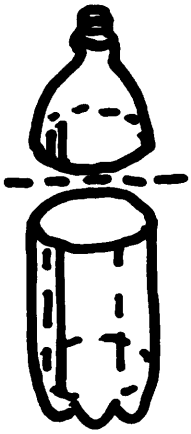
Student sheet 12A: Oxygen and water quality.

Student sheet 12B: Effects of nutrients on the river.

Student Information sheet 6: Dissolved oxygen.

Advanced preparation

1. Collect several litres of river, creek, dam or lake water.
2. Duplicate Student sheets as required.
3. If conducting as a demonstration, prepare an overhead of the Dissolved Oxygen over Time graph from Student sheet 12A: Oxygen and water quality.

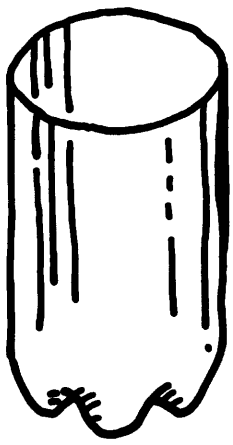


Activity instructions

1. If a demonstration, show the Dissolved Oxygen over Time graph and interpret the results.
2. Organise small groups and distribute materials OR conduct as a demostration experiment.
3. First label the jars as follows: Control; Organic Waste.
4. Add 1 litre of river water to each jar. Explain that we need to use creek water because tap water contains chlorine to kill organisms.
5. Add organic waste (2 tablespoon fertiliser) to the jar labelled Organic Waste and stir in until it is dissolved.
6. Draw a line on the jar to mark the water level.
7. Put the uncovered jars in a sunny window for one week
8. Keep the remainder of the creek water in a separate jar and use it to top up the experiment jars if water evaporates.
9. Record Day 1 results straight after set up.
10. Students or teams inspect the jars after 5 days and again record D.O. reading, colour, odour, and temperature.
11. Summarise the results from the experiment and draw conclusions.

    [See the completed Effects of Nutrients on the River diagram on page 61].

Note
Algae can sometimes take 10 to 20 days to grow, so extend the experiment's running time if necessary.



[Adapted from Please don't feed the Bay activity, *Chesapeake Choices and Challanges.* Chesapeake Bay Foundation and Maryland State Dept Education. USA. 1995 and Too many nutrient activity, *Nonpoint Source Pollution Prevention. Grades 3-5.* Air and Waste Management Association. USA. 1993.]

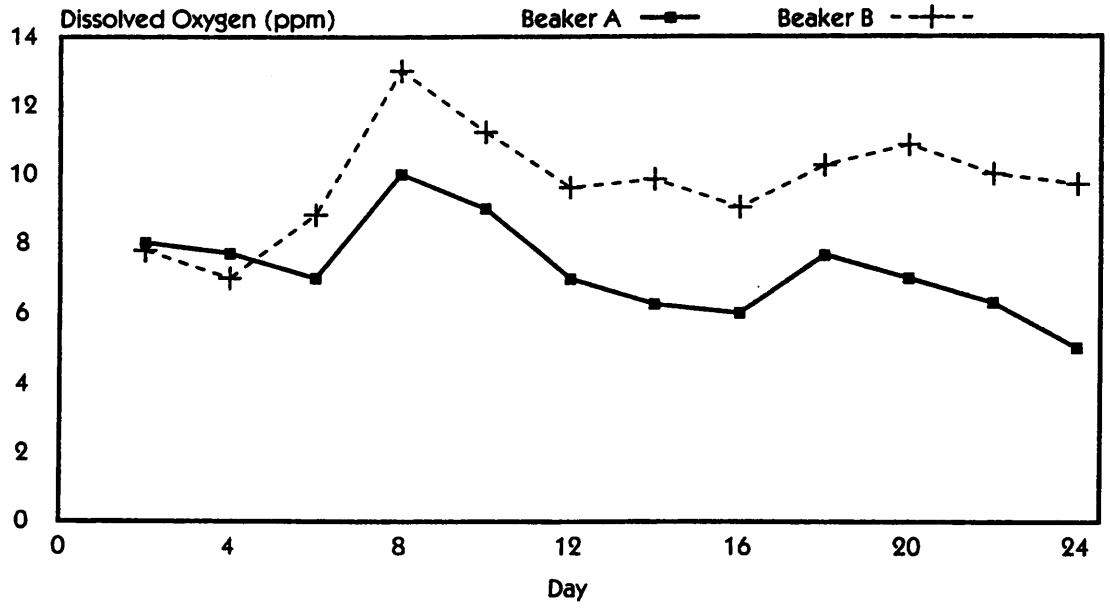
Oxygen and water quality

Activity instructions

1. Below are the results from a 24 day experiment. In your group, discuss what the graph shows, then complete the questions.

