Stream Connections

Teacher Resource

environment SOUTHLAND
REGIONAL COUNCIL
Te Taiao Tonga

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Photo reproduced courtesy of Rimu School and Fairfax Media/Southland Times.

Contents

Introduction

Welcome to Environment Southland's revised Stream Connections education resource.

Our intention in developing this resource is to support:

- good quality teaching and learning ABOUT Southland's freshwater resources
- meaningful learning experiences IN nature
- learning and action-taking FOR the protection and enhancement of streams

Essential prior learning

Environment Southland strongly recommends that students complete the classroom activities in the 'Preparation for Field Trip' section, prior to the field trip. This will give you a chance to assess what they already know and build on their prior knowledge before embarking on the field trip.

Many of the activities in this resource involve maps. Please contact Environment Southland if you need assistance in obtaining a map of the stream your class will be studying.

The field trip

The field trip activities form the core of this resource. Information and learning activities have been chosen and designed to:

- prepare students for the field trip
- guide activities during the field trip
- support analysis and reflection and drawing conclusions after the field trip
- assist in the planning of action projects

Many children are 'indoor, computer kids'. Teachers and parents need to create opportunities for them to reconnect and understand the natural world they live in. Students need help to experience their environment from a range of different viewpoints, such as sensory, observational, measuring and auditing, and also from different cultural perspectives.

Choose a site with these characteristics:

- Slow to moderately flowing water; shallow (less than knee-deep); no deep pools or rapids.
- Upstream of any known discharges e.g. treated wastewater outfalls.
- A stream bed with a gravelly or rocky bottom.
- Safe access to the stream e.g. no steep banks.
- Open space next to the stream where children can stand or sit safely.
- A safe place for vehicles to park.

Before you go on the fieldtrip, you will need to get a copy of a fieldguide to help you identify the invertebrates you collect from the stream. You can either:

1. Borrow an identification guide from Environment Southland, or
2. Print out the Landcare Research guide to freshwater invertebrates of New Zealand http://www.landcareresearch.co.nz/research/biocons/freshwater/guide.asp. It has a page for mayflies, a page for caddisflies, a page for stoneflies, etc.

You may be able to borrow equipment for the stream study from Environment Southland.

Developing action competence

Environmental education is an action-focused approach to learning that engages students in the physical, social, cultural and political aspects of their environment. Learning occurs not just ABOUT the environment, and IN the environment, but has an action focus FOR the environment.

Stream Connections is therefore not just about monitoring a stream. It's about getting students to think about what their results mean, to make meaningful connections with waterways and to participate in action to improve their environment.

How to use this resource

Rivers and streams provide wonderful contexts for learning. By focusing on rivers and streams, teachers can create rich opportunities for students to develop many of the competencies described in the New Zealand Curriculum.

The activities in the Stream Connections pack are designed to support good teaching and learning in these contexts and can help students to achieve the objectives of several learning areas.

Activities are designed to meet the needs of levels 3 and 4 (years 5-8) teachers and their students. Teachers of other levels are encouraged to adapt the activities to suit their students.

Some teachers may choose to implement a programme of learning in the sequence suggested. Others may prefer to pick and choose from the activities in the resource and adapt them as required.

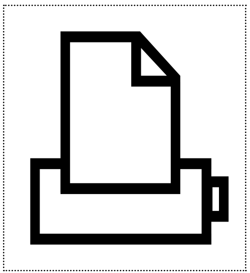
This resource is copyright-free so teachers should feel free to make copies of activities and adapt them as required. The resource can be obtained from Environment Southland either as a paper copy or on a disc, and can be downloaded from the Environment Southland website: www.es.govt.nz.

Several of the activities in this resource refer to Southland Water 2010, Environment Southland's State of the Environment report series:

- Our Health
- Our Ecosystems
- Our Uses
- Our Threats

These reports are an excellent source of information, data and stories about Southland's water resources and communities. Hard copies of these reports can be obtained free of charge from Environment Southland, or downloaded from our website www.es.govt.nz.

Winton School using clarity tube



See this symbol?

It appears on the top right corner of many of the pages in this resource. Anytime you see this symbol, it means the page is recommended for photocopying.

Curriculum links for level 3

Learning area	Strand	Achievement objective	1. The water cycle	2. Our uses	3. Freshwater ecosystems	4. Stream life	5. Water quality	6. Our impacts	7. Water management	8. Investigate water quality	11. Interpret your results	12. Develop an action plan
Science	Planet Earth & Beyond	Investigate the water cycle and its effect on climate, landforms and life	1.1 1.2 1.3 1.5 1.6					6.3 6.4				
Science	Planet Earth & Beyond	Appreciate that water, air, rocks and soil, and life forms make up our planet and recognise that these are also Earth's resources			3.4 3.5 3.6							
Science	Living World	Explain how living things are suited to their particular habitat and how they respond to environmental changes, both natural and human-induced			3.1 3.2 3.3 3.7	4.1 4.3 4.4 4.5						
Science	Living World	Begin to group plants, animals and other living things into science-based classifications			3.1	4.1-4.5						
Science	Nature of Science	Ask questions, find evidence, explore simple models and carry out appropriate investigations to develop simple explanations						6.2 6.3		8.1-8.7	11.1-11.7	
Science	Nature of Science	Explore various aspects of an issue and make decisions about possible actions						6.3				12
Science	Nature of Science	Begin to use a range of scientific symbols								8.1-8.7	11.1-11.7	
Social Sciences	Social Studies	Understand how cultural practices vary but reflect similar purposes	1.4 1.7	2.3-2.5				6.5		8.1-8.7		
Social Sciences	Social Studies	Understand how people make decisions about access to and use of resources						6.5				
Social Sciences	Social Studies	Understand how groups make and implement rules and laws							7.1			
Social Sciences	Social Studies	Understand how people view and use places differently		2.6 2.7								
Mathematics & Statistics	Number & Algebra	Use a range of additive and simple multiplicative strategies with whole numbers, fractions, decimals, and percentages.									11.1-11.7	
Health & Physical Education	Personal Health & Physical Development	Identify risks and their causes and describe safe practices to manage these					5.1 5.2					
English	Speaking, Writing & Presenting	Show a developing understanding of how to shape texts for different purposes and audiences		2.3					7.2			
Learning languages	Cultural Knowledge	Understand and produce information and ideas		2.2				6.1				
The Arts	Communicating & Interpreting	Present and respond to drama, identifying ways in which elements, techniques, conventions and technologies create meaning in their own and others' work	1.4									

Curriculum links for level 4

Learning area	Strand	Achievement objective	1. The water cycle	2. Our uses	3. Freshwater ecosystems	4. Stream life	5. Water quality	6. Our impacts	7. Water management	8. Investigate water quality	11. Interpret your results	12. Develop an action plan
Science	Planet Earth & Beyond	Investigate the water cycle and its effect on climate, landforms and life	1.1-1.3					6.4				
Science	Planet Earth & Beyond	Develop an understanding that water, air, rocks and soil, and life forms make up our planet and recognise that these are also Earth's resources	1.5 1.6	2.1	3.4 3.5 3.6			6.3 6.4				
Science	Living World	Explain how living things are suited to their particular habitat and how they respond to environmental changes, both natural and human-induced			3.1 3.2 3.3 3.7	4.1 4.3 4.4 4.5						
Science	Living World	Begin to group plants, animals and other living things into science-based classifications			3.1	4.1-4.5						
Science	Nature of Science	Ask questions, find evidence, explore simple models and carry out appropriate investigations to develop simple explanations						6.2 6.3		8.1-8.7	11.1-11.7	
Science	Nature of Science	Explore various aspects of an issue and make decisions about possible actions						6.3				12
Science	Nature of Science	Begin to use a range of scientific symbols, conventions and vocabulary								8.1-8.7	11.1-11.7	
Social Sciences	Social Studies	Understand that events have causes & effects							7.2			
Social Sciences	Social Studies	Understand how producers and consumers exercise their rights and meet their responsibilities							7.2			
Social Sciences	Social Studies	Understand how people participate individually and collectively in response to community challenges							7.2			12
Mathematics & Statistics	Geometry & Measurement	Use appropriate scales, devices and metric units for length, area, volume and capacity, weight (mass), temperature, angle and time								8.1-8.7	11.1-11.7	
Mathematics and Statistics	Number & Algebra	Use graphs, tables and rules to describe linear relationships found in number and spatial patterns									11.1-11.7	
Health & Physical Education	Healthy Communities & Environments	Investigate and describe lifestyle factors and media influences that contribute to the well-being of people in New Zealand		2.6 2.7								
Health and Physical Education	Relationships with Other People	Describe and demonstrate a range of assertive communication skills and processes that enable them to interact appropriately with other people		2.6 2.7								
Health & Physical Education	Personal Health & Physical Development	Access and use information to make and action safe choices in a range of contexts					5.1 5.2					
English	Speaking, Writing & Presenting	Show an increasing understanding of how to shape texts for different purposes and audiences		2.2 2.3					7.2			
Learning languages	Cultural Knowledge	Understand and produce information and ideas						6.1				
The Arts	Communicating & Interpreting	Present and respond to drama, identifying ways in which elements, techniques, conventions and technologies create meaning in their own and others' work	1.4									

Use the Action Learning Cycle to plan a programme of learning and action IN, ABOUT & FOR your local stream

8. Investigate water quality:
Activities 8.1, 8.2, 8.3, 8.4, 8.5, 8.6

14. Measure and document what you did:
All activities

1. The water cycle:
Activities 1.1, 1.2, 1.3, 1.4, 1.5, 1.6, 1.7

2. Our uses:
Activities 2.2, 2.3, 2.5, 2.6

3. Freshwater ecosystems:
Activities 3.1, 3.2, 3.7

4. Stream life:
Activities 4.1, 4.2, 4.5

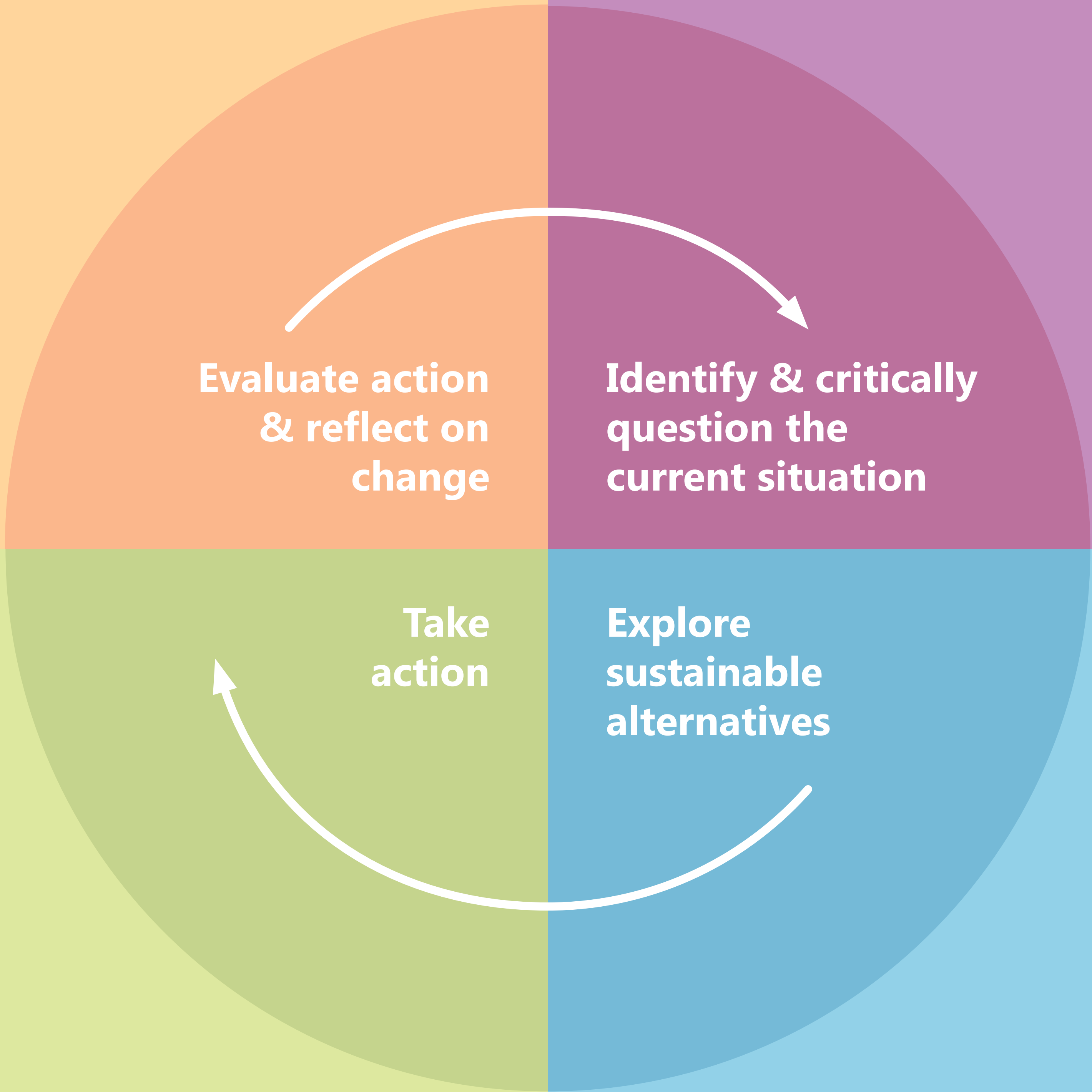
5. Water quality:
Activity 5.1, 5.2

6. Our impacts:
Activity 6.1

7. Water management:
Activity 7.2

8. Investigate water quality:
Activities 8.1, 8.2, 8.3, 8.4, 8.5, 8.6

11. Interpret your results:
Activities 11.1, 11.2, 11.3, 11.4, 11.5, 11.7



4. Stream life:
Activities 4.3, 4.5

6. Our impacts:
Activities 6.3, 6.4, 6.5

12. Develop an action plan:
All activities

13. Take action:
All activities

2. Our uses:
Activities 2.1, 2.4, 2.7

3. Freshwater ecosystems:
Activities 3.3, 3.4, 3.5, 3.6

4. Stream life:
Activities 4.3, 4.4

6. Our impacts:
Activities 6.2, 6.3, 6.4, 6.5

7. Water management:
Activity 7.1

11. Interpret your results:
Activity 11.6

Adapted from The Action Learning Cycle © Toimata Foundation

These activities have been designed to prepare students for the practical field trip and should be completed in the classroom in the weeks before the field trip.

Preparation for field trip

1. The water cycle

What is the water cycle?

TEACHER NOTES

The water cycle (also known as the hydrologic cycle) is the journey water takes as it circulates from the land to the sky and back again.

The sun's heat provides energy to evaporate water from the earth's surface (oceans, rivers, lakes, etc.). Plants also lose water to the air - this is called transpiration. As it rises, the water vapour cools and condenses, forming clouds. When the clouds meet cool air over land, precipitation (rain, sleet, or snow) is triggered and water returns to the land or sea. In Southland, wet westerly winds drop most of their moisture on the western side of the Fiordland mountain ranges (5,000-10,000mm/yr). Rainfall on the eastern side is much lower (700-1,500mm/yr).

Some of the precipitation soaks into the ground becoming part of the groundwater, and some flows over the land as surface runoff, eventually returning to the sea. As water moves through the landscape, it picks up contaminants. There are natural processes, such as filtration through soil and wetlands, which can restore water to a healthy state when our catchments are working well.

ACTIVITY IDEAS

Learning area	Strand	Achievement objective
Science	Planet Earth and Beyond	Investigate the water cycle and its effect on climate, landforms and life

1.1 Teach the water cycle using your interactive whiteboard

Display an image of a landscape (mountains, river, sea and sky) on the interactive whiteboard and explain how the water cycle works. Draw arrows on the image to illustrate evaporation, the movement of the air by wind, condensation as the air rises and cools over the mountains, rainfall and the flow of the river back to the sea.

1.2 Demonstrate elements of the water cycle

Switch on a kettle (pre-boiled to save time) and show the water evaporating as it heats up. Hold a mirror against the steam and show the condensation against the cold mirror.

1.3 Build a mini-water cycle

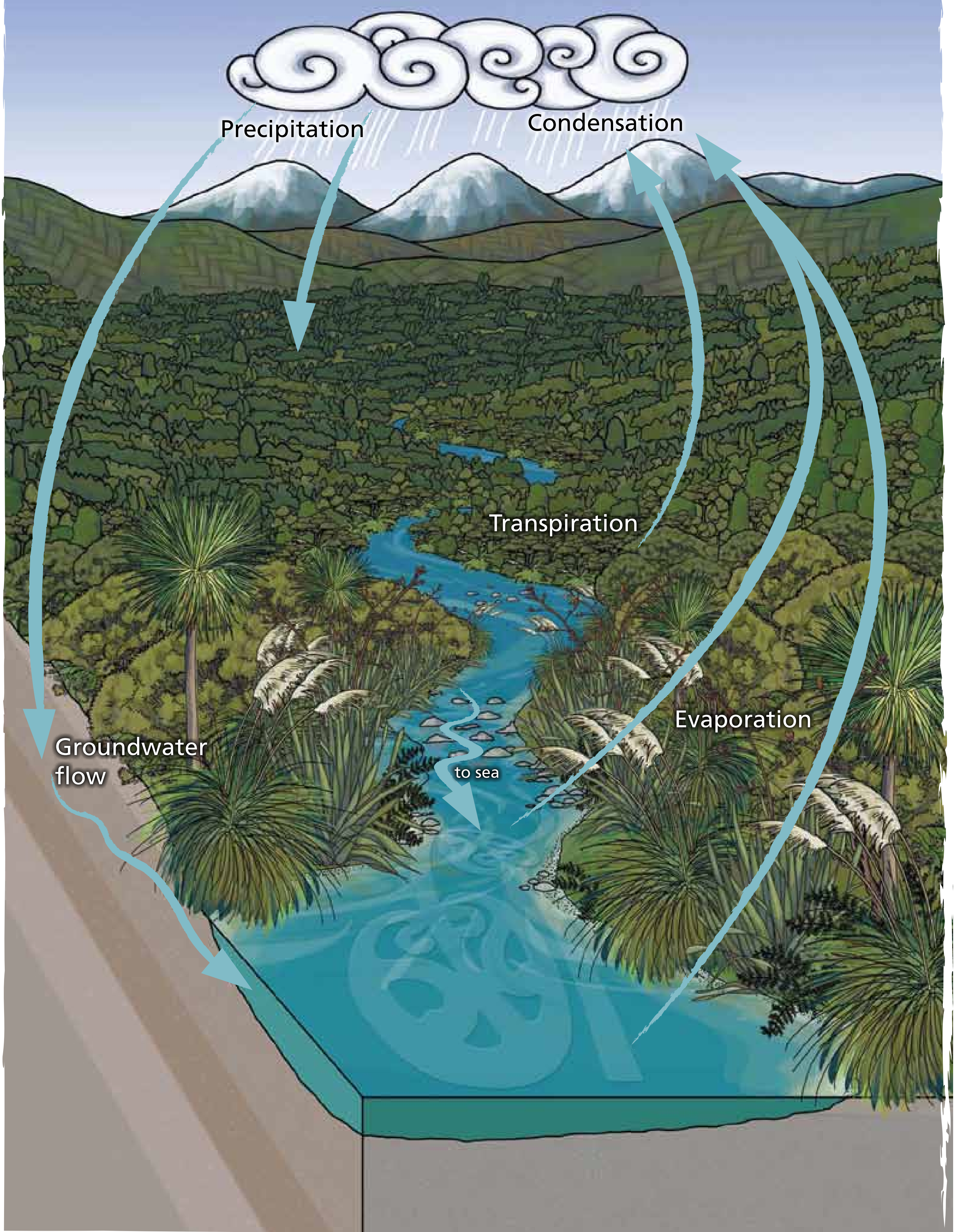
Place a small container in the centre of a larger bowl and pour water around it. Ensure that no water splashes into the small container. Cover the top of the larger bowl with clear plastic wrap, making sure it seals firmly. Put a small stone in the centre of the plastic wrap, directly over the centre of the smaller container. Place the bowl in direct sunlight. The water will evaporate as a result of the heat of the sun and will condense on the plastic wrap and drip into the smaller container, like rain. Experiment with different liquids, different sizes of container and different colour containers. Measure the amount of water you place in the large bowl. Leave the bowls in direct sunlight for 1-2 weeks and observe. At the end of this period, measure the water. Discuss the results.

RESOURCES

To download resources for the interactive whiteboard, go to a website specialising in learning activities for interactive whiteboards, (such as Promethean Planet www.prometheanplanet.com) and search for "water cycle."

[Disclaimer: Please note that information contained in this website has been referred to in good faith. It has not necessarily been reviewed, may not be accurate or reliable and is not to be construed as representing Environment Southland's views, policies or values.]

Water in the catchment



Creation stories

TEACHER NOTES

Many cultures around the world have stories about how the earth was created, and different explanations about how the land, sky, sea, water and living things came into existence. There are also many stories about water, for example, the story of Noah's Ark and the Great Flood. The story of Ranginui and Papatūānuku is a Māori creation story which also describes some of the elements of the water cycle.

ACTIVITY IDEAS

1.4 Share creation stories from different cultures

Learning area	Strand	Achievement objective
Social Studies		Understand how cultural practices vary but reflect similar purposes
The Arts	Drama	Present and respond to drama, identifying ways in which elements, techniques, conventions and technologies create meaning in their own and others' work

1. Ask the students to share any stories they have heard about how the earth was created, e.g. the great flood.
2. Read the story of Ranginui and Papatūānuku (over the page).
3. Draw pictures of Ranginui, Papatūānuku and the atua.
4. Act out the story or illustrate the roles of the various characters in the water cycle:
   - Ranginui (sky)
   - Papatūānuku (earth)
   - The tears of Ranginui and Papatūānuku (rivers and seas)
   - The tears of Ranginui (dew)
   - The sighs of Papatūānuku (morning mist)
   - Tānemahuta (atua of the forests)
   - Tangaroa (atua of the sea)
   - Tāwhirimātea (atua of wind and storms)

STORY: Ranginui and Papatūānuku

Life began with the separation of Ranginui (sky father) and Papatūānuku (earth mother). From them emerged the various atua. Ranginui, the sky, dwelt with Papatūānuku, the earth, and was joined to her. The children of Ranginui and Papatūānuku, who were very numerous, lived in the darkness between them, for their parents were not yet parted.

The offspring of Ranginui and Papatūānuku, worn out with continual darkness, met together to decide what should be done about their parents, that man might arise. "Shall we kill our parents, our father and our mother, or shall we separate them?" they asked. Tūmatauenga, the fiercest of the offspring and the guardian of war, spoke out. "It is well. Let us kill them." But Tānemahuta, guardian of the forest, answered "no, not so. It is better to separate them, and to let the sky stand far above us and the earth lie below here. Let the sky be a stranger to us, but let earth remain close to us as our nursing mother." Some of the other sons, and Tūmatauenga among them, saw wisdom in this and agreed with Tānemahuta. Others did not agree, including Tawhirimatea, the guardian of winds and storms. They decided that Ranginui and Papatūānuku must be forced apart.

The children began by taking turns to attempt this deed – but the embrace of Ranginui and Papatūānuku was too strong. When it was Tānemahuta's turn, he placed his shoulders against the earth, his mother, and his feet against the sky. Great Tānemahuta thrust with all his strength, which was the strength of growth. Far beneath him he pressed the earth. Far above he thrust the sky, and held him there. The sinews that bound them were stretched, taut. Tūmatauenga sprang up and slashed at the bonds that bound his parents and the blood spilt red on the earth.