After 10 days Beaker A became cloudy. A yellowish colouring was observed in Beaker A by the 13th day. After 16 days Beaker A had a green, thick 'pea soup' appearance. Beaker B remained clear throughout the experiment. Below is a graph showing the results of the dissolved oxygen tests for Beaker A and B.

Dissolved oxygen over Time



2. How has the level of dissolved oxygen changed over the 24 days?
3. Explain the differences in oxygen levels in the 2 jars over time.

Experiment instructions

1. Label the 2 jars as follows: Jar 1 = Control; Jar 2 = Organic Waste.
2. Add 1 litre of river water to each jar.
3. Add organic waste (2 teaspoons fertiliser or tablespoon cow manure) to the jar labelled Organic Waste and stir in until it is dissolved.
4. Draw a line on the jar to mark the water level.
5. Record the D.O. reading, colour, odour, and temperature of both jars and record this in the Day 1 column of the record table.
6. Put the uncovered jars in a sunny window for one week. Keep the remainder of your creek water in a separate container and use it to top up the experiment jars if the water level falls as water evaporates, add more water.
7. Inspect your jars after 5 days and record their D.O. reading, colour, odour, and temperature in the Day 5 column of the record table.

Oxygen and water quality cont.

Record table

	Jar 1 Control	Jar 2 Organic waste
Day 1 D.O. reading (% saturation) colour odour temperature		
Day 5 D.O. reading (% saturation) colour odour temperature		

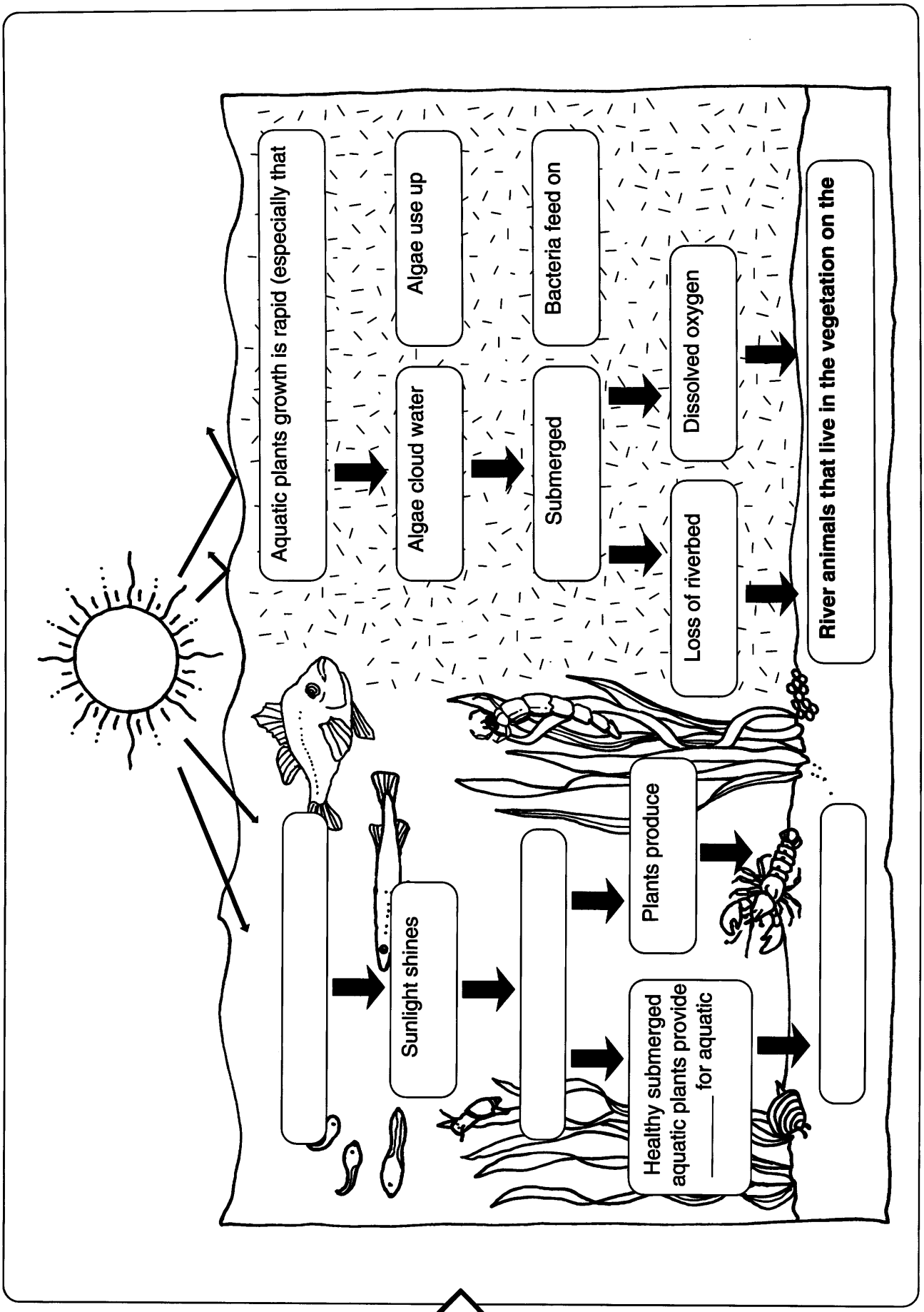
8. Explain your results.
   How has the level of dissolved oxygen changed over the time of your experiment?