The children thrived in the new light-filled world. Their mauri, their lifeforce, developed and they brought new life into the world. Tānemahuta became atua of the forests, while Tangaroa became atua of the sea. Tawhirimatea became atua of wind and storms. Up to the present time Ranginui, the sky, has remained separate from his wife, the earth. But their love has never diminished, and at the beginning Ranginui and Papatūānuku shed an immense quantity of tears. So great was this weeping that much of the land that had been dry was covered by the sea. At length, lest all the land be lost, the children of Ranginui and Papatūānuku turned their mother over, so that she and Ranginui should not be always seeing one another's grief. Ranginui's tears are now the dew drops that form in the night on Papatūānuku's back. The morning mists that form in the valleys are her sighs.

SOURCE: www.māori.org.nz accessed 21/01/10.

Artwork supplied courtesy of Toimata Foundation
Artist: Nathan Foote

What is a catchment?

TEACHER NOTES

The word catchment (or watershed) refers to all the area of land which supplies water to a particular waterbody. For example, the catchment of a stream is all the land that slopes from the top of the hills surrounding it down towards that stream. The catchment of a river includes all the land that supplies water to all the streams and lakes that feed into that river. A river catchment can be very large. For example, the combined catchments of the Waiau, Aparima, Oreti and Mataura rivers cover 54% (18,305km^2) of the region.

It is important to think about your stream in relation to its catchment because the hydrology, health and functions of the stream are affected by the landscape, human activities and characteristics of the catchment. Ngāi Tahu, like other Māori, conceptualise water as an undivided entity and as part of a system of lakes, rivers, lagoons and wetlands along with their associated beds, riparian margins and adjacent land. Rivers are seen as connecting the entire landscape. This is the concept of ki uta ki tai, which means “from the mountains to the sea”. The river ecosystem is seen as all components of the landscape that are directly linked by and to that river, including the source area, the channel from source to sea, riparian areas, the physical and chemical nature of water in the channel, associated groundwater, wetlands, floodplains, the estuary, and the near-shore marine ecosystem. The catchment is understood to include the soils, water, flora, fauna and all the relationships between them.

When rain falls on healthy soil, the water infiltrates into the soil and is released later. This provides a slow supply of water for plants, allowing them to grow. Water storage in the soil, and in wetlands and swamps, prevents rapid run-off which can cause flooding. Where the soil is in poor condition and where wetlands have been drained, the water cannot be stored in this way and flooding is more likely to occur. Wetlands also help to purify water, by trapping sediment, slowing water flow which allows germs in the water to die, and by releasing nitrogen in the water back to the air. This means that often when water comes out of wetlands it is much cleaner than when it went in. Because they purify water, wetlands are like the kidneys of the land.

Water also flows into and under the ground where it can be stored for many years. Most of the freshwater in New Zealand is actually under the ground. If it is in good condition, the soil on top of groundwater acts as a filter that cleans water as it moves down towards underground aquifers, or flows below the ground to be released at springs or river beds. It is because water is stored in the soil and groundwater and released slowly, that rivers and streams continue to flow even when it has not rained for a while.

ACTIVITY IDEAS

Learning area	Strand	Achievement objective
Science	Planet Earth and Beyond	Develop an understanding that water, air, rocks and soil, and lifeforms make up our planet and recognise that these are also earth’s resources
Science	Planet Earth and Beyond	Investigate the water cycle and its effect on climate, landforms and life

1.5 Use a map to teach about Southland's major river catchments

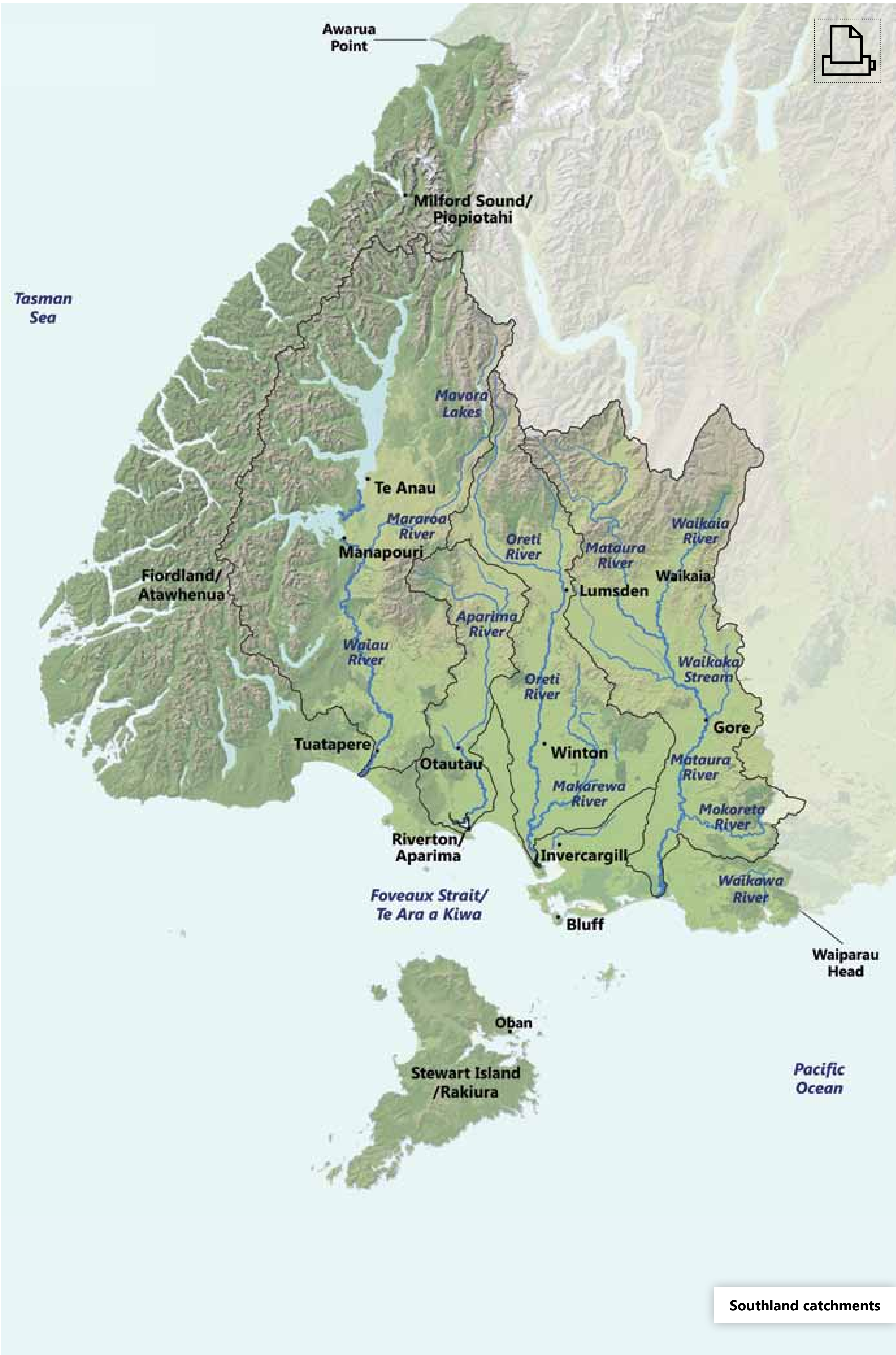
1. Get students to complete the following tasks using the map of Southland's catchments:
    a. Shade in each catchment on your map in a different colour
    b. Which river has the largest catchment area?
    c. Which catchment is your school in?
    d. Do you have a favourite river or stream? Why did you choose that one?
    e. Which river or stream is most important to you? E.g. the river your drinking water comes from, or the river you visit most often for fishing or holidays or recreation.
2. Find out whether your catchment has cultural importance to Ngāi Tahu or other cultural groups (refer to teacher notes for activity 1.7).

1.6 Identify learners' prior knowledge about the stream you will visit for the field trip

1. Show the class a map of the stream where you will do your field trip. Find out what the students already know, for example:
    a. What is the name of the stream?
    b. What is the name of its catchment?
    c. Where does the stream start?
    d. Where does the water come from?
    e. Where does the water flow to?
    f. What is the catchment like, e.g. flat or steep, rural or urban, pristine or highly modified?
    g. Is there anyone in the class who lives near the stream? Ask them where the drinking water for their house comes from, e.g. from a bore or from rainwater.
    h. Does anyone in the class visit the stream for any reason, e.g. recreation, fishing?
    i. Identify the location of the site and directions, e.g. distance from school, direction of flow.

RESOURCE

Please contact Environment Southland if you need assistance in obtaining a map showing the stream where you will do your field trip.



Southland catchments

Cultural associations with Southland's catchments

TEACHER NOTES

The cultural importance of the Waiau, Aparima, Oreti and Mataura rivers to Ngāi Tahu is formally recognised in the Ngāi Tahu Claims Settlement Act 1998. National Water Conservation Orders on the Mataura and Oreti Rivers reflect their national significance, particularly as brown trout fisheries.

Oreti

The river formed one of the main trails from inland Murihiku to the coast, with an important pounamu trade route continuing northward from the headwaters of the Oreti and travelling, via the Mavora Lakes system, or Von River Valley, to the edge of the Wakatipu and onto the Dart and Routeburn pounamu sources. The kai resources of the Oreti supported numerous parties venturing into the interior, and returning by mōkihi, laden with pounamu and mahinga kai. Nohoanga along the river supported such travel by providing bases from which the travellers could obtain waterfowl, eels and inanga.

Waiau

Named during the southern voyages of Tamatea Ure Haea and his waka Takitimu. Takitimu was wrecked near the mouth of the river (Te Waewae Bay) and the survivors who landed named the river Waiau due to the swirling nature of its waters. The river was a major travel route connecting Murihiku and Te Ara a Kiwa (Foveaux Strait) to Te Tai Poutini. Summer expeditions to Manapouri for mahinga kai and access to pounamu were the main motivations for movement up and down the Waiau.

Wāhi ingoa associated with the Waiau are indicators of the range of resources the river provided: Waiharakeke (flax), Papatōtara (tōtara logs or bark), Kirirua (a type of eel found in the lagoon), Te Rua o te Kaiamio (a rock shelter that was a designated meeting place, similar to a marae) and Ka Kerehu (charcoal from the fire of Tamatea).

Aparima

The mouth of the river was a permanent settlement, with associated urupā nearby. There was also an important tauranga waka located here, from which sea voyages were launched to and from Te Ara a Kiwa, Rakiura and the titi islands. A carved tauihu (canoe prow) has been found in the estuary of the river.

The river was an important source of mahinga kai, particularly shellfish, mussels, paua, tuna and inanga. An eel weir was constructed at the narrows where the Pourakino River enters the Aparima. The relationship of the Aparima to the Takitimu mountains is an important relationship of Ngāi Tahu to the river.

Mataura

Several important Ngāti Māmoe and Ngāi Tahu tupuna are associated with the Mataura river, including the Ngāti Mamoe rangatira Parapara Te Whenua, whose descendants traditionally used the resources of the river, and Kiritekateka, daughter of Parapara Te Whenua, who was captured by Ngāi Tahu at Te Anau.

Tuturau, once a Ngāi Tahu fishing village, was the site of the last inter-tribal Māori war, in 1836. Ngāi Tahu (under Tuhawaiki) repelled the challenge and threat from northern invaders thus the south was kept from passing into the hands of the northern tribes. The Mataura was noted for its customary native fishery. Te Au Nui (Mataura Falls) was particularly associated with the taking of Kanakana. Inanga remains an important resource on the river. The estuary (known as Toetoe) is a particularly important customary food gathering location.

SOURCE: Ngāi Tahu ki Murihiku Natural Resource and Environmental Iwi Management Plan (2008). Te Tangi a Tauira – The Cry of the People.

ACTIVITY

1.7 Use storytelling to teach about cultural practices to protect water

Learning area	Achievement objective
Social Studies	Understand how cultural practices vary but reflect similar purposes

Get students to read the story about the creation of Lake Te Anau, and then answer the questions that follow. Many of the answers can be found at www.teara.govt.nz.

STORY: The creation of Lake Te Anau

High up in the mountains in the southwest corner of the South Island is Lake Te Anau. Once, however, there was no lake here, only a long deep gully where some people from the Waitaha tribe made their home. In the middle of their village was a magical spring which was said to be bottomless. Only the tohunga, Te Horo, and his wife, who had been appointed guardians of the well, were allowed to go near it. This was because the people believed that if a common person looked at the water in the well, disaster would fall on the whole village. The villagers were so terrified of a possible disaster that they always diverted their gaze from anything that was too close to the well, even the surrounding bushes. Te Horo used to go there and draw enough fish from it to feed the village.

One day a messenger came running to the village with bad news about a war that had broken out between certain tribes on the coast. Te Horo, who had thought that some of his friends might be involved, decided to see if he could help to make peace. So, having consulted the people of his tribe, he set out the very next day, but not before reminding his wife not to let anyone near the spring while he was away.

The tohunga's wife was young and beautiful and a little frivolous. When she was sure that her husband had gone she called on one of the men of the village, with whom she was in love. Together they dashed into the woods, like two children on an adventure, and found themselves at the place where the magical spring stood. Then, giggling, she dared him to look into it. "Not unless you do," he answered. And so they both peered in, just for a second. That quick glance at the water was enough to break the tapu. They stood there and watched in horror as the water rose to the top of the well, spilled over and flooded the whole village. This happened so quickly that everyone in the village drowned. The water continued to pour out in unceasing volumes until it filled the valley and eventually formed Lake Te Anau.

Now Te Horo happened to look back on his long journey towards the coast and he knew something terrible had happened. All he could see was a sheet of water. His village, his tribe, his valley, all had been drowned under a great expanse of water. Te Horo knew at once that someone in the village must have betrayed his trust and that this disaster was punishment from the gods. And he was filled with sadness because he knew that he would never see his wife, his people or his village again.

SOURCE: "Land of the Long White Cloud. Māori Myths, Tales and Legends" by Kiri Te Kanawa

QUESTIONS

1. What does the name "Te Anau" mean?
2. How is a tohunga different from other ordinary people?
3. The well was said to be tapu, what does this mean?
4. What happened when the tapu was broken?
5. What do you think the moral of the story is?

How much drinkable water is there on earth?

TEACHER NOTES

The amount of freshwater on earth is a small percentage of the total water available. The freshwater in groundwater, rivers and lakes is our primary source of drinking water and our existence depends on it. The students may be surprised to learn that groundwater and surface water make up such a small percentage of the earth's total water supply.

ACTIVITY

2.1 Demonstrate the percentage of earth's total water supply that is drinkable

Learning area	Strand	Achievement objective
Science	Planet Earth and Beyond	Develop an understanding that water, air, rocks and soil, and lifeforms make up our planet and recognise that these are also earth's resources

Equipment

- large bucket
- glass jar
- 2 cups
- 4 sticky labels and a pen
- blue food colouring (optional: use a few drops to the tint water for improved visibility)

Method

- Fill a bucket with 10 litres of water. Add a few drops of food colouring. This represents the total volume of water on earth (100%).
- Take 300mℓ of water out of the bucket and place it in a glass jar labeled "freshwater". This represents the total volume of freshwater on the earth (3%). The water remaining in the bucket represents the salt water in the oceans, seas and bays, saline lakes and saline groundwater. Label the bucket "salt water".
- Take 90mℓ of water out of the glass jar of "freshwater" and place it in a cup labeled "groundwater". This represents the total volume of groundwater on the earth (30.1% of the total freshwater).
- Take 1mℓ of water out of the glass jar of "freshwater" and place it in a cup labeled "rivers and lakes". This represents the total volume of fresh surface water on the earth (0.3% of the total freshwater).
- The water remaining in the glass jar of "freshwater" represents all the freshwater found in icecaps, glaciers, permanent snow and in the atmosphere (69.6% of the total freshwater)). Label the jar "frozen water and water in the atmosphere".
- Compare the amount of drinkable water (in the cups labeled "groundwater" and "rivers and lakes") with the amount of undrinkable water (the bucket of "salt water" and the jar of "frozen and atmospheric water").
- Represent these figures graphically – for example as a table, graph or pie chart.

Discuss the following:

- Is all freshwater safe to drink?
- What are some of the things that threaten the quality and availability of our freshwater sources (e.g. infrastructure, rainfall, competing uses)?
- What can be done to protect them and manage them wisely, now and into the future?

The importance of water

TEACHER NOTES

Water is important for...	Why?	What happens if we use too much or spoil the quality of our water?
Irrigation	Much of Southland is used for farming. Irrigation is important, especially during the dry seasons.	Farms would be at the mercy of the weather. There would be losses of production and livestock, affecting the rural economy.
Domestic use	Almost everything we do in our daily lives needs water.	Imagine if you couldn't clean, cook, drink, wash or get rid of your waste from the toilet because you had no water.
Cultural values	Cultural groups around the world have developed their own meanings, values and customs surrounding water.	Refer to section on traditional water classifications (p. 27).
Industry	The production of most things requires water – not just for cleaning and processing, but also for dealing with waste.	Industry and commercial activities could not continue or would not produce a service of an acceptable standard.
Recreation	High-quality water is important for many recreational activities, such as boating, fishing, tramping, swimming and picnicking.	We might not be able to do any of the things we take for granted in and around our rivers. How would this make us feel?
Landscape values	Waterbodies and their surroundings are natural features that are part of our identity – part of what makes Southland.	If the water and its surroundings are degraded in any way, they are no longer distinctive and are lost to us.
Plants, birds and fish	The level and quality of water affect the ecology of rivers. Plants, birds and fish rely on water resources, their habitat, for life.	Fish lose their water passages and space to live. Plants could die so breeding, spawning and nursery areas for fish, birds and aquatic insects are affected.

ACTIVITY IDEAS

2.2 Identify and build on students' prior knowledge about the importance of water

Learning area	Strand	Achievement objective
English	Speaking, Writing and Presenting	Show a developing (increasing) understanding of how to shape texts for different purposes and audiences

Brainstorm

Arrange the students in small groups and ask them to brainstorm why it is so important to have sufficient, good quality freshwater. Ask each group to share their ideas with the rest of the class.

Mindmap

Summarise all of the ideas in a mind map. Draw it on a large piece of paper and hang it prominently in the classroom.

Letter, essay or presentation

Ask students to choose a subset of ideas from the mind map (or choose from the list below) and write a letter, give a speech or present a slideshow on the importance of having sufficient, good quality water. They should specify who the intended audience is and what the purpose of the letter / speech / slideshow is.

Ideas to consider:

- drinking
- washing
- food processing
- health and sanitation
- waste disposal
- agriculture
- industry
- energy-generation
- transport
- sports
- recreation
- tourism
- culture
- aquatic ecosystems
- terrestrial ecosystems
- coastal ecosystems
- any other purpose you can think of

RESOURCES

Refer to Environment Southland's report: Southland Water 2010: Our Uses (e.g. page 24)

Values and uses

TEACHER NOTES

New Zealand's rivers and streams were very important to early Māori and to European settlers, as they provided drinking water, food and transport routes. Because villages and towns needed fresh drinking water, they were usually located close to streams. Māori had many mahinga kai (food gathering places) along streams where they caught tuna (eel), other native fish, kakahi (shellfish) and koura (freshwater crayfish). Walking tracks often followed waterways and canoes navigated the larger rivers.

Cultural use is often described as relating to activities like collecting plants, fish, animals and other natural materials for cultural purposes. But it also includes activities related to visiting or interacting with a place or landscape, such as campsites or settlements.

Water is regarded by Māori as an inheritance from the past and entrusted to the future. It is perceived as having mauri. Mauri is often translated as the 'life force' - the essence of a being, the power that makes it what it is. It is considered that all natural things, and some things that humans build, have a mauri. Land, plants, rivers and buildings all have their own mauri, which must be respected and protected. Any interference with or severance of the mauri by way of pollution, indiscriminate exploitation, human or toxic wastes, can destroy or diminish the mauri and thus render the waterway lifeless. Where water has become unclean, its mauri suffers and human beings can also suffer - such as when shellfish are contaminated. As kaitiaki (guardians), Māori protected the mauri of the waterways to ensure they would be in a good state for future generations.

ACTIVITY IDEAS

2.3 Research values and uses of your local stream

Learning area	Achievement objective
Social Studies	Understand how cultural practices vary but reflect similar purposes

1. Find out how your local stream is used and valued today:
    - Identify the major uses of the river or stream, e.g. agricultural, industrial, household and recreational uses
    - Invite guest speakers to come and talk to the class about the waterway, e.g. people from your local council, Environment Southland, members of Landcare groups, historians, people who live and work in the area, members of the rūnanga, or anyone who has an opinion on the local waterway.
2. Research the waterway to find out about its historical or cultural importance e.g. to early European settlers or Māori:
    - Visit your library to gather historical information about your area.
    - Ask iwi or kaumātua to come and visit your school to explain the cultural significance of your river or stream.
3. Use a mind map to summarise the information you have gathered.
4. Present your information in a visual and interesting way to your class, school and community, e.g. a poster, PowerPoint, newsletter or community meeting. You could make a large scrapbook and include pictures, anecdotes from guest speakers, maps and historical information, as well as thoughts from your own students, their families and friends.

Customs and proverbs relating to water

TEACHER NOTES

Cultural groups around the world hold their own beliefs and customs surrounding water. In many cultures, water is used for purifying and cleansing, both in a physical sense (washing ourselves) and in a ritual sense. For example, in Māori culture, water is sprinkled in a house whose occupier has died, for washing hands after being in an urupā (cemetery), and after being with a dead person at a tangihanga. Hindus believe that water from the Ganges River can cleanse any place or object and that bathing in the river will wash away one's sins. It is therefore compulsory for every Hindu to take a dip in the Ganges River once in their lifetime. Many Christian groups around the world have the practice of baptism in which water is applied to a person's head or the person is immersed in water. This symbolises dying to an old way of life and being born again into a new way of life.

Many cultural groups have also developed their own proverbs about water. Proverbs are popular sayings (or words of wisdom) that are used throughout the world to express a truth based on common sense. Many proverbs use water to teach a truth, for example:

- "The frog does not drink up the pond in which he lives" (American Indian proverb)
- "Don't empty the water jar until the rain falls" (Philippine proverb)
- "You won't miss the water till the well runs dry" (unknown origin)
- "Filthy water cannot be washed" (African proverb)

ACTIVITY

2.4 Explore a range of international customs and proverbs relating to water.

1. Ask the students to tell the class about any customs they know of, where water plays an important role.
2. Use the Internet to find some more interesting water proverbs from around the world.
3. Invite students to invent their own proverbs to highlight the value of water and the importance of using water wisely.

Tikanga (correct practices) relating to water

TEACHER NOTES

According to Māori customs, every body of water has its own mauri and should therefore not be mixed with water from another source. Tikanga (correct practices) reflect this necessity. For example, separate facilities should be used for cooking and for washing the body. These waters should not be mixed. Long before Europeans came to Southland, Māori classified the waters of our region into different types (momo wai). Each momo wai is regarded as having different values and uses. Different water sources may be used for different purposes, such as a spring for ritual purposes and a river for ordinary washing. In some places, distinct parts of the same river would be identified as sources for ritual, for drinking water and for washing. Alternatively, a different time of the day could be set aside for using a river for the various purposes.

ACTIVITY

2.5 Learn about Māori tikanga (correct practices) relating to water

1. Ask students to read the explanations of the different water classifications in the table on the next page.
2. Ask them to discuss any local examples that seem to match the descriptions of the different water types (momo wai).

RESOURCES

Environment Southland's State of the Environment Report "Our Uses: Southland Water 2010: Part 3" has a chapter on cultural use. It can be downloaded from the website www.es.govt.nz/environment/monitoring-and-reporting/state-of-the-environment/water-2010. Read the story on pages 24-25, which describes the cultural significance of the Mataura River.

Traditional water classifications

TEACHER NOTES

Classifications ***Ki uta ki tai***	**Classifications by spiritual description**	**Classification by physical description**	**Classification by special uses**
Waimāori freshwater	*Waimāori* becomes waimāori when it comes into unprotected contact with humans has a mauri (which is generally benevolent) and which can be controlled by ritual	*Waimāori* the term used to describe water that is running freely or unrestrained, or to describe water which is clear or lucid	*Waimāori* normal, usual and ordinary
	Waiora pure water is termed Te Waiora a Tane, and to the Māori it contains the source of life and wellbeing the spiritual and physical expression of Ranginui the sky father, shedding tears at the loss of Papatūānuku , the earth. The rain is waiora	*Waiora* the purest form of water	*Waiora* used to purify and heal. can remain pure, as waiora, only if its contact with humans is protected by appropriate ritual prayers has the potential to give life, to sustain wellbeing, and to counteract evil
	Wai whakaheke tupapaku Classed as wai tapu		*Wai whakaheke tupapaku* are water burial sites
	Wai tohi Classed as wai tapu		*Wai tohi* used by a tohunga during initiation and baptism ceremonies
	Waikino water which has been polluted or debased, spoilt or corrupted. In waikino, the mauri has been altered so that the supernatural forces are non-selective and can cause harm to anyone	*Waikino* water which is rushing rapidly through a gorge, or water where there are large boulders or submerged snags which give the potential to cause harm to humans	
	Waimate has lost its mauri or life force has the potential to cause ill fortune, contamination or distress to the mauri of other living things, including people, their kai moana or their agriculture. The subtle differences between waikino and waimate seem to be based on the continued existence of a mauri (albeit damaged) in the former, and its total loss in the latter	*Waimate* dead, damaged or polluted water which has lost its power to rejuvenate either itself or other living things has a geographical meaning; to denote sluggish water, a backwater to a main stream or tide, but in this sense the waimate retains its mauri	
Waimataitai brackish water of estuarine areas the interface of freshwater and seawater			
Waitai the sea, the surf or the tide, sea water	*Waitai* has returned to Tangaroa in the natural process of generation, degradation and rejuvenation.	*Waitai* rough, angry or boisterous like the surf, or the surge of the tide.	

Source:
Tipa and Associates Ltd. 2011. Our Uses. Cultural use in Murihiku

Conflicting uses

TEACHER NOTES

The Southland way of life is closely tied to our lands and water. Many of our catchments have been managed primarily as an economic resource. Water is dammed, stored, diverted and extracted for various economic uses such as agriculture and industry.

Some of these uses may conflict with other values. For example, in the Māori view, it is offensive to discharge waste to the same waters that supply people with food. Damaging the mauri of a waterbody will affect its productivity and the quality of the food and other resources that people gather from it. For example:

- water pollution places the health of aquatic organisms and human population at risk
- fish movement within river systems may be disrupted
- the character of highly valued cultural landscape may be altered
- wāhi tapu and wāhi taonga areas may be lost
- kai gathering areas may be destroyed or access limited
- there may not be sufficient flow to maintain a waterbody's mauri

ACTIVITY IDEAS

Learning area	Strand	Achievement objective
Health and Physical Education	Healthy Communities and Environments	Investigate and describe lifestyle factors and media influences that contribute to the well-being of people in New Zealand

2.6 Investigate conflicting uses of your local stream

1. Ask the students to identify the range of people that use your local waterway and what they use it for, e.g. recreation, fishing, hunting, food-gathering, drinking water, irrigation, water for stock, to get rid of wastewater from industry or stormwater. This could be depicted in the form of a mindmap.
2. Identify what the various users need and want from the waterway. Students may need to interview a few people to find this information.
3. Conduct a survey or interviews to find out how uses have changed, e.g. is it still possible to swim, catch fish or gather food plants at this site? What has changed?
4. Identify possible conflicts between different users.
5. Identify how some users can enhance or spoil the experience or health and safety of other people who use the waterways.

2.7 Roleplay a potential conflict between different users of your stream

Learning area	Strand	Achievement objective
Social Sciences	Social Studies	Understand how people view and use places differently
Health and Physical Education	Relationships with Other People	Describe and demonstrate a range of assertive communication skills and processes that enable them to interact appropriately with other people

Do a roleplay exercise to explore what happens when one use comes into conflict with other uses. Ask the group to try to reach some kind of agreement (a compromise or a 'win-win' solution).

RESOURCES

Environment Southland's State of the Environment Report "Our Uses: Southland Water 2010: Part 3" includes several case studies that can help students to understand the needs and perspectives of different groups of water users, for example:

- Hydroelectricity: read the story on page 45 to find out about the Meridian Manapouri Power Scheme, New Zealand's largest water user, and its effects on the Waiau River.
- Irrigation: read the story on page 46 to find out how important groundwater is to farmers in Southland.
- Kayaking: read the story on page 51 about a man who loves to kayak on Southland's rivers and the changes he has seen in the Makarewa and Mataura rivers and the Mavora Lakes.

Irrigation

Kayaking

3. Freshwater ecosystems

What is an ecosystem?

TEACHER NOTES

An ecosystem is a community of organisms (plant, animal and other living organisms) together with their environment. Examples of ecosystems include forests, deserts, streams and wetlands.

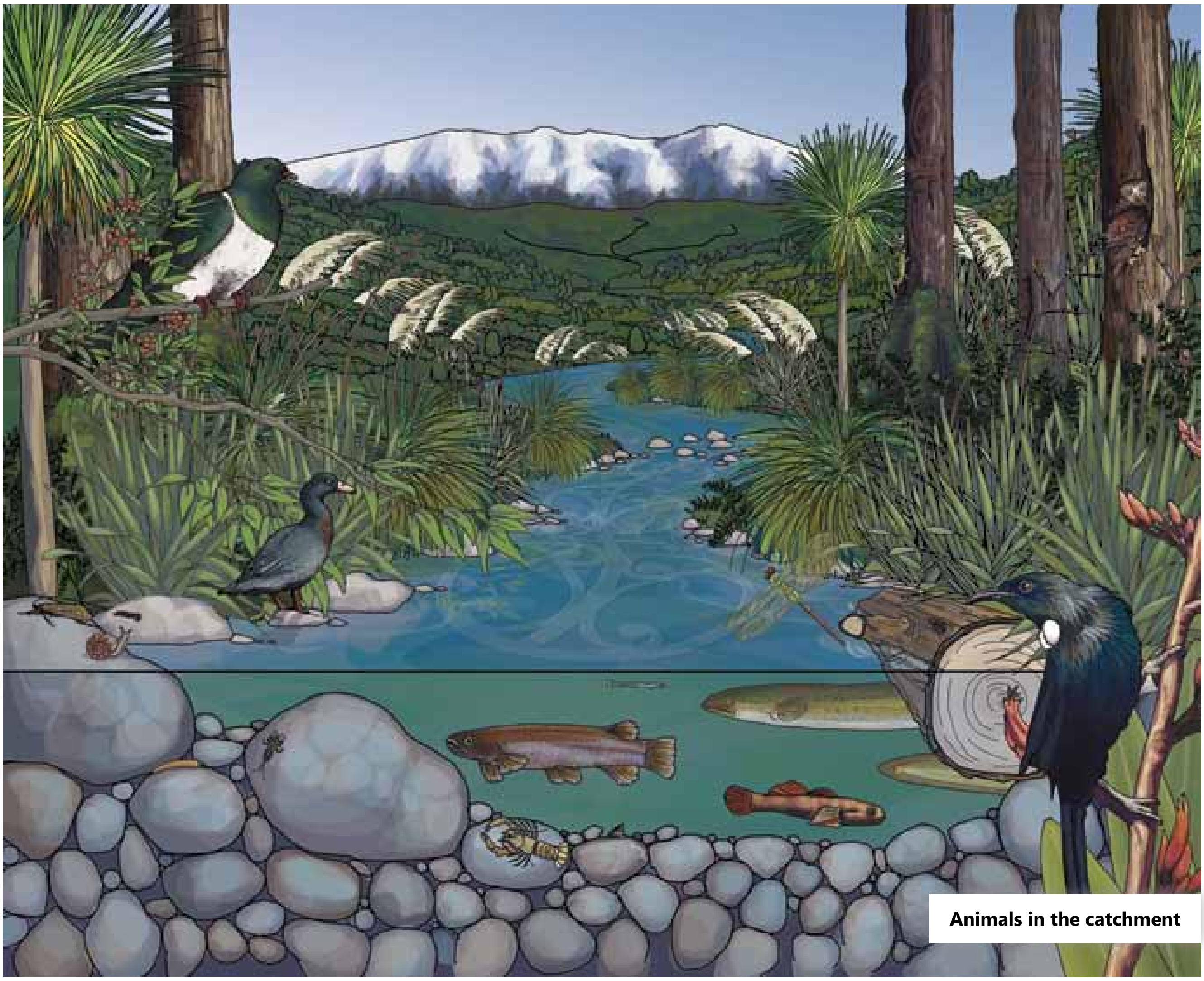
Within every ecosystem, there are important and complex relationships between the living (biotic) and non-living (abiotic) components. For example, the stream bed provides habitat for insects and fish. Aquatic plants help to stabilise the stream bed and banks and provide food and oxygen for the animals in the stream. Aquatic animals, such as insects, provide for fish, spiders, birds and even bats. Animals, in turn, produce carbondioxide and waste products containing nutrients which can be used by plants.

ACTIVITY IDEAS

Learning area	Strand	Achievement objective
Science	Living World	Explain how living things are suited to their particular habitat and how they respond to environmental changes, both natural and human-induced
Science	Living World	Begin to group plants, animals and other living things into science-based classifications.

3.1 Identify connections between us and our ecosystem

1. Ask the students whether they live as part of an ecosystem. Ask them to think about all the things they need in order to live and thrive. Where do these things come from? Can they think of anything that did not originally come from the earth? Even the technologies we use (cellphones etc.) are manufactured from materials (metals, oil-based synthetics etc.) that come from the earth.
2. Ask the students to draw pictures of themselves in the centre of a page. Now write or draw all the things they need to live (e.g. food, water, clothes, air, electricity, fuel, vehicles and machines).
3. Draw lines to show the connections between them, e.g.:
    - the crops we eat need good soil, water and light to grow,
    - our cars run on fuel which comes from oil in the ground,
    - the houses we live in are made from materials (timber, brick, cement) that were manufactured using methods that consumed water and energy
4. Discuss what would happen if some of those connections were cut e.g. if our crops failed because the climate changed; if we ran out of oil; if the groundwater became too polluted to drink.


Animals in the catchment

Food chains and food webs

TEACHER NOTES

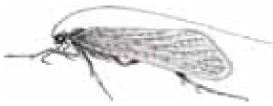
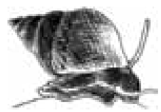
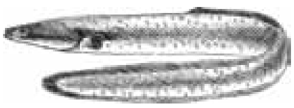
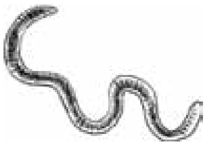
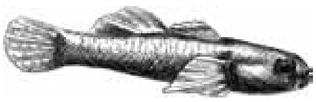
All living things need energy to live and grow. Plants have the ability to make their own food by capturing energy from sunlight in a process called photosynthesis. Plants are therefore referred to as producers. Animals cannot capture energy from sunlight. The only way animals can obtain energy is by eating, or consuming, plants or other animals. Animals are therefore referred to as consumers. Without plants, humans and all other animals would starve.

Food chains show how one living thing provides food for another. Energy passes along a food chain from producers to consumers, as one member of the chain is consumed by the next.

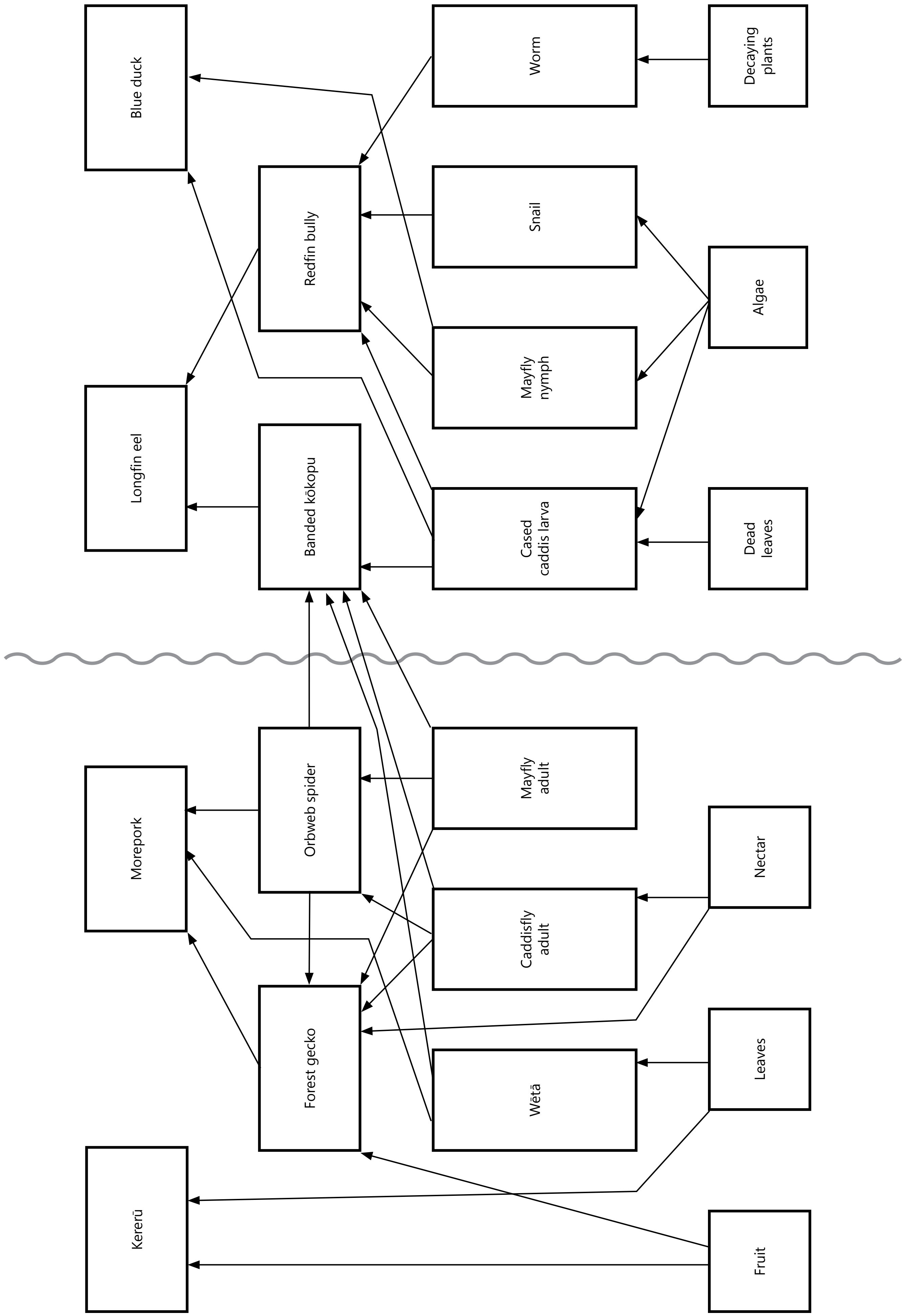
ACTIVITY

3.2 Build freshwater food chains and food webs

- Ask students to write down 3 different food chains that they are likely to find in and around a stream.
- Photocopy the images provided to make Food Chain Cards. Students can use the cards to build their own food chains and foodwebs.

 **Tree wētā:** I eat leaves. I am eaten by birds and banded kōkopu when I fall into the stream.	 **Caddisfly adult:** I eat nectar from plants. I am eaten by banded kōkopu, spiders and geckos.	 **Kererū:** I eat fruit, berries and leaves from trees.
 **Morepork:** I eat spiders, geckos, wētā and other insects.	 **Forest gecko:** I eat mayfly and caddisfly adults, spiders, fruit and nectar.	 **Orbweb spider:** I use my web to catch flying insects like mayfly and caddisfly adults. I am eaten by banded kōkopu.
 **Blue duck:** I eat mayfly and caddis larvae	 **Mayfly adult:** I have no mouthparts and don't eat while I'm an adult. I am eaten by spiders, geckos and fish.	 **Water snail:** I eat algae that grows on rocks in the stream.
 **Longfin eel:** I eat fish such as banded kōkopu and bullies.	 **Cased caddis larva:** I eat algae that grows on the rocks and dead leaves that fall into the stream.	 **Banded kōkopu:** I eat insects and spiders that fall into the stream. I also eat caddisfly larvae.
 **Worm:** I eat decaying plants and other material.	 **Redfin bully:** I eat mayfly nymphs, caddis larvae, snails and worms.	 **Mayfly nymph:** I eat algae that grows on the rocks in the stream.

MODEL ANSWER



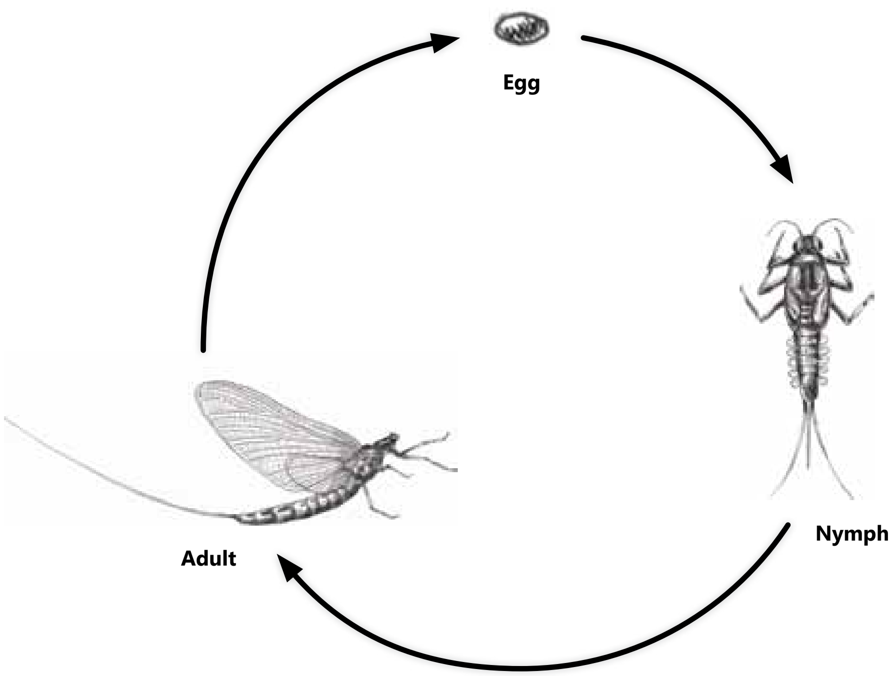
Stream health

TEACHER NOTES

Streams play a key role in the ecosystems of New Zealand. They feed and link together freshwater sources, maintain good water quality and support habitats that sustain biodiversity. Aquatic organisms have adapted over hundreds of thousands of years to live in their specific environments. Some are very sensitive to changes in the physical and chemical characteristics of their environment. Keeping a healthy diversity of life in a stream is therefore dependent on good habitat and good water quality.

A healthy stream performs a number of important ecological functions, including:

- providing natural drainage for the catchment
- providing habitats for plants and animals
- completing the lifecycles of many invertebrates
- filtering pollutants in run-off from urban and agricultural areas, thereby helping to protect lakes and rivers downstream
- processing leaves and other organic material into fine particles, which are an important food source for organisms further downstream
- transporting nutrients to waterbodies downstream
- holding back sediment which would otherwise reduce water quality and disturb aquatic animal life cycles and the growth of aquatic plants
- slowing runoff during heavy rain, which helps to minimise downstream erosion and encourage infiltration of water into the ground.



A healthy stream has:

- a variety of in-stream habitats for aquatic life such as insects and fish
- a well-vegetated riparian zone which acts as a buffer between the stream and the land. Plants growing in the riparian zone remove nutrients and filter out sediments in water running off the land. Good vegetation cover helps to stabilise streambanks, provides habitat for terrestrial animals like birds and insects, and enhances habitat for in-stream inhabitants by providing protected living spaces, shade and food.
- forests and wetlands in the catchment help to reduce stormwater (floodwater) flow
- good quality water. Water naturally carries many substances including oxygen, carbon dioxide, nitrogen, phosphorus, other dissolved minerals, bacteria and sediments. The amount of each substance will depend on the surrounding vegetation, soil type, land use and climate.
- sufficient quantities of water to sustain a range of aquatic and riparian habitats

Mauri

Mauri is a central component of the Māori perspective on the environment. It refers to the life supporting capacity, or life force present in all things. A healthy mauri requires good water quality. A healthy mauri has the ability to build floodplains, reshape channels, build river mouths and sustain biodiversity.

Stream degradation

Changes to the stream, for example changes in water velocity and depth, temperature, substrate (material on the bottom) and in-stream cover (e.g. undercut banks, boulders and large pieces of wood) can affect the ability of aquatic plants and animals to thrive in the stream.

Many streams have been degraded by development, industrial activity or bad agricultural practices over the years. There have been cases where human activity has had such an impact on stream habitats, that many species can no longer survive and their populations have collapsed. Fortunately, degraded streams can be rehabilitated if we change the activities that caused the initial damage, and restore the surrounding habitats by reintroducing suitable plants and animals.

ACTIVITY IDEAS

3.3 Compare healthy and degraded streams

Learning area	Strand	Achievement objective
Science	Living World	Explain how living things are suited to their particular habitat and how they respond to environmental changes, both natural and human-induced

Look for photographs or pictures of streams in varying states of health (e.g. good, moderate, poor and very poor). Get students to compare them and spot the differences. TIP: Look for differences in channel shape, bank steepness, erosion, vegetation (amount of vegetation, types of plants in the stream and in the riparian zone), stream bed, water colour etc.

3.4 Illustrate a well functioning freshwater ecosystem

Learning area	Strand	Achievement objective
Science	Planet Earth and Beyond	Appreciate (develop an understanding) that water, air, rocks and soil, and life forms make up our planet and recognise that these are also Earth's resources

1. Get students to design a poster, collage, tapestry or mural to illustrate a well functioning freshwater ecosystem. Things to include: clean, flowing water; plants and animals in different life stages; riparian vegetation and wetlands to filter pollutants from the land; abundant food for insects, fish and bird life; stable stream banks etc.
2. Brainstorm ideas about what people could do to improve the ecological functions of a degraded stream.

RESOURCES

The Landcare Research website has excellent photographs and explanations to assist with this activity. Go to Landcare Research's online guide to the freshwater invertebrates of New Zealand: Click on "stream quality" to see a series of photographs of streams in different states of health: http://www.landcareresearch.co.nz/research/biocons/freshwater/stream_quality.asp.