   How has the colour, odour and temperature of the water changed over time?

9. Draw conclusions.
   Explain the differences in oxygen levels in the 2 jars over this time.

10. Complete the annotations to the diagram: Effects of nutrients on the river.
11. List ways that nutrients can get into rivers.

Effects of nutrients on rivers



Information sheet 5

Phosphorus

What is phosphorus and where is it found?

Phosphorus (foz-for-us) is a mineral found in rocks and soil. In Australian soils it is found in low levels. Phosphorus is absorbed by plant roots and is a nutrient found in all living things. When people buy fertiliser for their farms or gardens, it contains nutrients such as phosphorus to help plants grow. Introduced plants need more phosphorus to grow than do plants native to Australia.Some types of phosphorus are used for other purposes. Phosphorus is sometimes put into laundry detergent to clean clothes.

What effect does phosphorus have on waterways and wetlands?

When too much phosphorus enters a river, lake or wetland, it makes the plants in the water grow more quickly, especially the microscopic algae. The tiny algae multiply quickly and this makes the water turn green and become cloudy [the green colour comes from the very large numbers of these tiny floating plants]. As older algae die, they sink to the bottom but new algae keep growing. Bacteria decompose the dead plants that sink to the bottom. These decomposers use up most of the oxygen in the water. They actually use more oxygen than the amount added by the extra plants through photosynthesis. Therefore, too much phosphorus leads to too many algae, which leads to less oxygen in the water.

This is what happens when too much phosphorus enters the water:

1. Phosphorus enters the water.
2. Plants take up the phosphorus and grow too well.
3. Algae reproduce quickly and create an algal 'bloom'.
4. The algal bloom shades out the submerged vegetation.
5. The algae soon die and sink to the bottom.
6. Bacteria decompose these plants, using up oxygen.
7. Oxygen levels drop, killing fish or aquatic insects.
8. Phosphorus continues to enter the water.
9. The cycle continues.

Where does the phosphorus come from?

Phosphorus enters the water from:

- human and animal wastes carried into waterways from poorly treated sewage, broken pipes or runoff
- some industrial wastes
- soil carried into waterways from eroding areas
- over-fertilised lawns, gardens and farms from which fertiliser is carried away when it rains
- animal wastes (e.g. dog poo) that are carried into waterways by stormwater

Too much phosphorus affects lakes and ponds more than rivers. Lakes do not flow like rivers so trap the nutrients, leading to an increase in their levels. High levels of phosphorus can cause very serious problems for lakes and wetlands. Rivers are more affected by too much phosphorus in summer when river levels are lower.

[Adapted from *Water Studies for Younger Folk.* GREEN. 1992.]