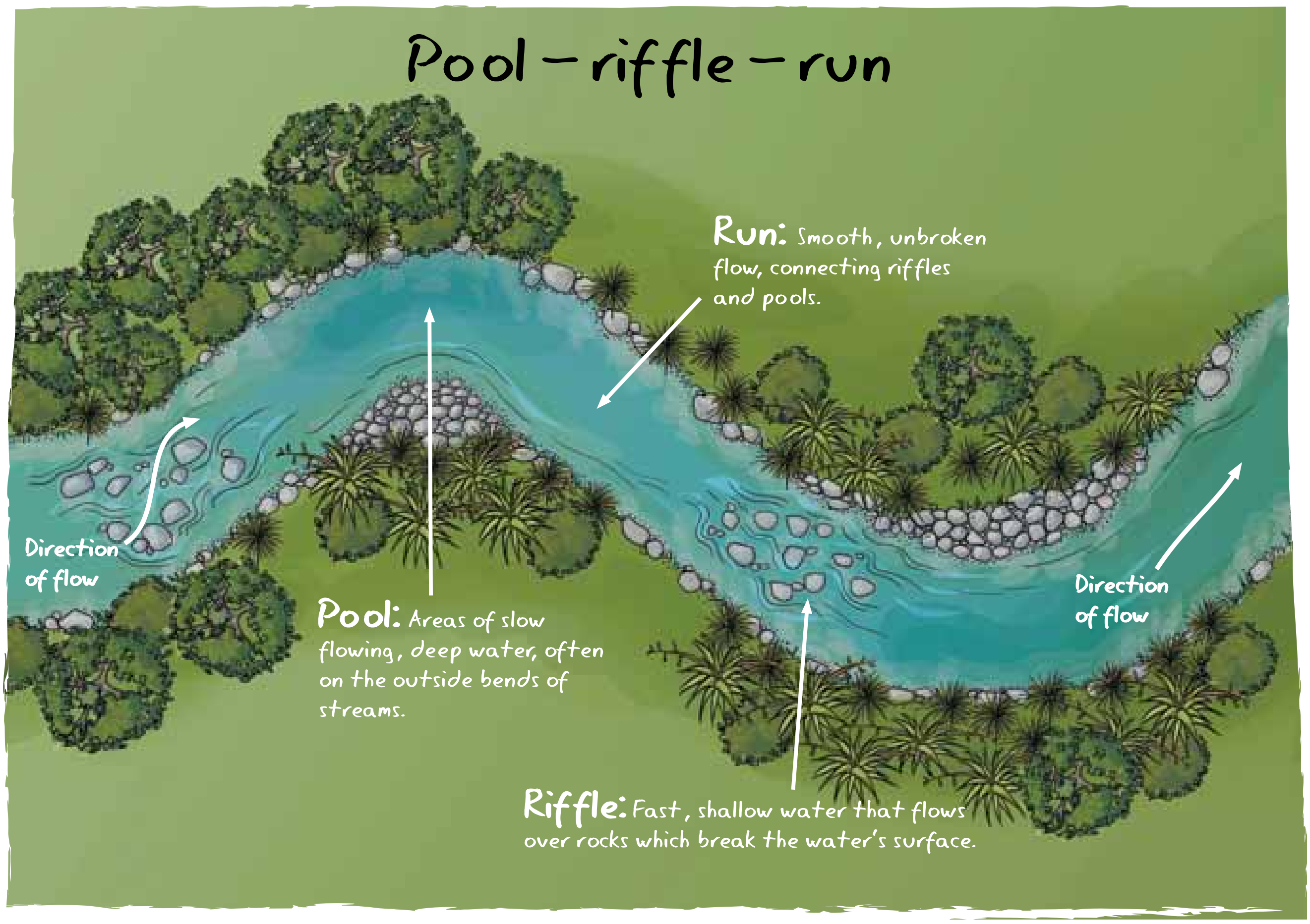
Aquatic habitats

TEACHER NOTES

Fish habitat preferences

Different species of fish prefer different habitats within the stream. For example, trout and salmon need streams of clean, cool, fast-flowing water to spawn in. The bed of the stream should have gravel of a certain size (1-4 cm in diameter) in which to lay their eggs. Small salmon and trout need to feed on small insects that live under stones on the streambed. That means the habitat needs to be suitable for those insects, too. Whitebait species love bushy streams, where they find both shelter and food, with a rain of insects falling from the overhanging plants.

The suitability of a particular habitat is also influenced by things like water velocity and depth, temperature, substrate (material on the bottom) and in-stream cover (for example, undercut banks, boulders and large pieces of wood).



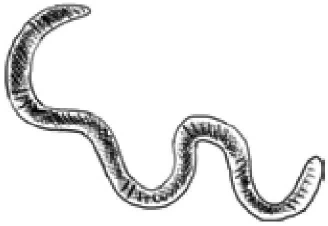
Examples of habitat types preferred by particular species:

Rapids and riffles	torrentfish, bluegill bullies, kōaro, alpine galaxiid, and upland longjaw galaxiid species
Runs	juvenile eels, trout, and some galaxiid and bully species
Pools	adult eels, lamprey, various juvenile galaxiid species and adult kōkopu

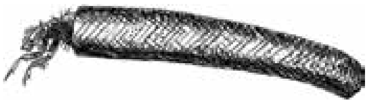
SOURCE: www.niwa.co.nz/our-science/freshwater/research-projects/habitat-requirements-of-new-zealand-freshwater-fish

Invertebrate habitat preferences

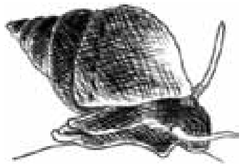
Many aquatic invertebrates are known to be sensitive to pollution or habitat modification. The absence of different invertebrates in a stream can therefore give us an indication of how healthy the stream is. There have been cases where human activity has had such an impact on stream habitats, and the plants and animal they support, that many species can no longer survive and their populations collapse. The worst examples of this have led to a wider awareness of the value of stream restoration and conservation. Degraded streams can be restored if we change the activities that caused the initial damage, and then rejuvenate the surrounding habitats by reintroducing the correct plants and animals.



Waterworm



Caddis larva



Watersnail

Dragonfly nymph

Mayfly nymph

ACTIVITY

3.5 Illustrate an ideal freshwater habitat

Learning area	Strand	Achievement objective
Science	Planet Earth and Beyond	Appreciate (develop an understanding) that water, air, rocks and soil, and life forms make up our planet and recognise that these are also Earth's resources

1. Get the students to design a poster, collage, tapestry or mural to illustrate an ideal habitat for freshwater fish and invertebrates. Things to include: flowing water, rocks, stones and gravel on the stream bed, plants on the stream banks, invertebrates, fish, birds and sunlight.
2. Brainstorm ideas about what people could do to improve the quality of habitats in a degraded stream.

RESOURCES

The Landcare Research guide to freshwater invertebrates of New Zealand has excellent photographs and explanations to assist with this activity.

http://www.landcareresearch.co.nz/research/biocons/freshwater/stream_quality.asp

Ecosystem services

TEACHER NOTES

We depend on a huge range of resources and processes that are supplied by the natural environment. These benefits can be referred to as 'ecosystem services'. It is helpful to think about these services in four categories: provisioning services (e.g. production of food and water); regulating services (e.g. control of climate and disease); supporting services (e.g. nutrient cycles and crop pollination); and cultural services (e.g. spiritual and recreational benefits).

Healthy catchments can provide a range of ecosystem services. For example, healthy wetlands help to purify water by trapping sediment, slowing water flow which allows germs in the water to die, and by releasing nitrogen in the water back to the air. Often, the water that comes out of wetlands is much cleaner than it was when it went in.

ACTIVITY

3.6 Use the case study from New York City to learn about ecosystem services

Learning area	Strand	Achievement objective
Science	Planet Earth and Beyond	Appreciate (develop an understanding) that water, air, rocks and soil, and life forms make up our planet and recognise that these are also Earth's resources

Read the case study about the catchment protection programme in New York City and then answer the questions that follow.

CASE STUDY

New York City's drinking water is world-renowned for its good quality. New York City is one of only five large cities in the United States that is not required to filter its drinking water. The City's water comes from the Catskill and Delaware catchments, which have excellent natural filtering abilities because of their abundant forest vegetation, wetlands and soils with good levels of carbon. Healthy catchments like the Catskill and Delaware are able to purify water through natural abiotic processes such as soil adsorption and filtration of chemicals, plus biotic recycling via root systems and soil microorganisms.

But it was not always this way. The health of these catchments was being threatened by development, runoff from agricultural lands and impervious surfaces, and discharges from wastewater treatment plants. Water quality was declining to alarming levels and the City was considering spending US$6-8 billion on a new water filtration plant to treat the water. But then authorities considered an alternative proposal to restore the catchment's natural filtration services. They calculated that it would cost about US$1-1.5 billion to restore ecosystem services in the catchment. This was significantly less expensive than the cost of the proposed water filtration plant.

In 1997, New York City and various agencies and partners signed the historic Watershed Memorandum of Agreement in which they agreed to implement a catchment protection programme. The City implemented agricultural, forest and stream best management practices including buffers and setbacks, soil-conserving tilling and grazing practices, stream-bank fencing and erosion-prevention forestry practices. After reducing the input of sewage and pesticides to the catchment, water quality improved to levels that once again met government standards.

This decision resulted in significant cost savings and other benefits, including:

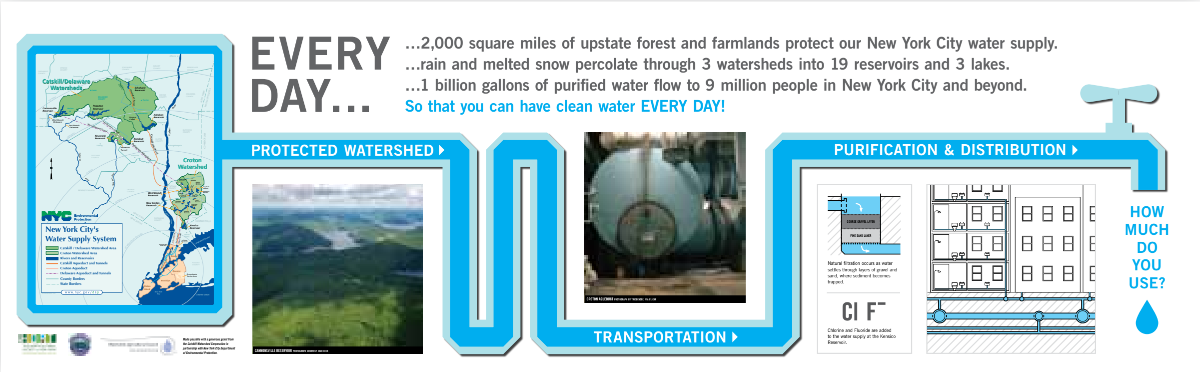
- Safer drinking water for both rural and urban residents
- Preservation of open space and the rural character of the Catskill/Delaware catchment
- Protection of other valuable ecosystem services such as flood control and storage of carbon by plants

SOURCE: For more information, look up the New York Watershed Protection and Partnership Council www.dos.state.ny.us/watershed.

For a New Zealand example, go to the United Nations website and look for the case study of Oratia catchment in Waitakere City: www.un.org/esa/dsd/dsd_aofw_mg/mg_success_stories/csd6/oratia.htm.

QUESTIONS

1. Can you see any similarities between the needs of New York City and the needs of towns in New Zealand?
2. Where does the water for your town / nearest town come from?
3. Can you think of any other ecosystem services that our urban areas rely on? (Think about water, air, land, food, landscape character, carbon-fixing, pollination of crops, removal of waste etc.)
4. Can you think of any ways to protect Southland's ecosystem services? Choose one that you think is a priority and write it down as a recommendation for your city / district / regional council.



ACTIVITY

3.7 New Zealand water journeys

Learning area	Strand	Achievement objective
Science	Living World	Explain how living things are suited to their particular habitat and how they respond to environmental changes, both natural and human-induced

This is a visualisation and guessing game which tells the stories of New Zealand 'water journeys'. Each of the stories below is read out and then the question is asked: "Who am I?" Students could also choose one of the stories to illustrate.

Journey 1

Water is important to take me to a new place where I can grow.

I would like to grow near a stream, where I will one day produce bright yellow flowers and attract birds like the tui.

I broke out of my seedpod and when it rained, I was carried downhill by the rain water until I dropped into a stream.

As I travel down the stream, my hard seed coat is scratched and broken so that water can enter to help me germinate.

Who am I?

I am a kōwhai seed. Kōwhai trees are often found naturally near streams. Streams distribute seeds and also help to break open the hard seed coat.

Journey 2

I started out life as an egg. One night, under a full moon, the sea water came right up a small stream and flooded the grass next to the stream. My mother laid my egg on a piece of rough grass. I clung to the grass, maturing inside my egg. At the next full moon, the tide rose up again and I emerged from my egg into the water. I travelled down to the mouth of the stream, swam out to sea and spent my early days there.

Now I am on my way back up the stream, towards the best place for me to spend my adult days - in a nice pool in a cool mountain stream, in the bush.

The water flowing out of my stream down at the sea was so full of dirt I almost didn't want to try and come up it.

Then I just escaped being netted by someone who wanted to put me into a fritter!

Now I am struggling to jump up a little waterfall that is falling from a pipe that someone has put under the road. My stream now flows through the pipe and I can't quite jump up to get through the pipe and up to the stream on the other side.

Who am I?

I am a whitebait fish. Whitebait are the young of at least five species of New Zealand native fish, known as galaxiids, including inanga and the kōkopu family. The adults of many of these species live in the headwater streams, where overhanging vegetation keeps the stream cool and provides logs to hide under and leaves for stream bugs that the fish feed on. The young whitebait live in the sea and then migrate upstream. When the rivers are very turbid (silty), some species of whitebait will avoid the river or slow their migration. Obstructions from pipes, culverts and dams often block their passage back to the headwaters.

Journey 3

I came from England with my husband because my brother was going to inherit my father's small farm and we couldn't afford to buy a farm of our own in England.

We thought there was a good opportunity for us to get some land in a new place they called New Zealand. Queen Victoria has claimed New Zealand as a British colony and they are looking for settlers. From all the advertising, it sounds really good. Our passage on this ship was paid for to help us come.

My husband, four children and I have been on this sailing ship now for nearly two months.

There are lots of us onboard and the water we have to drink tastes bad.

We often get sick and our youngest baby got a bad stomach bug and nearly died.

We are looking forward to seeing our new block of land.

Who am I?

I am a settler coming to New Zealand. The migrants of the 1830s-1880s are the ancestors of most New Zealanders. To attract migrants, in competition with Canada, Australia, South Africa and the US, New Zealand was marketed in Britain through public meetings, lecture tours, painting exhibitions and advertising. These often celebrated achievements that did not yet exist. Some migrants received assistance with their passage. The journey could take three to six months and shipboard disease was especially dangerous for children. Migrants who survived the arduous journey arrived full of hope.

Journey 4

My family spent the summer in the south, enjoying the plentiful food of the cold seas.

Now we are swimming northwards to the warmer waters of the Pacific. Maybe we'll even visit the coast of Southland.

When we get there, my mother will give birth to another calf.

When I was a calf, my mother taught me how to find the best places to feed. My favourite food is krill.

Most of my relatives live in the waters around the Auckland Islands and Campbell Island.

Who am I?

I am a southern right whale. In winter, southern right whales migrate north to New Zealand waters to breed. Females breed once every 3 years. The Auckland Islands and Campbell Island are the strongholds of the southern right whale and they occasionally visit the southern coasts of the South Island. Preservation Inlet, Te Waewae Bay and Bluff Harbour are popular destinations for the whales. Sometimes they come quite close to shore. Where the whales go from October to May is a mystery. They probably migrate to rich feeding grounds in the Southern Ocean to build up their reserves for winter.

Journey 5

We are travelling in a large, double hulled canoe that we made back in our warmer island home. We left to find new land and food sources and we are carrying some of our seeds with us to see if they will grow. We have yams, kūmara, and taro with us as well as some fruit seeds. We find our way by watching the stars and the sun and feeling the winds.

Who am I?

I am a Polynesian voyager. The first Polynesian settlers came to New Zealand from warmer Pacific islands. Many of the foods they brought with them did not survive in the colder New Zealand climate, but kūmara and taro could be grown in warmer sites. Some trees such as karaka are also thought to have been brought from Polynesia. Evidence indicates that Polynesians purposefully explored and colonised much of the Pacific and were extremely skilled navigators.

Journey 6

I start my journey as snow and ice melt on a high mountain, then I trickle and flow, getting bigger and bigger, as I journey towards the sea.

Over time, I have transported many things, animals and people. In my top reaches, where the water is icy cold and running swiftly over rocks, blue ducks like to bob and dive. In my lower reaches, tuna (eels) travel up from the sea to reach the swampy areas they love.

Māori waka once travelled on my surface laden with meat, vegetables and flax, going to be sold to the settlers in the town.

Then there were the big paddle boats that could travel on me, but only part of the way.

Once I used to play and spread out across the plain in a flood, but now I am hemmed in by stopbanks and people are safe from my water - most of the time!

I used to be cool and fresh with trees overhanging me and shading me and the fish and the insects liked it that way. But now my banks are bare and I get so hot! When the bush was covering the land I was cleaner, but now there is a lot of dirt and animal waste in my water.

Who am I?

I am a river. Rivers have always been important routes for both wildlife and people, and for trade. They also provide habitat for a wide range of life. Blue ducks (whio) are one of the few aquatic birds in the world which prefer alpine waters. Eels migrate from ocean to freshwater and back again during their life cycle.

Journey 7

I cannot move now, but when I was young I floated in the ocean.

I relied on the sea to take me to a new place where I could settle on a rock to grow into an adult and develop my beautiful shell of iridescent blue, green and purple.

I still rely on the sea for transport - not for me, but to bring me my food. I filter my food out of the sea as it surges back and forth above me with the waves and currents.

If the water flowing over me has sewage in it, I can get infected with bacteria.

The bacteria don't harm me, but they might make you sick if you eat me.

Who am I?

I am a pāua. In the early stages of their life cycle, pāua are free floating. It is dangerous to eat pāua that have been living in water contaminated by faecal bacteria.

REFLECT

1. In these stories, what are all the ways water helps to move things and people around?
2. How are the waterways near your school important to people, plants and other animals?
3. Do you think there are any animals that migrate through the water near your school?
4. Are there any blockages or obstructions in the river?
5. Think about someone or something that relies on water. Write your own water journey and see if your friends can guess who or what the story is about.

RESOURCES

Environment Southland's State of the Environment Report "Our Uses: Southland Water 2010: Part 3" includes a story about the fascinating fish that travel up and down along the Mataura River. Read the story on pages 24-25. The report can be downloaded from the website www.es.govt.nz/environment/monitoring-and-reporting/state-of-the-environment/water-2010.

Microorganisms

TEACHER NOTES

A microorganism or microbe is an organism that is so small that it is microscopic (invisible to the naked eye). Microorganisms are very diverse. They include bacteria, fungi, microscopic plants (green algae) and animals such as plankton.

Microorganisms are vital to humans and the environment. Some participate in cycles such as the carbon cycle and nitrogen cycle. Others decompose other organisms' dead remains and waste products. Some even live inside the human digestive system and help us to digest food.

However, some microorganisms, including viruses, bacteria and protozoa, are the cause of infectious diseases. They are present in contaminants such as human sewage or animal waste. These can affect us if we swim in, gather food from, or drink polluted water.

Nutrient enrichment of rivers and lakes, which can occur as a result of fertiliser and effluent runoff, can lead to growth of toxic algae and phytoplankton. These can adversely affect the health of people, livestock and pets.

ACTIVITY IDEAS

4.1 Discover microbial pond life

Learning area	Strand	Achievement objective
Science	Living World	Explain how living things are suited to their particular habitat and how they respond to environmental changes, both natural and human-induced
Science	Living World	Begin to group plants, animals and other living things into science-based classifications.

1. Get students to collect a sample of water from a pond. Use a dropper to place a drop of pond water on a microscope slide. Cover with a coverslip and examine it under a microscope. Ask them to draw, describe, name and compare some of the interesting organisms they discover.
2. Set up a small fish tank in the classroom. Pour a layer of sediment from a pond into the tank and then fill it with pond water. Include pond plants such as Nymphaea or Elodea. Over the next few days, ask the class to observe the tank and to note the changes in the water and what is growing on the glass. Take water samples and scrapings from the side of the tank and examine them under a microscope. If the tank is kept for several days or weeks, the water should be aerated for a few minutes every second day.
3. Fill some large glass jars with pond water. Add a bit of pond sediment and plant material to each jar. Show students how to suspend a microscope slide horizontally in each jar so that the slide is completely submerged in the water. (This can easily be done with a popsicle stick and two loops of fishing line). Wait 24 hours and then get students to carefully retrieve their slides from the water, making sure that some of the pond water remains on top of the slide. Remove excess water from the underside of the slide, cover with a coverslip and examine under a microscope. Ask them to draw, describe, name and compare some of the interesting organisms they discover. Do they find more of one type of organism in the sediment than at the top of the jar? Are different types of organisms found at different depths? If the jars are kept for several days or weeks, the water should be aerated for a few minutes every second day.

RESOURCES

Environment Southland's State of the Environment Report "Our Health: Southland Water 2010: Part 1" provides a wealth of information about water quality and human health. The report can be downloaded from the website www.es.govt.nz/environment/monitoring-and-reporting/state-of-the-environment/water-2010.

Invertebrates

TEACHER NOTES

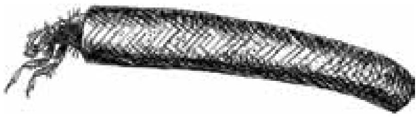
New Zealand's streams are home to hundreds of tiny animals that live on and under rocks, water plants or pieces of wood in the stream. These animals include insects, crustaceans, molluscs, worms, leeches and hydra. Together, they are sometimes referred to as 'macroinvertebrates' which means they have no backbone and that they are big enough to be seen without a magnifying glass or microscope. New Zealand has over 500 species of macroinvertebrates.

Invertebrates are an important part of the aquatic food chain:

- Some feed on rotting leaves and wood.
- Some graze on algae.
- Some are able to filter tiny food particles from the water.
- Some are predators which catch and eat other invertebrates.
- Aquatic invertebrates are also an important food source for fish, spiders, birds and even bats.

Most of the invertebrates found in streams are the larvae of various insect species which live out their juvenile stages in freshwater.

Dragonfly nymph

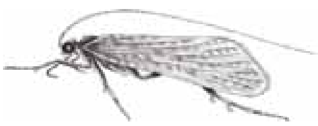


Caddis larva

Mayfly nymph

Those that survive to adulthood emerge from the water as winged adults in the warmer months. The adults fly away, possibly to another stream, find mates and lay their eggs in the water.

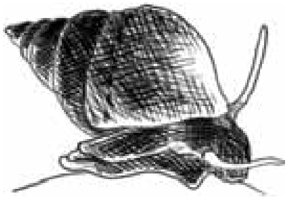
Adult dragonfly



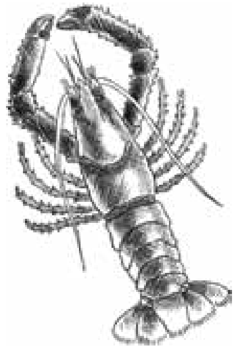
Caddisfly adult

Mayfly adult

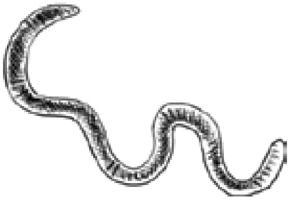
Other stream inhabitants include molluscs (e.g. snails and mussels), worms, amphipods, isopods, and crustaceans (e.g. shrimps and koura).



Water snail



Koura



Water worm

Freshwater invertebrates can tell us a lot about how healthy our rivers and streams are. If there are many different types present in a stream, it usually means that the water is clean, cool and that conditions are generally good. A stream without invertebrates has a major problem, possibly caused by pollution or drying of the stream.

Some invertebrates are known to be less tolerant of pollution than others. Pollution of a waterway, directly or through excessive algae growth, reduces the number of pollution-sensitive species such as mayflies, caddisflies and stoneflies. At the same time, there may be an increase in pollution-tolerant species such as midge larvae and snails.

ACTIVITY IDEAS

4.2 Research and classify freshwater invertebrates

Learning area	Strand	Achievement objective
Science	Living World	Begin to group plants, animals and other living things into science-based classifications.

1. Find out which invertebrates are likely to be found in the streams near you.
2. Select one and then research the following:
   a. Which Kingdom, Phylum, Class and Order does it belong to?
   b. How does its design make it suited to living where it does?
   c. How sensitive is this animal to changes in water quality and habitat?