Complete these

What happens when too much phosphorus enters the water?

1. Complete these sentences and number them in the right order. [Or cut completed sentences into cards and place in the correct sequence].
   Smaller plants (algae)_____and_____.
   Phosphorus enters the _____.
   Bacteria_____these plants, using up_____.
   P_____ take up the phosphorus and _____.
   O _____ levels drop.
   Fish and aquatic insects _____.

Dissolved Oxygen

Dissolved Oxygen (D.O.)

Aquatic animals need to breathe in oxygen just like land animals and people do. Lungs do not work in water; they get flooded and the animal or person drowns). Aquatic animals such as tadpoles and fish have gills instead of lungs to take up oxygen dissolved in the water.

Clean, healthy water has plenty of dissolved oxygen (100% is excellent). If the level of dissolved oxygen drops or increases too much, the quality of the water drops. Some aquatic animals such as Stonefly larva and native Australian Grayling need lots of dissolved oxygen. These animals can therefore only live in Excellent and Good quality water. A few aquatic animals such as European Carp can live in water with low oxygen levels, i.e. Poor quality water.

Sources of Dissolved Oxygen

1. The atmosphere: Waves, wind, waterfalls and riffle areas trap oxygen and mix it into the water.
2. Aquatic plants produce oxygen through photosynthesis during the day and release this dissolved oxygen into the water.

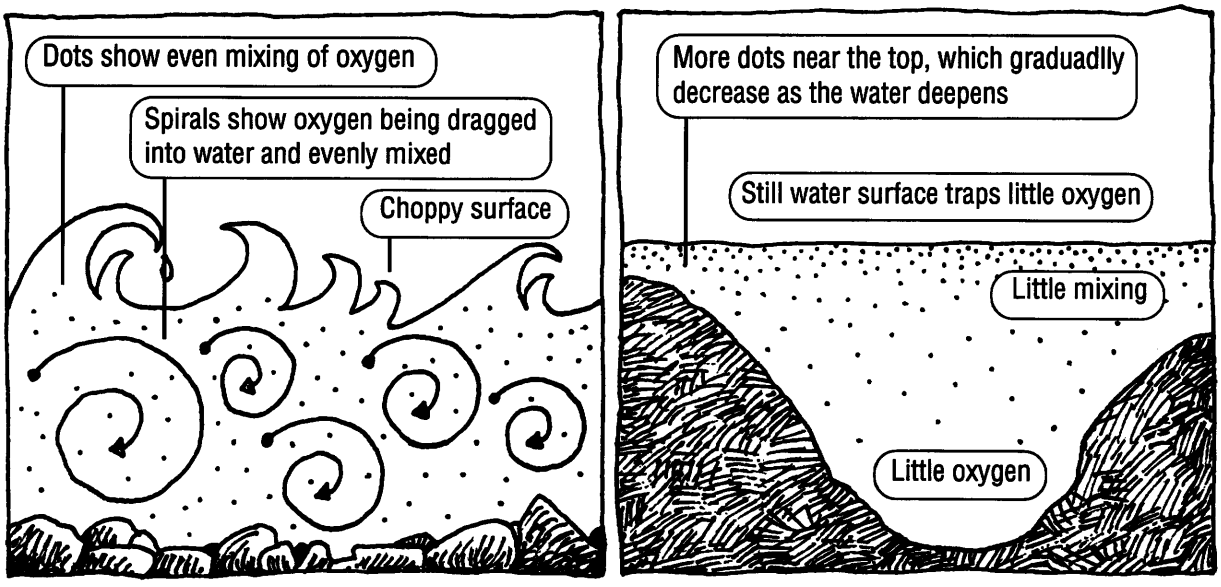
What causes the levels of Dissolved Oxygen in water to drop?

The main reason is that organic waste levels in the water have increased.

Organic wastes come from:

- dead plants and animals in the water
- untreated sewage and stormwater
- runoff from urban or rural areas

Decomposers (e.g. bacteria) break down organic waste, using up oxygen in the process. The more waste there is in the water, the more decomposers there are, using up more oxygen.