RESOURCES

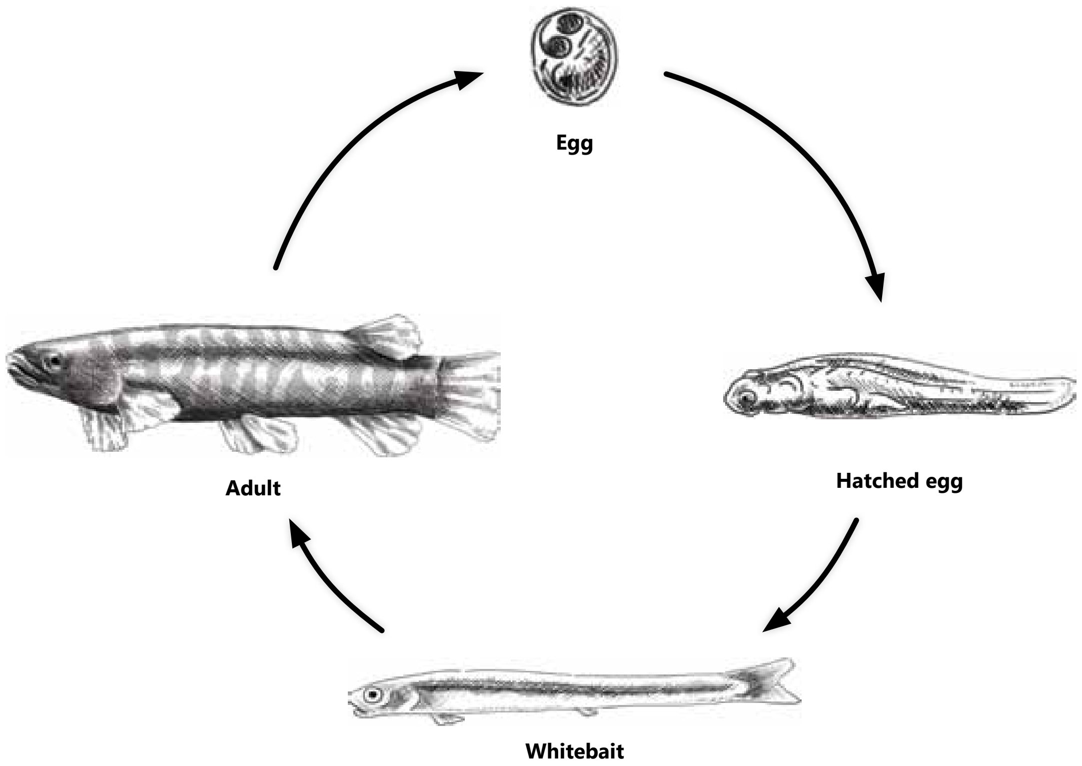
Waikato Regional Council has an excellent poster called “New Zealand’s Freshwater Invertebrates” with photographs and information about the main groups of invertebrates found in streams.

Fish

TEACHER NOTES

New Zealand has about 40 native freshwater fish species. How many can you think of? (Trout are not native). Many of these fish are nocturnal and secretive, so they are not well known. About half of our native fish spend some part of their lives at sea - so they need easy access between freshwater and the sea.

Many people are surprised to learn that 'whitebait' are the juveniles of five species of native migratory fish: Inanga, Kōaro, Banded kōkopu, Shortjawed kōkopu and Giant kōkopu. These species all belong to a group referred to as galaxiids because the patterns on their skin resemble galaxies of stars.

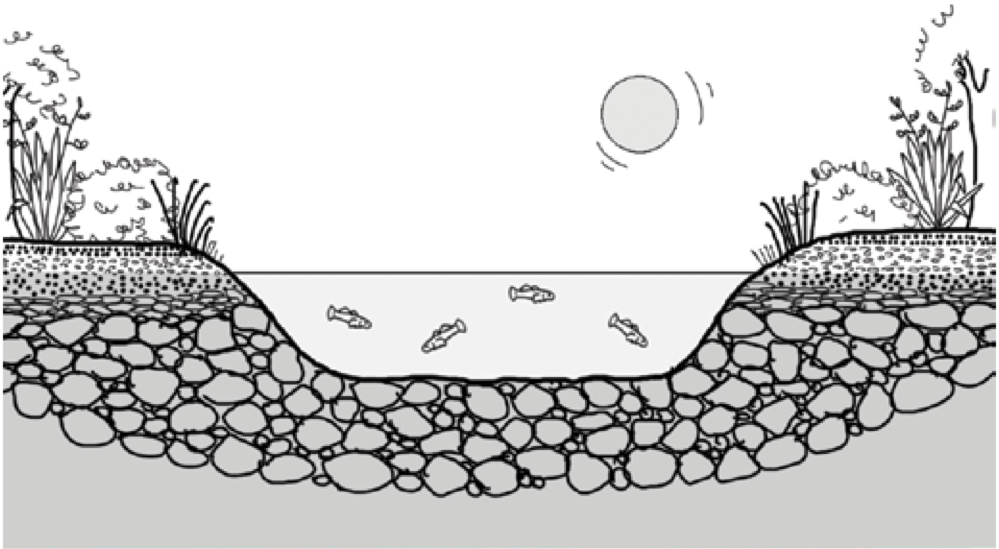


Threats to native fish

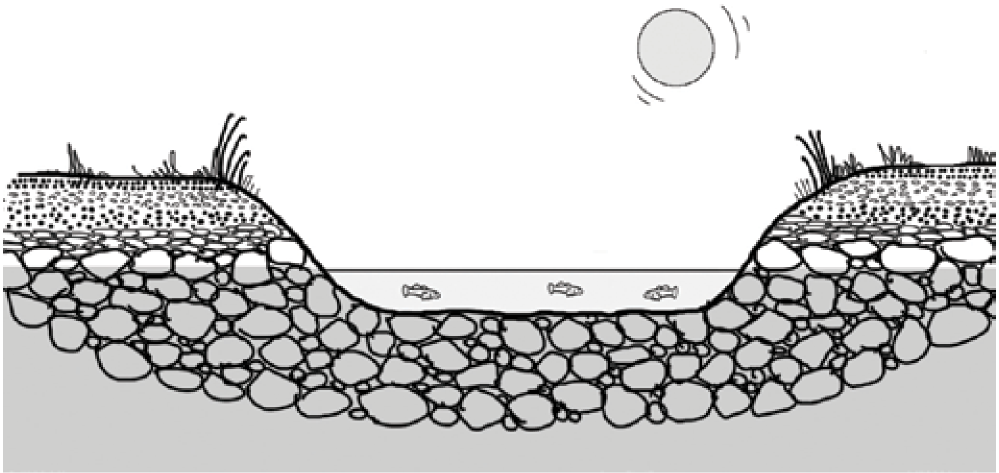
1. Migratory species are affected by dams and badly made or poorly maintained culverts, which can prevent them from migrating from the sea to freshwater habitats

Poorly-designed culvert preventing fish passage upstream

2. Native fish habitat is being lost as wetlands are drained and streamside vegetation removed
3. Some introduced fish compete with native fish for food and space, prey on their eggs and young, or can change the quality of water
4. Contaminants such as sediment and chlorine discharged into the water can affect fish
5. Water abstraction – take too much and there might not be enough for fish to live in!



Normal water level suitable for fish habitat



Water level reduced below fish habitat requirements

ACTIVITY

4.3 Research and illustrate freshwater fish

Learning area	Strand	Achievement objective
Science	Living World	Explain how living things are suited to their particular habitat and how they respond to environmental changes, both natural and human-induced
Science	Living World	Begin to group plants, animals and other living things into science-based classifications

1. Find out which native fish species are likely to be found in the streams near you, e.g. bullies, eels, lamprey, mudfish, non-migratory galaxiids, smelt, torrentfish, migratory galaxiids.
2. Select one and find out how its design makes it suited to living where it does.
3. Design a poster to warn people against releasing exotic fish into ponds and streams.

RESOURCES

- NZ Landcare Trust has developed a series of six Fish Factsheets. This resource focuses on New Zealand's unique freshwater fish and highlights the factors that impact on their survival. Order hard copies from NZ Landcare Trust or download them free of charge from http://www.landcare.org.nz.
- Fish and Game has a range of free education resources for New Zealand schools. http://www.fishandgame.org.nz/education.
- Environment Southland's State of the Environment Report "Our Ecosystems: Southland Water 2010: Part 2" (pages 35-39) includes a section on the life in our waters.
- Environment Southland's State of the Environment Report "Our Uses: Southland Water 2010: Part 3" has a story about flyfishing on the Mataura. Read the story on page 57 which describes how fish populations in the Mataura River are changing.
- These reports can be downloaded from the website www.es.govt.nz/environment/monitoring-and-reporting/state-of-the-environment/water-2010. A poster of Freshwater Fish in Southland is also downloadable from this page.
- Waikato Regional Council has an excellent poster called "New Zealand's Freshwater Fish" with photographs and information about the main groups of native fish found in streams.

Torrent fish *(Z. Moss)*

Aquatic plants

TEACHER NOTES

Aquatic plants complete part or all of their life cycle in or near the water. Some aquatic plants are single-celled organisms (e.g. phytoplankton) that can make water turn green in colour when they are abundant. Others have long filaments that grow on rocks and make them slippery or slimy when you pick them up. Some aquatic plants are quite large and appear similar to plants that we see on land. These aquatic plants are often referred to as 'macrophytes', which means 'large plants'.

Aquatic plants can be grouped into three categories:

- Submerged aquatic plants grow below the water's surface. They may be rooted or non-rooted to the bottom sediments.
- Floating aquatic plants float freely on the water's surface. Floating-leaved plants have their leaves on the surface, but they are attached to bottom-rooted plants by long stalks or petioles.
- Emergent aquatic plants are rooted in the water-logged sediments while leaves and stems protrude up above the water's surface.

ACTIVITY

4.4 Research aquatic plants

Learning area	Strand	Achievement objective
Science	Living World	Explain how living things are suited to their particular habitat and how they respond to environmental changes, both natural and human-induced
Science	Living World	Begin to group plants, animals and other living things into science-based classifications

1. Find out which aquatic plants are likely to be found in the streams near you.
2. Select one and then research the following:
    a. Find out how its design makes it suited to growing where it does.
    b. Is this plant edible? Can it be used for anything e.g. weaving?
    c. Does this plant contribute positively to life in the stream, e.g. does it provide food or habitat for animals? Do the roots help to stabilise streambanks? Does it shade the stream and keep it cool?
    d. Does this plant have a negative impact on the stream, e.g. does it choke the waterway? Does it smother other plants?
3. Discuss what could be done to increase the positive impacts and decrease the negative impacts of aquatic plants in streams.

Pest plants

TEACHER NOTES

Pest plants originate from other countries and several have successfully invaded New Zealand lakes, wetlands and streams.

When pest plants replace our native plants, there are significant environmental consequences:

- Important plant and animal species are lost (biodiversity)
- Habitats for native fish and wildlife can be adversely modified or destroyed
- Recreational activities such as swimming, boating and fishing can be restricted
- Pest plants can ruin the aesthetic appeal of a waterbody

Pest plants can also adversely affect economic and cultural values. They can:

- Restrict irrigation and drinking water takes
- Clog hydroelectric dams
- Block navigational pathways
- Restrict water movement causing flooding
- Reduce tourism and property values
- Out-compete or smother other plants

Didymo

Didymosphenia geminata (Didymo) is a freshwater alga native to the northern hemisphere. Didymo was first identified in Southland (and New Zealand) in October 2004 in the Waiau and Mararoa River systems. Didymo attaches itself firmly to streambeds and can form thick brown mats on rocks, plants and other materials in the water. Established mats can produce long, flowing streamers that turn white at the ends and look similar to tissue paper. Didymo appears slimy, but feels like wet cotton wool and does not break apart when rubbed.

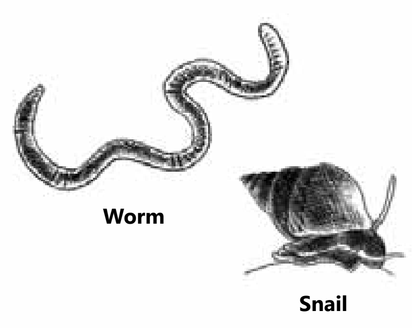
How did it get into our streams?

The most likely scenario for its sudden appearance in Southland is that of a human-assisted transfer, e.g. by recreational users such as anglers or kayakers.

Although Didymo is not considered a significant risk to humans, it has the potential for substantial negative impact on in-stream ecosystems. Didymo can form large mats on the bottom of streams, rivers and even the splash zones of lake edges. Freshwater fish, plant and invertebrate species can be adversely affected as thick growths reduce the number of suitable habitats available to them. Studies on some Didymo-infected Southland rivers have shown a possible shift in invertebrate species composition. The percentage of mayflies, stoneflies and caddisflies (all of which are important trout food) decreases as Didymo growths build up.

Didymo on aquatic plants *(Z. Moss)*

These invertebrate species can then be replaced with larger populations of other invertebrates, such as snails and worms (lower quality trout food).



This may impact on Southland's and New Zealand's world renowned trout fisheries.

What can we do about Didymo?

- Check - before leaving the river, remove all obvious clumps of algae and look for hidden clumps. Leave them at the affected site. If you find any later, do not wash the equipment affected down the drain. Treat them with the approved cleaning methods below, dry them and put them in a rubbish bin.
- Clean - soak and scrub all items for at least one minute in either hot (60°C) water, a 2% solution of household bleach or a 5% solution of salt, nappy cleaner, antiseptic hand cleaner or dishwashing detergent. A 2% solution is 200 ml, a 5% solution is 500 ml (two large cups), with water added to make 10 litres.
- Dry – if cleaning is not practical, wait an additional 48 hours after the item is completely dry to touch, before contact or use in any other waterway.

ACTIVITY

4.5 Research and control pest plants

Learning area	Strand	Achievement objective
Science	Living World	Explain how living things are suited to their particular habitat and how they respond to environmental changes, both natural and human-induced
Science	Living World	Begin to group plants, animals and other living things into science-based classifications.

1. Find out which pest plants are likely to occur in the streams near you.
2. Do some research to find out what problems are caused by these plants.
3. What methods are used to control them?
4. What can you do to help prevent them from spreading?
5. Make a poster to tell other people what they can do to help.

RESOURCES

Environment Southland's State of the Environment Report "Our Uses: Southland Water 2010: Part 3" includes a story about a man who loves to kayak on Southland's rivers. Read his story (on page 51) which also describes how the spread of Didymo in our rivers has affected him and his hobby.

More information on Didymo can be found at www.biosecurity.govt.nz/didymo.

Is it safe to swim and play in our waters?

TEACHER NOTES

During summer, water quality at most of our popular freshwater bathing sites is generally good enough for swimming - except after heavy rainfall and/or when water flow is higher than usual. Our cleanest swimming sites are Lakes Te Anau and Manapouri and the Mararoa River at South Mavora Lake. The Mataura River at Gore is one of Southland's worst bathing sites.

What are the risks?

- If you swim in polluted water, you could be exposed to disease-causing micro-organisms (pathogens) such as viruses, bacteria and protozoa, and get sick.
- High levels of pathogens in water are a result of human or animal faecal matter getting into water.
- The major sources of pathogens are sewage, industrial discharges and runoff from agricultural land.

How can you reduce the risk?

- Keep away from stormwater outlets.
- Keep away from streams and areas with possible runoff from intensive agriculture.
- Avoid swimming during and for up to two days after heavy rainfall.

How can you tell if the water is safe for swimming?

- Poor water clarity is often associated with high levels of faecal bacteria. Look at the water colour. How murky is it? If you can't see your toes, it's probably too dirty for safe swimming.
- Try to remember when it last rained. After heavy rainfall you should wait two days before swimming, because of the higher risk of pollution from agricultural runoff, stormwater drains and sewage overflows. If you can't remember, look up rainfall information on Environment Southland's website, www.es.govt.nz.

Stormwater drain outlet

How can you access water quality information about your favourite swimming site?

Between December and March each year, Environment Southland monitors 7 freshwater bathing sites and 13 marine bathing sites around Southland to check whether they are safe for swimming and shellfish gathering. Samples are collected once a week from each site.

You can access up-to-date water quality information for each site on Environment Southland's website, our automated telephone information service and posters around western Southland. It's easy! Go to www.es.govt.nz. Select Environment > Coast > Bathing Waters > Bathing Site Monitoring. Link on the link to see a map of monitored bathing sites. Water quality is indicated with a green, amber or red spot depending on levels of bacteria in the water. Find your favourite swimming site on the map, and make your decision based on the colour given to that spot. Or double click on a location to see all of the water quality results for that site OR call (03) 211-5010 and follow the instructions to hear the latest water quality data.

What levels of pathogens are considered safe?

The national guideline values for marine and freshwater bathing sites are shown below:

Level of risk	Marine (enterococci/100mℓ)	Freshwater (E. coli/100mℓ)
Green = Minimal health risk	No single sample greater than 140	No single sample greater than 260
Amber = Health risk may have increased	One single sample between 141 and 280	One single sample between 261 and 550
Red = Significant health risk	Two consecutive single samples greater than 280	One single sample greater than 550

ACTIVITY IDEAS

5.1 Learn how to select a safe swimming spot and minimise the risks

Learning area	Strand	Achievement objective
Health and Physical Education	Safety Management	Access and use information to make and action safe choices in a range of contexts
Health and Physical Education	Personal Health and Physical Development	Identify risks and their causes and describe safe practices to manage these

Imagine that you are planning a trip or holiday to a freshwater bathing site to enjoy your favourite pastime e.g. gathering of mahinga kai, swimming, kayaking or fishing.

1. Look for your site on a map. Identify the catchment it is in.
2. Find out which estuary the river flows into.
3. Look up surface and coastal water quality information (on the Environment Southland website).
4. Identify risks and their causes and describe safe practices to manage them.
5. Decide whether your site is safe to visit and use for your planned activity.

5.2 Would you swim in these streams?

	Freshwater bathing site	
	Sunny Streams	Raging River Reach
E. coli / 100mℓ: 7 Feb 14 Feb 21 Feb	 121 16,000 238	 <10 220 10
Which mode applies (green, amber or red)?		
Would you swim at this site (yes/no)?		

Our waterways are changing

ACTIVITY

6.1 Use story-telling to learn about how streams have changed over time

Learning area	Strand	Achievement objective
Learning languages	Cultural Knowledge	Understand and produce information and ideas

Read the story being told by Moko's grandfather and then answer the questions.

> "When I was growing up, e Moko, we had plenty of water. Waimāori, e Moko. Good, clean, freshwater. We had different places to get our wai from, depending on what you wanted to use it for. That creek out there, it used to be a lot wider and deeper in my day. We used to wash our tinana in that wai even before Tamanuiterā got up in the morning. That was our wai horoi. No bathrooms in those days. Just a beautiful cool awa.
>
> Later in the day, we would take our clothes, our towels and sheets down there to wash them. It was a good time to catch up with other people in the valley. The tamariki would play around in that wai and the adults would chat about all sorts of things as we washed our clothes.
>
> The water that runs through the gorge is very dangerous, e Moko. We were not allowed to play or swim in that waikino. The current was too strong and its gushing waters hid many dangerous things. Over there at the foot of those hills, was another awa. It was Waimāori for our wai unu. The tamariki weren't allowed to play over there, either. Not because it was dangerous, e Moko, but because that wai was only used for drinking and cooking.
>
> See our sacred maunga, e Moko? That water up there was our waiora. It started in a mātāpuna and flowed down through those hills. There was a wairere there that fell down into a beautiful puna. That was our wai tapu e Moko, only used for certain rituals and ceremonies. I was taken there soon after I was born for my pure and tohi. These are some of the rituals of your tupuna to cleanse and welcome a newborn baby into this life. These rituals are still important, e Moko, but the young ones have got new ideas now, or they're too busy to listen and to think about it.
>
> Āe, e Moko. A truly beautiful place. In those days the hills were covered with bush and huge trees like kauri and tötara, karaka and taraire. There they stood, reaching their branches out to touch the rays of Tamanuiterā. Now all those rākau have been chopped down. All the bush has been cleared - all gone, e Moko, all gone. That's why the hills are sliding down into the gullies. All that dirt has filled up the puna. You can't see that puna anymore. Only a drain there now. And when it rains, the water just pours off those hills and down into the valley. This valley never used to flood. Now you get waipuke every time it rains for a couple of days or more.
>
> Like I said, e Moko, we had plenty of clean, fresh water back then. But now, the awa has turned to waipiro. That repo wasn't there then. Now we need a repo to clean the wai before it flows out into the moana, to the waitai. A repo is like our kidneys; the kidneys of Papatūānuku. But it can't clean out that mud hole down by those factories. That's waimate. The pūkeko won't live there, nothing can live there. Now don't you go playing around down there, e Moko!"

Discuss the following:

1. What has happened to the stream since the grandfather was a child?
2. Why has this happened?
3. How could the mauri of the stream be restored?
4. Make a list of all the words the grandfather used to describe the water (Waimāori, wai horoi, waikino, wai unu, waiora, waipiro, waimate). Can you think of an example that you have seen, for each type?
5. Ask an older relative or person you know to tell you about a local stream and the changes they have seen over time.
6. Students could act out the story of Moko to the rest of the school or community to raise awareness of pollution and its impact on a creek.

RESOURCES

Environment Southland's State of the Environment Report "Our Uses: Southland Water 2010: Part 3" includes a story about changes to the Mataura Falls. Refer to pages 24-25 to find out how the Mataura Falls used to look and how the site has changed. The report can be downloaded from Environment Southland's website: www.es.govt.nz/environment/monitoring-and-reporting/state-of-the-environment/water-2010.

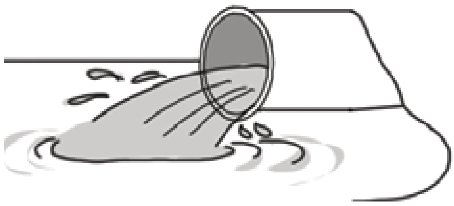
Mataura Falls *(A. Henderson)*

Water pollution

TEACHER NOTES

Point source pollution

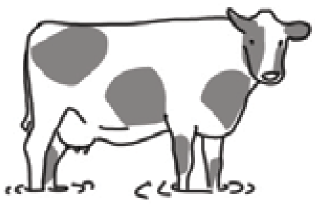
The term 'point source' refers to pollution that comes from a specific identifiable source. Often, it is possible to identify a pipe which carries polluted water from the source to the receiving waterbody. Examples of point sources include discharges from industries, wastewater treatment plants, septic tanks and soak holes.



Wastewater pipe

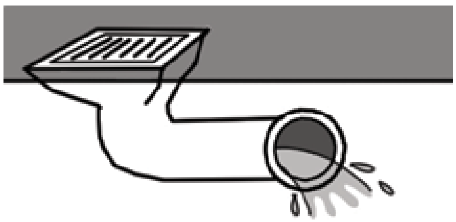
Non-point source pollution

The term 'non-point source' refers to pollution that does not have a single identifiable source. Examples include runoff or infiltration from fertiliser application or stock grazing.



Livestock grazing

Non-point source pollution is caused by rainfall or snowmelt (stormwater) moving over and through the ground. Stormwater runoff is the most common pathway for contaminants from non-point sources to get into water. As the runoff moves, it picks up and carries away natural and human-made pollutants, finally depositing them into lakes, rivers, wetlands, coastal waters, and even groundwater.



Stormwater drain

Non-point sources include:	Types include:
Urban and suburban areas	Litter, debris, oil, toxic contaminants and chemicals, pet wastes
Rural areas (pastoral, arable and forest lands)	Soil, fertiliser, pesticides, herbicides, bacteria and nutrients from livestock and faulty septic systems
Construction sites	Soil, debris
Atmospheric inputs	Air pollution can be washed out of the atmosphere by rain
Mining operations	Acid drainage
Marinas and boating activities	Paint, solvents, oil, fuel, sanitary waste

Stormwater

TEACHER NOTES

Stormwater is created when rain falls. When rainfall lands on natural areas like forests and wetlands, the water soaks into the ground. In a city or town, much of the rainfall lands on roofs or roads, so it does not soak into the ground. Instead, stormwater flows into stormwater drains. From there, stormwater flows into nearby creeks, streams and rivers.

When it rains, pollutants on the ground get mixed in with stormwater. The polluted stormwater goes into the stormwater drains and then flows into nearby streams which in turn flow into lakes or the sea.