Effects of temperature

Activity

1. Read Student Information sheet 7: Temperature, then complete the following:

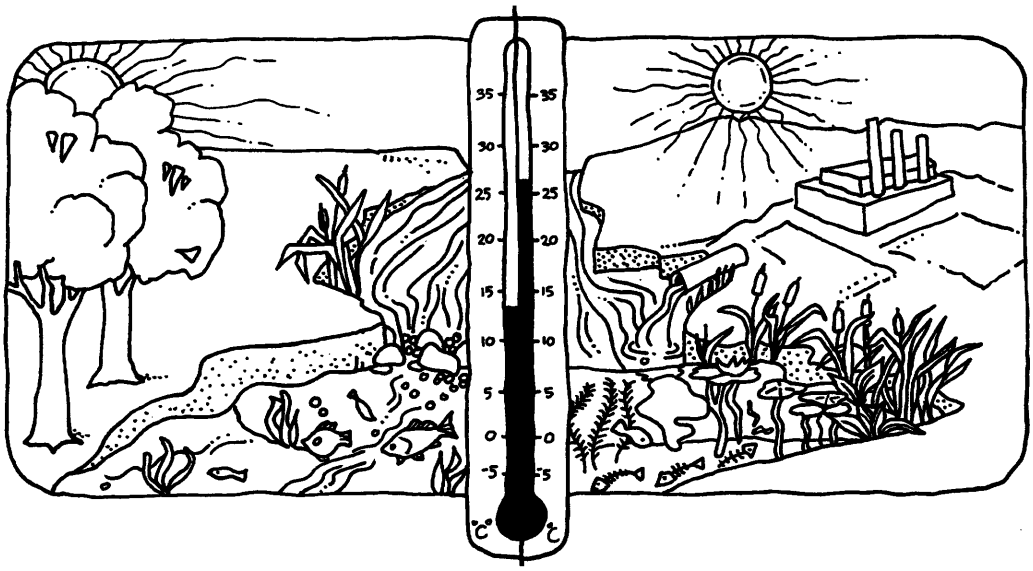
Cross out the incorrect word to complete these sentences:

i). As temperatures rises, the amount of dissolved oxygen in the water decreases / increases.

ii). As water temperature rises, animals' need for oxygen in the water increases / decreases.

iii). Clearing trees from the river bank can increase / decrease the temperature of the water.

Thermal Pollution



[Adapted from *Water Studies for Younger Folk.* GREEN. 1992.]

2. Write a paragraph explaining what has caused the differences you can see in the right hand side section of the above river scene.

_____

_____

_____

3. Draw a river scene with a factory and nearby roads , paths, car park and very little river bank vegetation.

Draw arrows and write labels on your river scene to show how the river's temperature may be increased.

(e.g. Warm water flows into the river from a factory.
The water temperature increases because of _____.)

Temperature

Temperature

The temperature of the water affects:

- the amount of dissolved oxygen in the water
- the rate of photosynthesis
- animal survival

Oxygen

Cold water can hold more oxygen than warm water.

Photosynthesis

As the temperature rises, so to does the rate at which plants photosynthesise. A temperature rise increases plant growth - more plant growth means more plants die. When plants die, decomposers eat them and use up oxygen. When the rate of photosynthesis increases this leads to a need for oxygen by more aquatic organisms.

Animal survival

Many aquatic animals can only survive within certain water temperature ranges. If the water temperature changes too much, many organisms can no longer survive in it.

If the water becomes too hot it will no longer have enough oxygen nor enough food plants (and the animals that eat the plants). Some aquatic animals such as fish only breed in certain temperature ranges.

For example, Stonefly nymphs need cool water temperatures. Dragonfly nymphs and Carp can live in warmer water.

If wastes are added to water, this often increases the temperature of the water. This leads to lower oxygen levels, which weakens many insects and fish. Weakened animals get sick and die more easily.

How humans affect river temperatures (Thermal pollution)

In summer, the sun heats up the bitumen and concrete on roads, paths and parking lots. When rain falls on these areas, it warms up before it runs into the river.

Water is used by some factories to cool their production processes. This warm water is sometimes disposed of into rivers.

Cutting down trees along the river bank removes shade. The sun shines directly on the water and warms it more than if there is a tree canopy over it.

Cutting down trees can also lead to erosion, causing soil to wash into the water. Muddy (turbid) water is darker and so absorbs more heat from the sun than clear water.

[Adapted from *Water Studies for Younger Folk.* GREEN. 1992.]