ACTIVITY

6.2 Demonstrate how stormwater drains can carry pollution to streams

Learning area	Strand	Achievement objective
Science	Nature of Science	Ask questions, find evidence, explore simple models and carry out appropriate investigations to develop simple explanations

This activity is designed to demonstrate to students how stormwater drains collect pollutants from non-point sources during heavy rainfall and deliver them to streams and rivers.

Equipment

- Aquarium
- Rectangular cardboard box
- Water
- Watering can
- Spray bottle
- Examples of pollutants:
  - Green food colouring (representing pesticides or fertilisers)
  - Dishwashing liquid (representing detergents used for washing cars)
  - Vegetable oil (representing motor oil)
  - Soil/sand/pebbles (representing sediment or erosion)
  - Grass clippings (or shredded paper) and twigs
  - Lunch waste and other rubbish

PREPARATION

Fill the aquarium half-way with water and place it in an accessible area where it can be easily viewed by the students. Cut a hole in the bottom of the box and place the box on top of the aquarium. The box represents the stormwater drain and the aquarium represents the waterway that receives the stormwater. Leave the sides of the aquarium uncovered so that the students can view its contents.

INSTRUCTIONS

1. Introduce this activity with a discussion about stormwater drains and their purpose.
2. Discuss where the water in a stormwater drain comes from and goes to.
3. Have students list all of the things that they can think of that might enter a stormwater drain during a rain storm.
4. Assign a group of students to each pollutant provided. Discuss each pollutant, including its use or origin and how it could enter the stormwater drain.
5. Have each group of students place their pollutant into the stormwater drain (box). Use the watering can to represent rain washing the pollutant into the waterway.
6. After adding all of the pollutants, examine the contents of the waterway. Discuss how the waterway has changed and how viewing this change makes the students feel.

7. Discuss the following questions:
    a. How does the pollutant damage the environment?
    b. Do the people who are responsible for the pollutant want to damage the environment?
    c. Why do you think people damage the environment?
    d. How can this type of pollution be stopped?

FOLLOW-UP QUESTIONS

1. What types of pollution are natural?
2. What types of pollution are added by people living in the surrounding community?
3. What could be done to stop pollutants from entering stormwater drains?
4. How can we remove the pollution from the water?

VARIATIONS

Have the groups of students responsible for the pollution think of ways to remove the pollution from the aquarium. Try out some of their ideas. Which pollutants were easy to remove? Which were difficult to remove?

Soapy water flowing into a stormwater drain

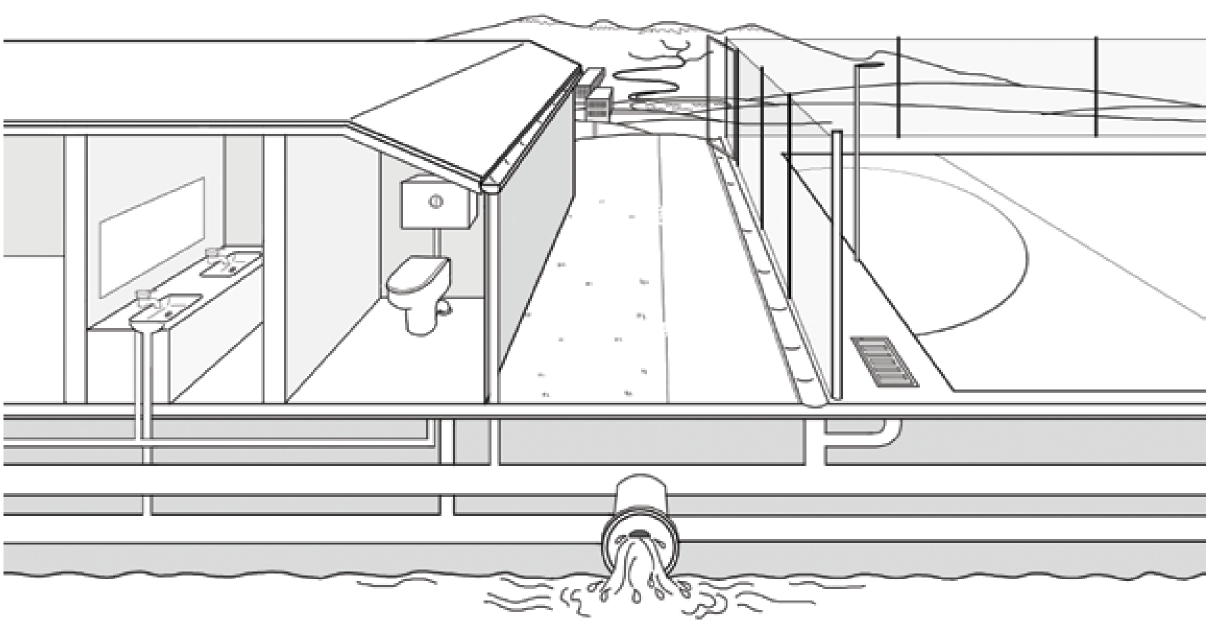
Soapy stormwater discharging into a stream

ACTIVITY

6.3 Investigate the stormwater drainage system at your school

Learning area	Strand	Achievement objective
Science	Nature of Science	Ask questions, find evidence, explore simple models and carry out appropriate investigations to develop simple explanations
Science	Nature of Science	Explore various aspects of an issue and make decisions about possible actions
Science	Planet Earth and Beyond	Develop an understanding that water, air, rocks and soil, and lifeforms make up our planet and recognise that these are also earth's resources
Science	Planet Earth and Beyond	Investigate the water cycle and its effect on climate, landforms and life

1. Ask your city or district council to give you a map of the stormwater drains around your school.
2. Ask your school principal if your school has a copy of the drainage plan for the property. This should indicate where the stormwater drains and pipes are located.
3. Do an investigation in and around your school to find out where stormwater from roofs and roads goes to. Indicate the location of gutters, pipes and drains on the map.
4. Where does the stormwater go to once it leaves the school grounds?
5. Try to find out which waterway the stormwater ends up in.
6. Think of a way to alert people using the school grounds that the water running into the stormwater drains ends up in the waterway. (E.g. Make signs or paint pictures of fish on drains). Templates for painting fish on drains can be obtained from Environment Southland or from the Invercargill Environment Centre.
7. Can you think of any other ways to protect stormwater?



Stormwater and wastewater systems at a school

Management of streams on agricultural land

TEACHER NOTES

Agriculture still dominates Southland's economy, its landscape and its environment. Agricultural activities are the largest single contributor of nutrients – nitrogen and phosphorus – to our surface and groundwater resources. They are also the major contributor of microbiological and other contaminants and a major consumer of water resources. The pressures exerted by agricultural activities on the environment are strongly related to land use and productive intensity. Changes in either can have a marked effect on the type, magnitude and extent of the environmental pressure.

Of the total area devoted to agriculture in Southland, much of it is used for grazing. This land is primarily used for dairying. Between 1990 and 1999, Southland changed from being a relatively minor dairying region to a significant one. Favourable dairy prices, coupled with a suitable climate and an abundance of comparatively cheap, good quality land, have encouraged a large number of Southland farmers to convert from sheep and cropping to dairy.

Tile drains

In Southland, millions of kilometres of underground drains have been laid – particularly on farmland - to enhance drainage from paddocks. These are called tile drains. Tile drains are designed to quickly collect water from the surrounding land and discharge it into the nearest drain or stream. Without tile drains, certain parts of Southland would not be able to be farmed. However, the disadvantage of tile drains is that they prevent the water they are carrying from filtering through the soil zone. Normally, natural processes would remove some of the nutrients before the water reaches the stream or groundwater. But tile drains create a shortcut for water and channel it, and any nutrients, sediment and contaminants it contains, directly into our rivers and streams.

ACTIVITY

6.4 Research and debate how streams should be managed on agricultural land

Learning area	Strand	Achievement objective
Science	Planet Earth and Beyond	Develop an understanding that water, air, rocks and soil, and lifeforms make up our planet and recognise that these are also earth's resources
Science	Planet Earth and Beyond	Investigate the water cycle and its effect on climate, landforms and life

1. Get students to research different viewpoints about stream management on farms in Southland.
2. Set up a class debate about what can be done to improve stream health in rural areas.
3. Write letters or submissions on how to improve the health of a local waterbody (e.g. Waituna Lagoon). Send the best one to The Southland Times or Environment Southland.

River and drainage management

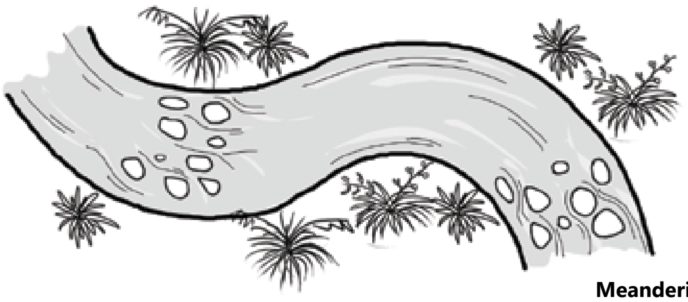
TEACHER NOTES

Environment Southland helps communities to reduce the risk of flooding and erosion to their properties by carrying out river and drainage works within river catchment rating districts.

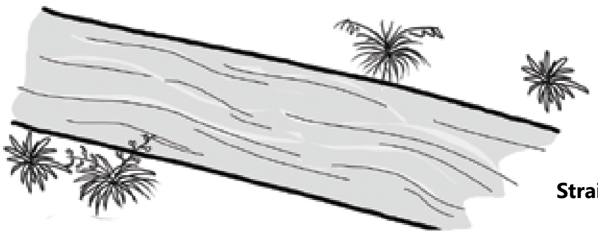
Environment Southland's land drainage and river catchment programmes aim to:

- Reduce the risk of flooding and soil erosion
- Reduce the amount of sediment entering waterways
- Improve water quality
- Improve bank stability
- Improve river environments, for example creating a better habitat for a wide variety of animals and plants.

Many streams and rivers across Southland have been straightened to improve drainage. Stopbanks have been created on most rivers to protect urban and rural communities from flooding.



Meandering stream



Straightened stream

While these works have been good for land production, they have not been good for the biodiversity of the region. Unfortunately, straightening of the streams has resulted in a loss of native plant and animal species in many riparian areas.

ACTIVITY

6.5 Research river and drainage management

Learning area	Achievement objective
Social Studies	Understand how people make decisions about access to and use of resources

1. Research the floods of 1984 in Southland and describe their impact on the region.
2. Find out how Māori traditionally viewed natural hazards such as floods. What can we learn from this approach?
3. Find out what methods are being used in other countries to protect people from floods.
4. Identify the positive and negative consequences of these different methods.
5. What recommendations would you like to make to Environment Southland?

RESOURCES

Environment Southland's State of the Environment Report "Our Threats: Southland Water 2010: Part 4" is a report on water-related hazards in Southland, what impact they have, and what we can do. Page 14 provides information on traditional Māori perspectives regarding natural hazards. The report can be downloaded from Environment Southland's website: www.es.govt.nz/environment/monitoring-and-reporting/state-of-the-environment/water-2010.

7. Water management

Who is responsible for looking after water?

TEACHER NOTES

Environment Southland is responsible for the management of the region's natural water resources. Environment Southland has written a Regional Water Plan which includes a set of rules to ensure sustainable management of Southland's rivers, lakes, groundwater, surface water, and wetland resources. It can be viewed or downloaded from the Environment Southland website.

Here are some examples of the jobs our staff members do:

- 24-hour Pollution response hotline: Staff are on call to respond to environmental complaints and emergencies 24 hours a day.
- Communications team: Works to provide the public with timely and accurate information and creates opportunities for you to have your say about our processes, so together we can make informed decisions about the environment.
- Consents team: The Consents team processes resource consents for activities that: discharge contaminants to the environment, use water, affect the beds of lakes and rivers or are in the coastal marine area.
- Environmental compliance team: Responds to pollution complaints and monitors resource consent holders to ensure consent conditions are met.
- Environmental education team: Aims to increase the public understanding and commitment to managing our environment sustainably.
- Environmental information team: Monitors and gathers information about the state of our environment to enable it to be managed for future generations.
- Hazard management team: Plans ahead to manage hazards including oil spills and provides advice and information on floods, coastal erosion and earthquakes.
- Land sustainability team: Promotes good land use practices that will have the least effect on the environment while still maintaining productivity.
- Biosecurity team: Manages pest animals and plants which are classified in the regional pest management strategy.
- Policy and planning team: Consults with communities to prepare various regional plans to ensure that our resources are protected and enhanced for future generations.
- River and drainage management team: Prepares and implements programmes for construction and maintenance of works to enhance river stability, efficiency and to prevent drainage problems.

Environment Southland also works with other organisations and community groups to improve specific waterbodies. Among other initiatives, fences are built and trees are planted to protect and enhance our waterways. The Living Streams programme is an example of a community-focused, catchment-protection initiative.

ACTIVITY

7.1 Write up a set of guidelines for managing waterways near your school

Learning area	Achievement objective
Social Studies	Understand how groups make and implement rules and laws

1. Identify the people in your school and community who make rules or guidelines that you are expected to comply with. How do they check whether you are obeying those rules?
2. Can you think of any existing laws or rules about waterways?
3. What are the intentions behind those rules?
4. Imagine that you have been given the job of writing a set of rules for managing the waterways near your school. Make a list of the rules you would like people in your community to follow.

RESOURCES

Go to Environment Southland's website to find information on rules relating to water.


An unfenced reach of the Sandstone Stream


The same site, two years after fencing and planting

ACTIVITY

7.2 Research a real-life issue to appreciate the complexities of water management

Learning area	Strand	Achievement objective
English	Listening, Reading and Viewing	Show an increasing understanding of how texts are shaped for different purposes and audiences
English	Speaking, Writing and Presenting	Show a developing (increasing) understanding of how to shape texts for different purposes and audiences
Social Studies		Understand that events have causes and effects
Social Studies		Understand how producers and consumers exercise their rights and meet their responsibilities
Social Studies		Understand how people participate individually and collectively in response to community challenges

ACTIVITY IDEAS

1. Research a real life example of a waterbody that has become degraded and which people would like to restore to health, e.g. Waituna Lagoon.
2. Read a range of newspaper articles about the issue. Compare the range of values, interests, passions of the writers. Describe how the language they have used in the articles reflects their perspectives.
3. Identify the causes, effects and range of solutions people are suggesting.
4. Identify the stakeholders and decision-makers involved. What are the main concerns of each of these groups?
5. Identify the ways people have got involved as individuals and groups in trying to solve these problems.
6. Write a response to one of the newspaper articles – think about your purpose and audience and choose appropriate content, language and text forms to convey your message clearly.
7. Debate the following statement: "As long as we can treat water to make it safe to drink, we shouldn't worry about what goes into it."

RESOURCES

You can find information about Waituna Lagoon on Environment Southland's website www.es.govt.nz. Type 'Waituna' into the search box.

For a range of newspaper articles about Waituna Lagoon, go to the Southland Times website: www.stuff.co.nz/southland-times. Type the words 'Waituna Lagoon' into the search box.

Go to www.learnz.org.nz to view a virtual field trip to Waituna Lagoon, hosted by LEARNZ. Students will learn about the threats faced by the Waituna Lagoon ecosystem, and the four "well-beings" (social, cultural, environmental and economic). Date of the fieldtrip: 12-14 September 2012. The field trip content will be available on the website indefinitely.

These field trip activities are designed to support good learning during the field trip and should be completed in the field.

Field trip

8. Investigate water quality

Learning area	Strand	Achievement objective
Science	Nature of Science	Ask questions, find evidence, explore simple models and carry out appropriate investigations to develop simple explanations
Science	Communicating in Science	Begin to use a range of scientific symbols, (conventions and vocabulary)
Mathematics and Statistics	Geometry and Measurement	Use appropriate scales, devices and metric units for length, area, volume and capacity, weight (mass), temperature, angle and time
Social Studies		Understand how cultural practices vary but reflect similar purposes

Caution

Students will need to get into the water to carry out these activities. Make sure they do not go any deeper than their knees. Ask them to get into the water carefully, so as not to disturb the sediment. It is best to do the clarity investigation upstream of the other investigations.

Clarity tube

EQUIPMENT AND RESOURCES:

Before you go on the fieldtrip, make sure you have all of the equipment and resources you will need for the stream study.

You may be able to borrow equipment from Environment Southland.

You will also need a fieldguide to help you identify the invertebrates you collect from the stream. You can either:

1. Borrow an identification guide from Environment Southland, or
2. Print out the Landcare Research guide to freshwater invertebrates of New Zealand http://www.landcareresearch.co.nz/research/biocons/freshwater/guide.asp. It has a page for mayflies, a page for caddisflies, a page for stoneflies, etc.

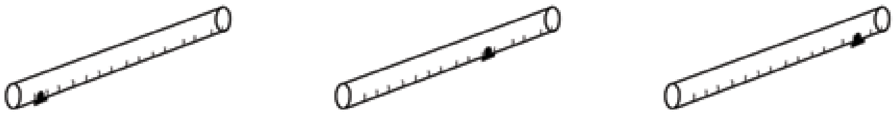
8.1 Investigate clarity

Equipment

- Clarity tube
- Bucket
- Data sheet

Instructions

1. Use a bucket or large jug to take a 2 litre sample of stream water.
2. Completely fill the tube with the water. Place the black disc magnet inside the tube and the other magnet on the outside of the tube. Place the tube cap firmly on the end.
3. Check that the viewing window is free of condensation.
4. Two students should hold the tube horizontally, with one student at the viewing window end and the other student at the opposite end.
5. The student closest to the viewing window should use the magnet to pull the black disc towards him/her to the window end of the tube. The disc should be clearly visible. Now slowly push the black disc away until it disappears from sight. Slowly move the disc back towards the window until it reappears. Read the distance (cm) marked on the side of the tube.



Clarity tube (note the magnet is moved from one end of the tube towards the other)

6. Record your result on the data sheet provided.
7. Repeat the reading with two other students. Before each reading, gently shake the tube. (Not too hard - we don't want bubbles.)
8. Take the average of the three readings to work out the clarity.
9. Repeat the method in:
    - Fast-flowing water
    - Slow-flowing water
    - Disturbed water
    - Undisturbed water

Note

Be very careful not to scratch the viewing window on the tube.

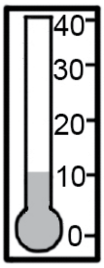
Gorge Road School using clarity tube

8.2 Investigate temperature

Equipment

- Thermometer
- Data sheet

Instructions



1. Use the thermometer to measure the temperature of the water in:
   a. shaded water with slow flow
   b. water in full sun, slow flow
   c. shaded water, fast flow
   d. water in full sun, fast flow
2. Record your results on the data sheet provided

West Gore School using thermometer

8.3 Investigate pH

pH

pH is the measure of the acidity of water. A pH of 7 indicates that the water is neutral. A pH higher than 7 is alkaline and a pH lower than 7 is acidic.

Equipment

- pH test kit containing a test tube and cap, pH test solution, colour card and instructions
- 5ml syringe
- Data sheet

Instructions

1. Use the syringe to collect exactly 5ml of water from the stream.
2. Remove the cap from the test tube and fill the tube with 5ml of water.
3. Add 3 drops of pH test solution to the test tube. Be sure to hold the dropper vertically to ensure the drops are equal in size.
4. Place the cap on the test tube and shake the tube to mix the solution.
5. Compare the colour of the solution with the colours on the pH colour card. It's best to hold the test tube against the white part of the colour card. The closest colour match indicates the pH of the water.
6. Record your results on the data sheet provided.
7. Pour the solution out onto the grass or stones and rinse the test tube before using it again.

Notes

The test tube has a childproof safety cap. To remove the cap push the red tab with the thumb of one hand while unscrewing the cap with the other hand.

Caution

pH test solution is irritating to the eyes and skin. In case of contact, rinse immediately with plenty of water. If swallowed, seek medical advice immediately.

8.4 Investigate velocity

Velocity

Water velocity is how fast the water in the stream is moving. Velocity affects the oxygen content of the water. Faster-moving water is better oxygenated than slow, stagnant water. Oxygen content is a major factor that determines what types of plants and animals can live in the stream.

Equipment

- Stopwatch
- Tape measure
- Two nylon ropes
- Floating object such as a ball or orange
- Data sheet
- Calculator

Instructions

1. Place one of the ropes across the stream. This rope will be the finishing point of your activity.
2. Measure 10m upstream from the rope and place the other rope across the stream here.
3. Drop the floating object in the stream just upstream of the starting rope.
4. Start the stopwatch as the object passes the starting rope.
5. When the object reaches the finishing rope, stop the stopwatch.
6. Record the time on the data sheet provided.
7. Repeat this procedure 2 more times and calculate the average of the 3 results.
8. Now divide the distance travelled (10m) by the average time. This gives you the velocity of the stream in metres per second.

Investigate bank erosion

Erosion

The word ‘erosion’ refers to the wearing away of the land by forces such as water, wind and ice. Bank erosion is the wearing away of the banks of a stream or river. The word ‘reach’ refers to any section of the stream or river. In this investigation you will measure the total length of a section of the river bank, and then you will measure any reaches that are eroded.

Equipment

- A measuring tool such as a measuring wheel or tape measure
- Data sheet

Instructions

1. Decide which bank you are going to measure: true left or true right. *Note:* When you are facing downriver, the true left bank is on your left and the true right bank is on your right.
2. Choose a starting point and an end point and then use the measuring wheel or tape measure to measure the distance between them (e.g. 50m).
3. Now walk back the same way and identify any reaches that have eroded banks. Measure the eroded reaches and record them on your data sheet.
4. Calculate the total length of eroded reaches and then work out what percentage of the total length this is.

8.5 Investigate depth

Caution:

You will need to get into the water to carry out these activities. If water goes above your knees or is very fast flowing, ask an adult to do those measurements.

Question

Is the stream the same depth all the way across?

Equipment

- Long ruler
- Tape measure
- Data sheet

Instructions

1. Do you think the stream is the same depth all the way across?
2. On your data sheet, draw what you think the cross section of the stream looks like.
3. Measure how wide the stream is.
4. Take depth measurements every 50cm and record the results on the data sheet
5. You will make a more accurate drawing of the cross section, back in the classroom, using the measurements you have taken.

West Gore School measuring depth

8.6 Investigate invertebrates

Caution:

You will need to get into the water to carry out these activities. Choose a part of the stream where you can see riffles (shallow, fast flowing, stony-bedded parts of the stream). Do not go in above your knees.

There are many different methods for assessing invertebrates.

At the simplest level, you can assess the health of the stream by seeing which types of invertebrates are present and which types are absent. This is known as a qualitative method, e.g. mayflies, stoneflies and caddisflies were present. Damselflies were absent.

Alternatively, you can count the number of each type of invertebrate you collected, e.g. 5 mayflies, 1 stonefly and 10 caddisflies. This is known as a quantitative method.

Equipment

- Gumboots
- Net
- White tray or bucket
- Paintbrush
- Data sheet
- Calculator
- Landcare Research guide to freshwater invertebrates of New Zealand

Instructions

1. Ensure that the sampling net and bucket/tray are clean.
2. Place the net on the streambed and step into the sampling area immediately upstream of the net. Disturb the substrate under your feet by kicking to dislodge cobbles or gravel and to scrape the underlying bed.
3. Sweep the net through areas containing woody debris, along the bank margins, and through aquatic plants to dislodge organisms. You can also pick up pieces of wood and stones and gently wash or brush organisms into the bucket/tray with water or a paintbrush.
4. Half fill a bucket with water then empty the material from the net into a tray or the bucket. Wash or pick all animals off the net.
5. Repeat at several different locations.
6. Identify as many different invertebrates as possible.
7. Count the number of each type and record the numbers on the data sheet provided.
8. Calculate the score
9. All invertebrates should be returned, living, to the water.

Invertebrates in a tub

8.7 Observe and draw

Equipment

- Pencil
- Clipboard
- Data sheet

Instructions

1. Look around you at the landscape the stream flows through.
2. Make notes about things you observe on the data sheet provided.
3. Draw a picture of the stream and its surroundings. Include as much detail as you can.

Things to look for:

- What is the waterway like? Is it a stream, river, wetland or estuary?
- Where does the water come from and where is it going to?
- What is the catchment like? Is it covered in bush, pasture or urban development?
- Is the waterway straight or does it have curves and corners?
- What does the stream bed look like? E.g. does it have a thick layer of mud and sediment, or can you see rocks, stones and gravel?
- Do you think the channel has been modified? How?
- Can you see a range of habitats for fish and invertebrates, e.g. riffles, runs and pools?
- Are the stream banks steep-sided, gentle, eroded or stable?
- What sort of plants grow on its banks?
- Is the stream choked with weeds?
- Is the stream shaded from the sun?
- Is the current fast, slow or stagnant?
- Is the stream higher or lower than usual? How can you tell?
- Can you see any stormwater drains or tile drains emptying into the stream?
- Are there any bridges, culverts, weirs or dams on the stream?
- Do you think the stream is clean and healthy? Would you swim here? Give a reason.
- Is there any indication of human influence on the stream? If so, what is it?
- Who comes to this place? What do they do here?
- How has this place been used in the past? How do you think it will be used in the future?
- Are there any species that can be used for weaving, medicinal uses, or eating? Would you eat food caught or gathered here? Give a reason.
- Make a note of any colours you may want to remember.

Photocopy these data sheets for use during the field trip.
Each group will need a complete set (i.e. 2 x A4 pages printed on both sides).

Name of group: .... **Date:** ....

Name of waterway: .... **Time:** ....

Weather conditions: ....

Clarity (cm)

	1	2	3	Avg
Fast-flowing water				
Slow-flowing water				
Disturbed water				
Undisturbed water				

Temperature (°C)

Shaded water with slow flow	
Water in full sun, slow flow	
Shaded water, fast flow	
Water in full sun, fast flow	

pH	

Velocity (m/s)

Distance travelled	Time	Average time (divide total time by no. of trials)	Velocity (divide distance travelled (10m) by avg time
10m	1.		
	2.		
	3.		
	Total = s	Average = s	Velocity = /s

Bank erosion

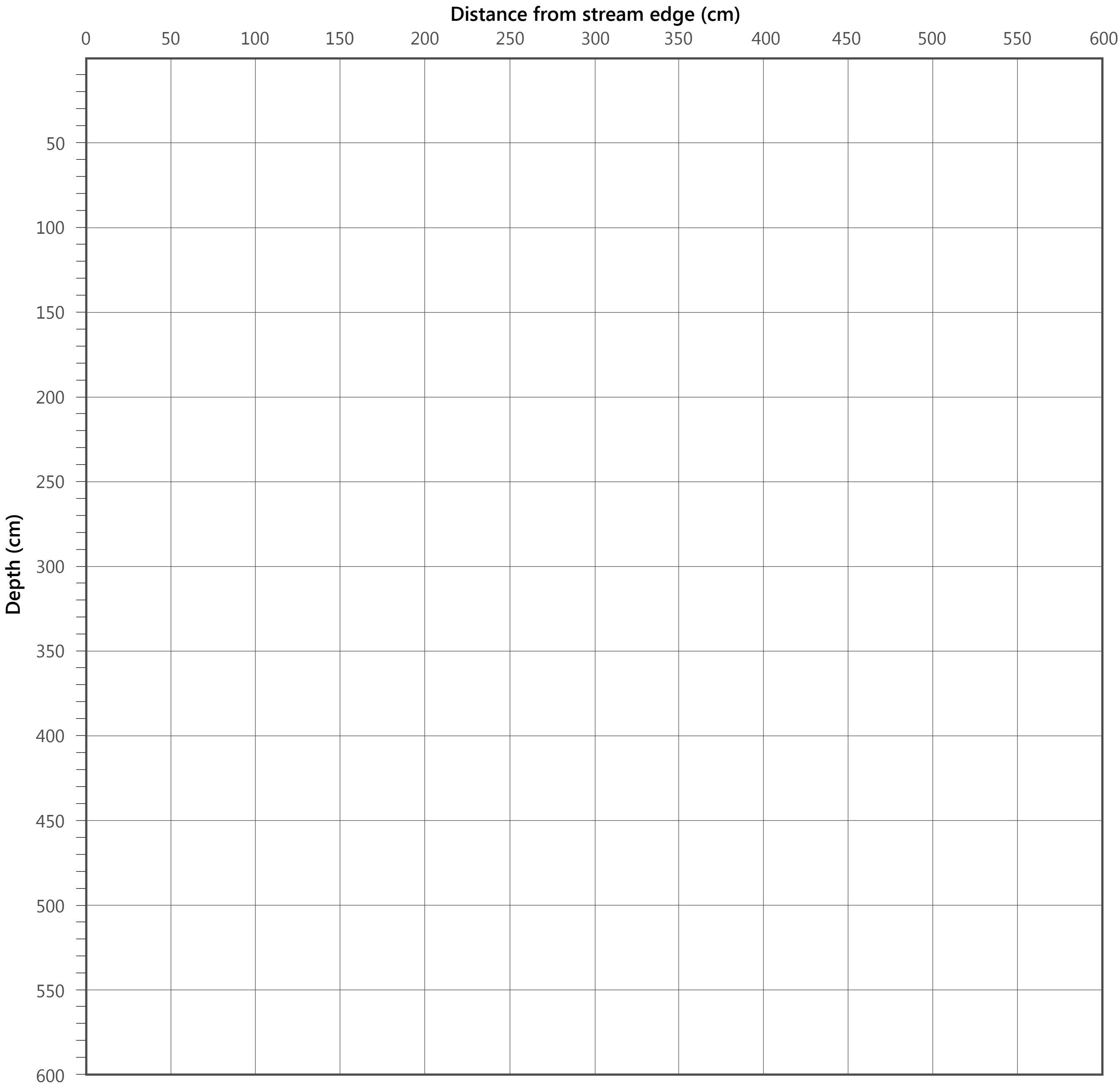
Which bank did you measure: true left or true right? ___________

Total length of bank measured (m)	Length of eroded reaches (m)	Percentage of bank that is eroded (%)
	Total =	

Cross section of the stream

Predict what you think the cross section of the stream looks like.

Distance from edge (cm)	Depth (cm)
0	
50	
100	
150	
200	
250	
300	
350	
400	
450	
500	
550	
600	



Drawing of the stream and its surroundings

Observations

Invertebrates

Taxon	Tolerance value*		No. collected		Sensitivity score
Mayfly nymph	8	X		=	
Stonefly nymph	5	X		=	
Purse / axehead caddis larva (tiny; with a wedge-shaped case)	2	X		=	
Cased caddis larva (found inside portable case of sand grains)	6	X		=	
Net-spinning caddis larva (free-living but shelters inside cases made of tiny stones)	4	X		=	
Green caddis larva (no case)	5	X		=	
Elmid beetle larva	6	X		=	
Damselfly nymph	5	X		=	
Dragonfly nymph	5	X		=	
Crustaceans (amphipods, water fleas)	5	X		=	
Dobsonfly larva	7	X		=	
Bloodworm (midge larva)	1	X		=	
Freshwater shrimp	3	X		=	
Flatworm, leech	3	X		=	
Water worm (thin brown/red)	1	X		=	
Water snail (rounded shell)	3	X		=	
Water snail (pointed shell)	4	X		=	
Sandfly larva	3	X		=	
Water boatman	5	X		=	
Backswimmer	5	X		=	
Koura	5	X		=	

Total no. collected	
Total sensitivity score	
Water quality score = total sensitivity score ÷ total no. collected	

Water quality score	Health of stream
0-1.9	Very degraded
2-3.9	Could be polluted
4-5.9	Slightly to moderately polluted
6-7.9	Moderately healthy
8-10	Healthy

Source:
Tolerance values for MCI-based biotic indices in hard-bottomed (Stark et al 2001) and soft-bottomed (Stark and Maxted 2007) streams (http://www.mfe.govt.nz/publications/water/mci-user-guide-may07/html/table1.html).

ACTIVITY IDEAS

Evaluation tree

Draw a tree shape on an A3 sheet of paper (does not have to be elaborate, an outline is perfect). Cut out leaf shape pieces of paper (or get students to cut them out) and ask students to write a comment on each side of the paper – e.g. something they enjoyed about the day, something they didn't enjoy, something they learned from the day, something they would have liked to have learned from the day. Students then stick their leaves to the tree.

Graffiti Wall

Draw a wall on a piece of A3 paper. Make sure the blocks are of a good size. Ask students to write their comments about the day in each of the blocks.

Hand Curtain

Get students to trace their hand onto a piece of paper or card. Cut them out. On each side of the hand students write their comments (positive and negative). Put a hole in each of the hands and thread through some twine, thread or wool to collect all of the hands in one line. The hand curtain can then be displayed on the wall.

Evaluation tree *(Knapdale School)*

These activities are designed to support students as they analyse the data from the field trip, draw conclusions and think about future action. They should be completed back at school in the weeks after the field trip.

After the field trip

11. Interpret your results

Learning area	Strand	Achievement objective
Mathematics and Statistics	Number and Algebra	Use graphs, tables and rules to describe linear relationships found in number and spatial patterns
Science	Nature of Science	Ask questions, find evidence, explore simple models and carry out appropriate investigations to develop simple explanations
Science	Nature of Science	Begin to use a range of scientific symbols, (conventions and vocabulary)
Mathematics and Statistics	Geometry and Measurement	Use a range of additive and simple multiplicative strategies with whole numbers, fractions, decimals, and percentages.
Mathematics and Statistics	Geometry and Measurement	Use appropriate scales, devices and metric units for length, area, volume and capacity, weight (mass), temperature, angle and time

Data analysis

TEACHER NOTES

Measurements of clarity, temperature and pH help to build a picture of how healthy the stream is. It is impossible to have average numbers for values that are acceptable for clarity, temperature and pH because they are dependent on so many variables including the location, season, time of day and recent rain. Therefore when looking at this data after the field trip it is important to instead use this information to contribute to an overall assessment of the stream.

Clean streams have very little fine suspended sediment in the water. Fish prefer clear water because they can see their food and can detect danger more easily. The presence of fine suspended sediment in the water may be caused by erosion, land runoff or stream bed disturbance upstream. Dirty water can harm fish because it is very abrasive and can clog their gills.

11.1 Analyse results: clarity

1. Discuss the different values you obtained for the clarity tests you did in fast-flowing water, slow-flowing water, disturbed water and undisturbed water
2. What does this mean for fish and invertebrates in the river?

11.2 Analyse results: temperature

1. Compare the stream site temperature to the temperature of a nearby river. Also look at weekly and annual fluctuations.
2. What was the average temperature of the stream on your field trip? Gather all temperatures recorded. Calculate the total. Divide by number of measurements taken.
3. How much do you think this fluctuates (changes) throughout the week or year?
4. Go onto www.es.govt.nz, click on the Rivers and Rainfall link in the blue box on the right side of the homepage. Then click on Water Temperature (top left hand corner). This page lists all the sites at which we continually measure water temperature. Scroll down and find the river that is closest to you, or maybe the river that your stream flows into. Select the site name. Look at the past week, does that correspond to your average result? Change the date range on the left. What is the coldest temperature in winter? What is the hottest temperature in summer?

11.3 Analyse results: pH

1. Display the "Effects of pH on Fish and Aquatic Life" table (below) on the interactive whiteboard.
2. Go through it with the class, looking at the ecological effect is for each outlined range of pH. For each effect ask whether your stream fits within the range.

Effects of pH on fish and aquatic life

pH value		Ecological Effects observed under research	Our Stream
Min	Max		
3.8	10.0	Fish eggs hatched within this range, but young were often deformed	
4.0	10.1	Only the most resistant fish species coped with a pH range as wide as this	
4.1	9.5	Trout tolerated water within this range	
4.5	9.0	Trout eggs and larvae developed normally within this range	
5.0	9.0	Most fish species tolerated water within this range	
	8.7	The upper limit for good fishing waters	
5.4	11.4	Fish avoided water with a pH level outside this range	
6.0	7.2	This was the optimum (best) range for fish eggs	
1.0		Mosquito larvae died when pH dropped to this level	
3.3	4.7	Mosquito larva survived within this range	
7.5	8.4	Best range for the growth of algae	

11.4 Analyse results: velocity and depth

Velocity

1. Work out your walking speed in metres per second. Do you walk faster or slower than the stream?
2. What determines the velocity of the stream?
3. Calculate how long it would take for a ball to travel from your field trip site to the sea.
   - Call up Google Maps on your interactive whiteboard.
   - Enter in your stream site. Look at the map and work out:
     a. the distance from your stream site to the sea in kilometres.
     b. the distance from your stream site to the sea in metres.
   - Divide the distance (m) to the sea by the stream's velocity (m/s). This gives you the total number of seconds. Convert seconds to minutes and minutes to hours. Ask the class – Is this the exact time it would take? Why or why not? [It would be unlikely, because of changes in depth, eddies, pools, branches, rocks, obstacles in the river. Some parts are faster, some are slower etc.]
4. Discuss how a stream's velocity affects temperature, oxygen levels, plant growth, sediment, plants and animals.

When a stream flows very slowly:

- the water warms up more quickly
- this encourages plant growth which in turn reduces oxygen levels
- slow flows allow sediment to settle on the stream bed
- this encourages growth of long filamentous algae

When a stream flows very quickly:

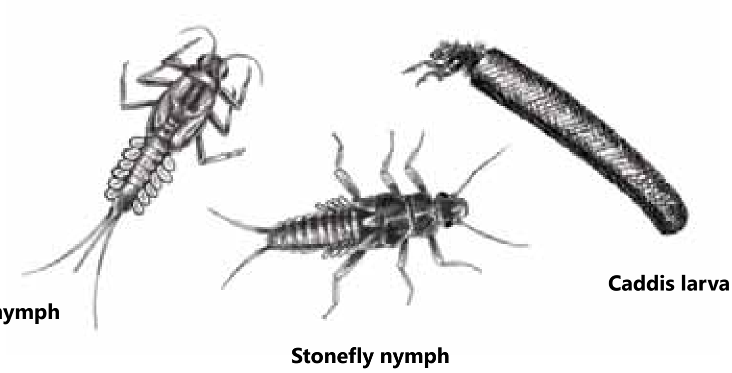
- plants and animals may be washed downstream
- fast flows may prevent invertebrates such as snails and caddis larvae from living in the stream
- sediments can be stirred up, making the water look dirty

Cross section of the stream

Use the data from your depth measurements (on your datasheet) to draw a graph:

1. Mark distance from the edge (50cm intervals) on the x axis and depth of water (cm) on the y axis.
2. Compare your graph with the cross section you drew during the field trip. How accurate was your prediction?
3. Was the stream the same depth all the way across?
4. Where was the deepest point?
5. Where was the shallowest point?
6. Would you expect the stream's water to move faster or slower in deep parts of the stream? Why?

11.5 Analyse results: invertebrates



Use the table below to work out if the stream is "healthy" or not.

Water quality score	Health of stream
0-1.9	Very degraded
2-3.9	Could be polluted
4-5.9	Slightly to moderately polluted
6-7.9	Moderately healthy
8-10	Healthy

Discuss whether this result agrees with the results you obtained from your other investigations.

What do our results mean?

TEACHER NOTES

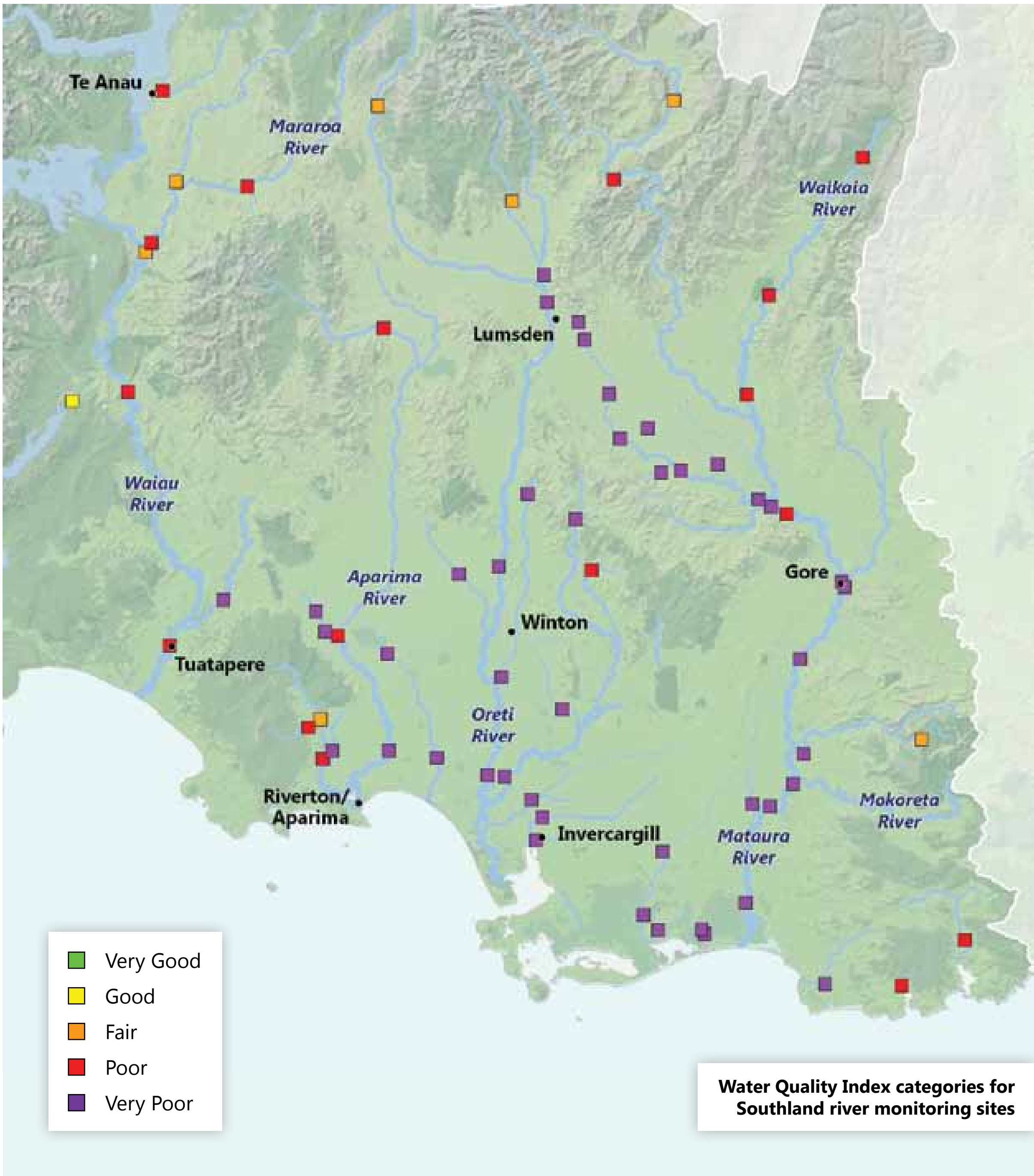
✔		✘
A moderate stream velocity is ideal for healthy communities of invertebrates and periphyton (algae).	**Velocity**	When a stream flows very slowly, the water warms up more quickly. This encourages plant growth which in turn can cause a large range in dissolved oxygen levels. Slow flows allow sediment to settle on the stream bed. When a stream flows very quickly, plants and animals may be washed downstream. Fast flows may prevent invertebrates such as snails and caddis larvae from living in the stream. Sediments can be stirred up, making the water look dirty.
A stream bed composed of boulders, cobbles and gravels is ideal for invertebrates and fish - especially if there are spaces between the boulders and cobbles for insects and fish to hide in.	**Stream bed**	A stream bed composed of very mobile materials (gravels, sand, mud, silt) is a poor habitat for stream life. Spaces between boulders and cobbles are likely to be filled with silt. During high flows, sediment becomes very mobile. This does not encourage the development of diverse, healthy stream-bed communities. Worms and larvae may survive by burrowing into the sand/mud/silt. Mud and silt may become stagnant, resulting in oxygen depletion.
Clean streams have very little fine suspended sediment in the water. Fish prefer clear water because they can see their food and can detect danger more easily. Plants need good light for photosynthesis and oxygen production.	**Clarity**	The presence of fine suspended sediment in the water may be caused by erosion, runoff or stream bed disturbance upstream. Dirty water can harm fish and invertebrates because it is very abrasive, reduces visibility and can block their gills. When habitats are silted up, they become unsuitable for many species. Silt interferes with hatching of eggs and development of larvae.
Healthy streams support many different types of invertebrates. Mayflies and stoneflies are the most sensitive of the invertebrates. They require rapidly flowing, clean water. So their presence is a good sign.	**Invertebrates**	Slow moving, stagnant streams and ponds cannot support sensitive species like mayflies and stoneflies. They may be able to support less sensitive species like snails, midges, worms, backswimmers and water boatmen. Note that these species may also be found in healthy streams.
Clean streams support fewer algae than nutrient enriched streams. If virtually no algae are visible, this indicates low concentrations of nutrients and/or intensive grazing by invertebrates that live on the stream bed. The presence of thin films of algae on stones indicates moderate to low nutrient concentrations - although they may be thicker at low velocities.	**Periphyton**	The presence of long filamentous green algae indicates there is moderate to high enrichment from phosphorus and/or nitrogen. These nutrients could have come from land runoff or discharge from treatment ponds. The presence of some thick, slimy (or jelly-like) brown mats and thick mats of green algae on stones, with some filamentous green and brown algae suggests moderate levels of enrichment from phosphorus and/or nitrogen. Cyanobacteria (blue-green algae) can produce natural toxins which are a threat to human and animal health when consumed or through contact.
Cool, clean stream water contains lots of oxygen for fish. Shading alongside the stream reduces the occurrence of extremely high water temperatures.	**Temperature**	Warmer water contains less dissolved oxygen. 'Good' invertebrates are generally not found in water warmer than 19ºC. Trout start to lose condition above 20ºC. Once the water temperature is over 22ºC, over a three day period, 50% of the animal population may die. Many organisms are unable to survive in temperatures above 30°C (except those adapted to life in hot springs). At the other end of the scale, temperatures below freezing point provide a very harsh environment because of the effects of ice.

The pH of clean stream water is usually close to neutral (6-8) and doesn't fluctuate greatly. A pH outside of this range does not imply pollution. A high pH may be caused by limestone; a low pH may be caused by peat.	**pH**	If the pH is very high or very low, there may be contaminants in the water that shouldn't be there. Water that is too acid or too alkaline can damage the skin and gills of fish and invertebrates. Extreme pH levels can kill aquatic life.
All stream waters contain some mineral salts as a result of natural conditions and processes. The underlying rock type determines the base level of nutrients in the water. Runoff and seepage are natural processes which add extra nutrients.	**Conductivity**	Sources of nutrients include runoff from cultivated land, stock faeces and urine. Sources of naturally occurring mineral salts include weathering and erosion of rocks.
Streams with good levels of DO usually contain a wide variety of aquatic life. Fast flowing streams tend to be better aerated than slow flowing streams.	**Dissolved Oxygen (DO)**	Streams with low DO levels cannot support sensitive species such as mayflies, stoneflies and caddisflies. At very low DO levels, only the most tolerant species can survive. DO is lowered by contaminants from sources such as sewage plants, animal feedlots, silage pits, weed-spraying activities, urban runoff, stormwater, dairy factories, pulp and paper and poorly designed or managed oxidation ponds. Waste from farm animals may enter the stream as surface runoff. Decaying organic matter causes a decrease in DO levels.
Unpolluted natural waters have BOD levels of 5mgL-1 or less.	**Biological O_2 Demand**	BOD is the amount of oxygen consumed by bacteria to break down organic matter in a stream. Treated sewage has BOD levels of 20-30mgL-1 and raw sewage has levels greater than of 150mgL-1. Polluted stormwater runoff from residential areas may have a BOD5 of 200-600mgL-1.
Nitrogen occurs naturally at low concentrations in surface waters. Under natural conditions, decaying plant material and other organic matter provide much of the nitrogen. Blue-green algae, the primary component of algal blooms, may introduce more nitrogen into the ecosystem.	**Nitrites / Nitrates**	High levels of nitrogen can result in algal blooms and excessive growth of aquatic weeds. When these plants die, they are broken down by oxygen-consuming bacteria, which remove oxygen from the water. Excessive weeds can choke streams. Sources of nitrogen in waterbodies include: fertiliser, animal wastes (mostly urine), runoff from intensively grazed paddocks and livestock feeding areas, stormwater runoff, decaying organic matter, including silage, industrial discharges.
Ammonium is found naturally in surface water. It is produced in anaerobic conditions from nitrites and nitrates or released during animal excretion.	**Ammonium**	High ammonium levels indicate high total ammonia levels. High levels of ammonium are usually caused by effluent discharge or stock in waterways.
Phosphorus is a nutrient that occurs naturally at low concentrations in water. Under natural conditions, most of the phosphorus comes from weathering of rocks and decaying organic matter.	**Phosphates**	If phosphorus levels are too high, eutrophication can occur. Nutrient rich water stimulates plant growth, resulting in algal blooms and growths. When plant material decays, oxygen is used up and fish may die. High levels of phosphorus may originate from streambank erosion, sewage effluent, industrial wastes, detergents from domestic and commercial sources, urban stormwater, and rural runoff containing fertilisers, animal and plant material.

ACTIVITY

11.6 Compare your results with long-term water quality information from Environment Southland

1. After your field trip, see if you can get hold of water quality information from Environment Southland to compare with your own data. If we don't have data for your specific site, we may have some for the river where your study was conducted. Contact Environment Southland if the website does not provide the information you need.
2. Plot the data on a graph or table and describe the relationship.
3. What are the differences you observe?



Map source: Environment Southland's State of the Environment Report *Our Ecosystems: Southland Water 2010: Part 2*

11.7 Illustrate your vision for a healthier stream

ACTIVITY IDEAS

Display the pictures of the stream that were drawn by the class during the field trip. If you like, you can photograph or scan the pictures so that they can be manipulated on the computer and displayed on your interactive whiteboard.

Add more details and labels, where required, for example:

- Plants (if you know, indicate whether they are natives or pests)
- Streambanks (indicate whether they are stable or eroded)
- Stream bed
- Mahinga kai
- Animals
- Fish habitat in the stream (e.g. riffles, runs and pools)
- Pollution
- Pipes
- Bridges
- Culverts etc.

The students are now going to create a vision for a healthier stream.

Consider all that the class has learned about your waterway. Compare this with pictures of a pristine waterway or wetland so you can get an idea of what your stream could look like if it were enhanced. Make a note of the plants, birds and insect life. Your river may have looked similar in the past. Discuss what the class believes needs to be changed or enhanced in your waterway.

Ask students to make computerised additions to their drawing to create a "vision for a healthier stream." Alternatively it could be photocopied and done with paint, pen or pencil.

Ideas they could add include:

- Stable banks
- Increased riparian planting
- Eradication of weeds
- Mahinga kai
- Shade
- Educational signage etc.

RESOURCES

Environment Southland's State of the Environment Report "Our Uses: Southland Water 2010: Part 3" includes a story about the Mātaitai restoration project at the Mataura Bridge. Read the story on pages 24-25 to find out what the vision for the site is. The report can be downloaded from Environment Southland's website: www.es.govt.nz/environment/monitoring-and-reporting/state-of-the-environment/water-2010.

These activities are designed to support students as they plan and implement action projects in response to what they learned before, during and after the field trip.

Taking action

12. Develop an action plan

Learning area	Strand	Achievement objective
Science	Nature of Science	Explore various aspects of an issue and make decisions about possible actions
Social Studies		Understand how people participate individually and collectively in response to community challenges

Now that you have researched your local waterway and are enthused about continuing to look after it, it's time to decide what to do. You will need to consider your time constraints, other school commitments and the age or level of your students. Your project does not have to be time-consuming or necessarily at the river. You may prefer to raise people's awareness by letting everyone know what your class has been doing – e.g. through a publicity campaign. This is just as important as any practical task because if people don't know what the problems are, how can they be expected to help solve them?

Tips for Planning

- Start small. Most people try to do too much. You can always do more once you have achieved your plan.
- You don't need a perfect plan.
- Do what works for you.
- It's OK to change your plan as you need to, but it is still important to have one.
- Give your action plan a name - something catchy that people will remember.
- Keep track of everything you do, so you'll know if you are successful.

Vision

What vision do you have for the environment?

- Using the original drawing of the stream and the new vision, ask students to create an action plan of how they could help to achieve the vision of the healthy stream.

Objective

- What action are you going to take to achieve your vision?

Location

- Where will this take place (e.g. at school, by the stream or the surrounding streets)? Remember it doesn't have to be outside of school to be taking action.

Prioritise

- What is the most important task on your mind map? Write it on your action plan under "What are we going to do?" Then write the next most important task and so on until all the tasks are on the plan.

Budget

- Brainstorm the resources (tools, information, people) you need to get each task done. Write them down. Are there other experts or organisations that can help?
- Projects don't have to cost the earth, or anything! Remember action can be taken in your school grounds.
- Funding options are also available and listed on the Environment Southland website under For Schools.

Timeframe

- Think about school terms and holidays. Is this going to be one-off or a long-term project? You should have a date that this action is to be competed by, or if long-term, when parts of the action are to be completed by.
- Get a calendar. Write "start" on today's date. When does the project have to be complete? The end of the term? A specific month? Write "finish" on that date.

People involved

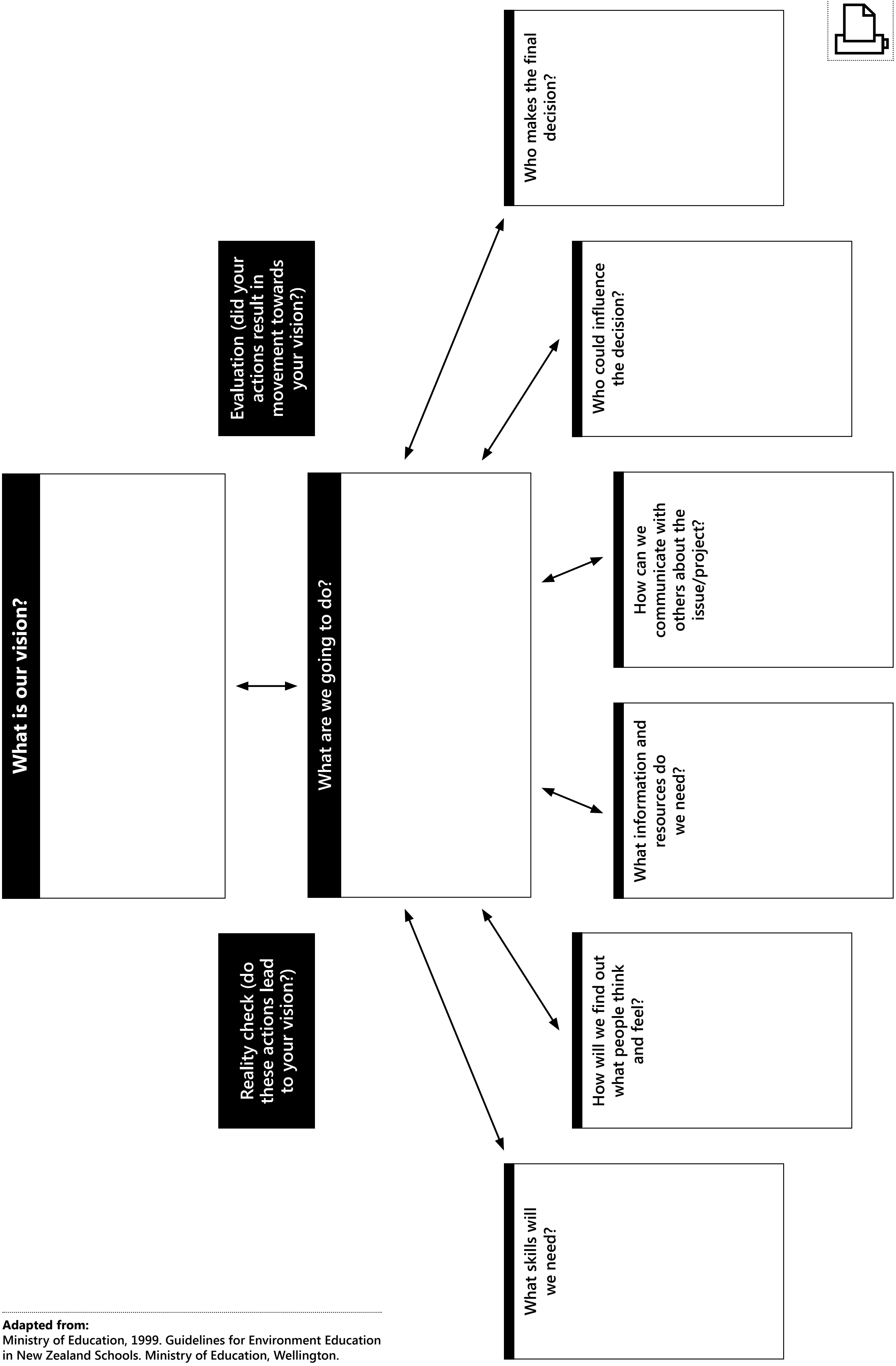
1. Roles need to be clearly defined. Who will be doing what? This person must make sure the job gets done. He or she can ask for help.
2. Now you need to get support for your ideas from the community. You need to make sure that what you want to change is also what other people want to change. If you haven't already invited people to talk to your class then now is the time to do this. You could also see if you can have some class representatives become a part of a local Landcare group. Think about inviting:
    - Farmers
    - Rūnanga / iwi representatives
    - District / City council
    - Environment Southland
    - Residents associations
    - Recreational groups (e.g. fishing or boating) who use the waterway
    - Other classes in your school who are learning about your river
    - Other schools in your area that are also learning about your river
    - Businesses
    - Family, friends and whanau

Safety

- Think of ways someone might get hurt on your project. What can you do to prevent it? What would you do if someone got hurt? Write your ideas in a "Safety Plan".

RESOURCES

Environment Southland's State of the Environment Report "Our Uses: Southland Water 2010: Part 3" has a story about Otama School's monitoring and action project at the Mataura River. Read the story on page 66. The report can be downloaded from the website www.es.govt.nz/environment/monitoring-and-reporting/state-of-the-environment/water-2010.



Adapted from:
Ministry of Education, 1999. Guidelines for Environment Education in New Zealand Schools. Ministry of Education, Wellington.


Student leaders planning to take action

13. Take action

Planting

Organise a planting day or grow your own plants for the future. Plants are important for the health of a river. They provide shade and protection from predators, create microclimates, absorb pollutants and beautify. For a long-term project planting can be ideal. Students grow their own plants for future planting. Contact Environment Southland if you are keen to undertake a planting. There may be may be a Living streams catchment or landowner in your area that would love your assistance!

Water monitoring

Set up a water monitoring group that can test the water on a regular basis. Contact the Environmental Education Officer at Environment Southland for help with setting this up, or to borrow some water monitoring equipment. There is also a booklet to assist with ongoing monitoring which is available from Environment Southland.

Art and design

Design brochures, pamphlets or street banners to describe the cultural, commercial, or recreational significance of your river. Paint a mural at school of your vision of the stream. Contact your local council, library and museum and see if you can display the information the class has gathered about the river for the community to see.

Fish on drains

If you are interested in the effects of stormwater on your stream, consider running a public education campaign focusing on protecting stormwater from contamination from activities such as washing cars on roads and pouring paints down the drain. Phone Environment Southland on 0800 76 88 45 to borrow the “fish on drains” templates.

Volunteer

Contact a Landcare group or community group and volunteer your time to assist them.

Students from Woodlands Full Primary School planting along the Waihopai River

14. Measure and document what you did

It is important to record what you did, so you can then measure your success and ensure that your project continues to receive support.

Examples of things you could measure:

- Record how many fish you painted on drains
- Record how many plants you planted
- How many people came to your meeting?
- Repeat the water quality investigations at the end of the project, then compare them with the results from the start of the project.

You could make a scrapbook to record what you did, make a story board, or record your actions on film and upload it onto the internet e.g. YouTube or your school's website.

Celebrate and share your project with others

After all your hard work, it's nice to celebrate. Not only is it fun, but it's a good way to say thank you to people who helped out. You could invite newspaper, TV or radio station reporters to your celebration. If they run a story on your success, lots of people will hear about the importance of water issues.

Plan to celebrate on special environmental days such as:

- World Wetlands Day
- World Water Day
- Save the Frogs Day
- World Migratory Birds Day
- World Environment Day
- Arbor Day
- Conservation Week
- Keep New Zealand Beautiful Week
- New Zealand Frog Week
- World Rivers Day

You can find these dates on Environment Southland's webpage, under the "For Schools" section.

Ideas may include:

- Contact the media to interview you and film your work. Arrange to visit media offices to show off your work and to give the public any important messages you may have.
- Record your actions on film and upload it to the internet.
- Send a report and pictures to Environment Southland to promote to other community and school groups.
- Hold a picnic by the river.
- Write a story for the community newspaper or your school newsletter.
- Hold a party in your classroom. Invite parents and experts that helped.
- Hold a community day in the field (Environment Southland staff could lend you a helping hand).

Take action!!

Useful contacts

Department of Conservation, Southland Conservancy Office	03 211 2400	www.doc.govt.nz
Environment Southland	0800 76 88 45	www.es.govt.nz
Fish and Game Council, Southland Region	03 215 9118	www.fishandgame.org.nz
Gore District Council	03 209 0330	www.goredc.govt.nz
Invercargill City Council	0800 422 435	www.icc.govt.nz
NZ Landcare Trust	03 208 7883	www.landcare.org.nz
Manaaki Whenua Landcare Research	03 321 9999	www.landcareresearch.co.nz
National Institute of Water and Atmospheric Research.	0800 746 464	www.niwa.co.nz
QEII National Trust	03 230 4843	www.openspace.org.nz
Royal Forest and Bird Protection Society of New Zealand	03 477 9677	www.forestandbird.org.nz
South Coast Environment Centre	03 234 8717	www.sces.org.nz
Southland District Council	0800 732 732	www.southlanddc.govt.nz
Southland Ecological Restoration Network		www.sern.org.nz
Te Ao Mārama Incorporated	03 931 1242	tami@woosh.co.nz
Toimata Foundation	07 959 7321	www.toimata.org.nz

Glossary

Āe	yes
Aquifer	the geologic formation of sand, soil and gravel where groundwater is stored
Atua	ancestor with continuing influence, god, demon, supernatural being
Awa	river, stream, creek, canal, gully, gorge
Biodegradable	capable of being broken down by living things like microorganisms and bacteria
Catchment	the area of land that contributes its rainfall to a river. The land surrounding the river influences the quality of the water
Clarity	how clear the water is. The more sediment there is in the water, the lower its clarity. A black disk inside a Perspex clarity tube is used to measure clarity.
Compost	fertilising material consisting of organic, decaying matter
Condensation	stage of the water cycle when water transforms from a gas into a vapour and becomes suspended in the atmosphere, visually represented by clouds
Conservation	not wasting, using something wisely
Contamination	an impurity in air, soil or water that can cause harm to human health or the environment
Depletion	occurs when water is used faster than it is replaced; can cause a shortage
Discharge	to expel water that naturally moves from an aquifer to a surface stream or lake
Drought	an extended period of dry weather
Evaporation	stage of the water cycle when water transforms from a liquid into a gas
Fertiliser	any chemical used to improve soil and promote plant growth
Groundwater flow	the movement of groundwater beneath the earth's surface
Groundwater	water contained under the ground's surface, between particles of and in the cracks of sand, soil and gravel; a common source of water for drinking and irrigation
Habitat	the place people live in is usually called a home but for animals and plants their home is called a habitat. A habitat is the place the animal or plant lives, eats and breeds.
Harakeke	New Zealand flax, *Phormium tenax* - an important native plant with long, stiff, upright leaves and dull red flowers. Found on lowland swamps throughout New Zealand.
Hazard	something that is dangerous; unsafe
Hydrologic cycle	see water cycle
Inanga	whitebait, *Galaxias maculatus* - a small silvery-white native fish.
Infiltration	see recharge
Irrigation	to supply water to crops, parks, golf courses and lawns
Iwi	extended kinship group, tribe, nation, people, nationality, race - often refers to a large group of people descended from a common ancestor
Kai	food
Kaitiaki	trustee, minder, guard, custodian, guardian, keeper
Kanakana	lamprey, pouched lamprey, *Geotria australis* - an eel-like fish that has a sucker mouth with horny teeth and a rasping tongue. A highly valued food of Māori.

Karaka	*Corynocarpus laevigatus* - tree with dark green, very glossy, large leaves and orange berries containing seeds which are poisonous unless roasted. Cultivated by Māori. Found on coastal regions.
Kaumātua	adult, elder, elderly man, elderly woman, old man
Kauri	*Agathis australis* - largest forest tree; found only in the northern North Island, it has a large trunk and small, oblong, leathery leaves
Kirirua	New Zealand long-finned eel, *Anguilla dieffenbachii*
Kōwhai	small-leaved native trees of the Sophora genus, common along riverbanks and forest margins and noted for their hanging clusters of large yellow flowers in early spring
Kūmara	sweet potato, *Ipomoea batatas*
Landfill	a low area of land that is filled in with layers of garbage and soil
Mahinga kai	Refers to natural resources and the area in which they are found. It includes the way resources are gathered, the places they are gathered from and the resources themselves, such as tuna (eel) or harakeke (flax) and paru (soils) which are used for dyes.
Marae	courtyard - the open area in front of the wharenui, where formal greetings and discussions take place. Often also used to include the complex of buildings around the marae
Mātāpuna	source (of a river)
Maunga	mountain, peak
Mauri	life force, life principle, special nature, source of emotions
Moana	sea, ocean, large lake
Mōkihi	raft made of bundles of raupō, flax stalks or rushes
Moko	grandchild - a term of address used by an older person for a grandchild or a young child - short for mokopuna
Momo wai	types of water
Ngāi Tahu	tribal group of much of the South Island, sometimes called Kāi Tahu
Nohoanga	seat, chair, seating, dwelling place
Nutrient	a substance that provides nourishment essential for life and growth. Plant nutrients that can find their way into waterways include nitrogen and phosphorus. Too many of these nutrients can upset the balance of life in the waterway.
Overuse	using more than necessary; wasteful
Papatūānuku	Earth mother and wife of Ranginui. All living things originate from them.
Pāua	abalone, sea ear, *Haliotis* spp. Edible univalve molluscs of rocky shores that have flat, ear-shaped shells with a row of small holes for breathing
Permeable	any material that allows water to penetrate through
Pollution	see contamination
Pounamu	greenstone, nephrite, jade
Precipitation	stage of the water cycle when water vapour molecules become too large and heavy to remain in the atmosphere and fall to the ground in the form of rain, snow, sleet, hail, etc.
Pukeko	purple swamp hen, *Porphyrio porphyrio* - a deep blue-coloured bird with a black head and upperparts, a white undertail and a scarlet bill that inhabits wetlands, estuaries and damp pasture areas.
Puna	spring (of water), well, pool
Pure	purification rites - designed to neutralise tapu

Quality	to be at a high degree of excellence; something that is good or well done
Rākau	trees
Rangatira	chief (male or female)
Ranginui	atua of the sky and husband of Papatūānuku, from which union originate all living things
Recharge	to increase the amount of groundwater through precipitation or surface water that absorbs into the aquifer, also called infiltration
Recycle	to produce a new item from an old item; to reuse parts of
Repo	swamp, bog, marsh
Rūnanga	council, tribal council, assembly, board
Runoff	water that does not become absorbed by the earth but flows across the surface of the land into a stream or lake
Saturation zone	the area where water fills the spaces between soil, sand and rock underground
Sediment	particles of rock that are deposited into a river by wind, water or ice
Seepage	to leak from
Septic system	underground pipes and tanks that store and dispose of human waste
Storage tank	container that stores potentially hazardous chemicals above or below ground
Tamanuiterā	atua of the sun
Tamariki	children
Tānemahuta	atua of the forests and birds and one of the children of Ranginui and Papatūānuku.
Tangaroa	atua of the sea and fish, he was one of the offspring of Ranginui and Papatūānuku and fled to the sea when his parents were separated.
Tangihanga	funeral
Tapu	a person, place or thing that is sacred, prohibited, restricted, set apart, forbidden, under atua protection. Tapu was used as a way to control how people behaved towards each other and the environment. Members of a community would not violate the tapu for fear of sickness or catastrophe as a result of the anger of the atua.
Taro	*Colocasia esculenta* - a plant with edible, starchy corms and large, edible, fleshy leaves
Tauihu	bow, prow, figurehead (of a canoe)
Tauranga waka	resting place, anchorage, place to land, mooring (in this case, for waka)
Tāwhirimātea	atua of the winds, clouds, rain, hail, snow and storms
Tikanga	correct procedure, custom, habit, lore, method, manner, rule, way, code, meaning, plan, practice, convention
Tinana	body
Titi	muttonbird, sooty shearwater, *Puffinsus griseus*, young of the sooty shearwater - a grey-faced petrel with a long slender bill hooked at the tip and silvery-grey flash on the underwings, which nests in underground burrows.
Tohi	dedication rite, baptism rite, child dedication ritual - a ritual ceremony over a child in flowing water while petitioning the atua to endow the child with the desired mental and physical qualities. The child was dedicated to the particular atua by immersion in the water or by sprinkling it with water from a branch dipped in the stream.
Tohunga	a skilled person, chosen expert, priest - a person chosen as a leader in a particular field

Tōtara	*Podocarpus totara, Podocarpus cunninghamii* - large forest trees with prickly, olive-green leaves not in two rows. Found throughout New Zealand. Popular for carving.
Tūmatauenga	the atua of war
Tuna	eel of various species, including the long-finned eel (*Anguilla dieffenbachii*) and short-finned eel (*Anguilla australis*).
Tupuna	ancestors
Urupā	burial ground, cemetery, graveyard
Wāhi ingoa	place names
Wāhi taonga	special (treasured) places
Wāhi tapu	sacred places
Wai horoi	water for washing, cleaning, wiping, cleansing
Wai tohi	Water used for religious purposes such as baptism, initiation ceremonies and to remove a tapu. This water must remain pure.
Wai unu	water for drinking
Wai whakaheke tupapaku	water burial sites
Wai	water
Waikino	Polluted water with the potential to harm all life forms. The mauri is damaged
Waikino	water that conceals danger or water that has been corrupted or altered to such an extent that it may cause harm
Waimāori	freshwater, mineral water.
Waimataitai	Water that is a mixture of saltwater and freshwater, such as estuaries and marshes. A source of mahinga kai
Waimate	Water so polluted that its life force has expired. It has no power to regenerate itself or living things. The mauri is lost
Waiora	The purest form of water. It has the potential to give life, sustain well-being, and counteract evil. Waiora is used by priests (tohunga) in sacred rituals to purify and sanctify
Waipiro	stagnant water
Waipuke	flood
Wairere	waterfall
Waitai	sea water; salt water
Waka	canoe
Water cycle	the never-ending movement of water through the atmosphere, ground and back again; also called the hydrologic cycle
Water table	the top of the saturation zone
Waterway	River, stream or drain. An area that water flows through
Well	a hole or shaft drilled into the earth to pump water to the surface
Whānau	extended family, family group, a familiar term of address to a number of people - in the modern context the term is sometimes used to include friends who may not have any kinship ties to other members
Wharenui	meeting house, large house - main building of a marae where guests are accommodated

Source of Māori definitions: www.māoridictionary.co.nz.

Teacher Resource

For further information, see www.es.govt.nz

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