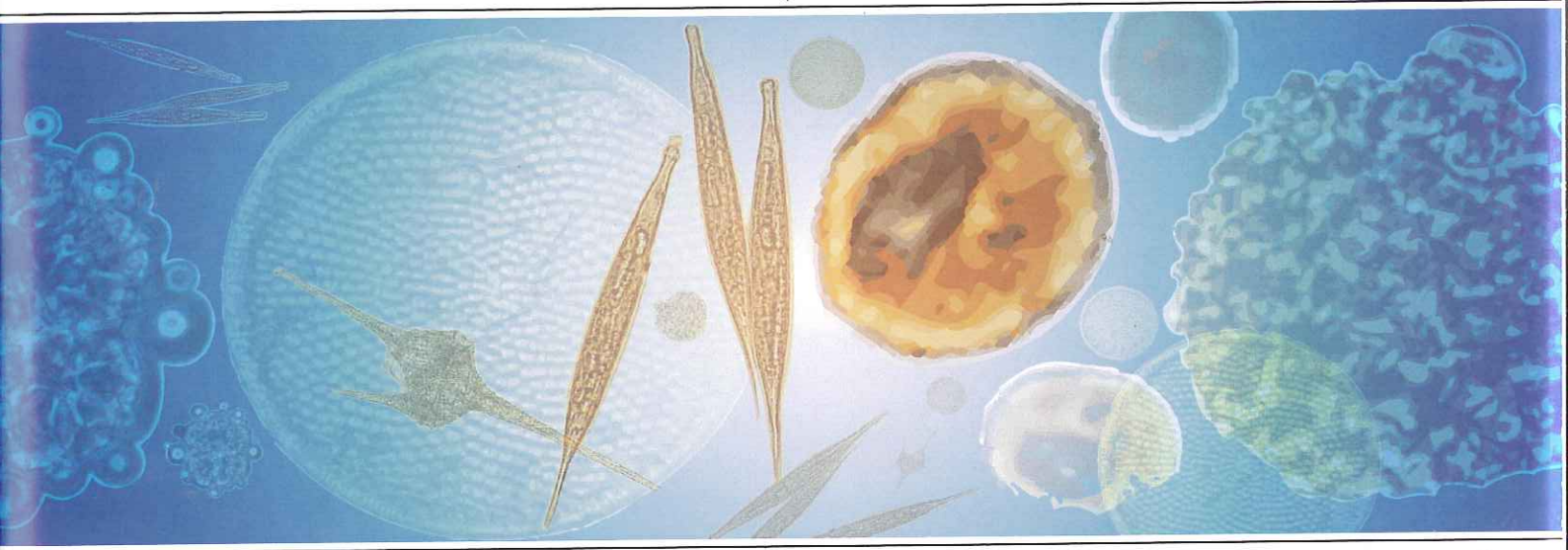
CAWTHRON INSTITUTE

90TH ANNIVERSARY

EXTRAORDINARY FRONTIERS



CAWTHRON SCIENCE, INNOVATION & MYSTERIES FROM OUR ENVIRONMENT

EDUCATION RESOURCE

CAWTHRON TRUST

CONTENTS

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This Education Resource has been prepared by Jo Thompson, Community Educator, Cawthron Institute and Imogen McCarthy, Educator, Nelson Provincial Museum. It is based on the scientific research of the Cawthron Institute, Nelson. The exhibition – ***Extraordinary Frontiers – Cawthron Science, Innovation & Mysteries from our Environment*** – was funded by a major grant from the Cawthron Trust as part of the 90th Anniversary celebrations of the Cawthron Institute.

Introduction to Cawthron Institute

Thomas Cawthron died on the 8th October 1915. He bequeathed £231,000, a large part of his estate, for the development of an industrial and technical school, institute and museum to be called Cawthron Institute.
When Cawthron Institute was opened in 1921 its aim was to do research "of benefit to the region and the dominion". Thomas Easterfield, Emeritus Professor of Chemistry at Victoria University College, was its first Director.
The early work of Cawthron Institute focused on soils, agriculture and biochemistry. It played an important role in stimulating government scientific research. In Cawthron Institute, the legacy lives on, in a reputation for enterprise and excellence in scientific research and consultancy. Ninety years on Cawthron Institute is recognised nationally and internationally for its science and research achievements.

What do we do today?

Today Cawthron Institute is a unique organisation in New Zealand - the country's largest, independent, "not for profit" research centre. The key areas of research that Cawthron Institute is involved in include:

- Aquaculture and biotechnology
- The protection and restoration of coastal and freshwater ecosystems
- The sustainable management and development of New Zealand's natural resources
- The protection of New Zealand from invasive aquatic organisms
- High quality analytical services to underpin the integrity of New Zealand products for domestic and international consumption

The Cawthron Exhibition

Extraordinary Frontiers;Cawthron Science, Innovation and Mysteries from our Environment is an interactive exhibition presenting past and present Cawthron Institute research and science.
As visitors travel through the exhibition, they will discover a variety of themes, each of which can be explored in greater detail with the use of this education resource.
Our objective in this exhibition is to stimulate and inspire students and adults, by demonstrating that science affects us in many different ways, every day of our lives.
Once inspired and aware of the importance of science, students can understand the processes that surround them and make informed decisions in their lives, from the affects of human activities on rivers and coastal environments, to uses of selective breeding and algal fuel technology.
Enjoy!

Gillian Wratt
Chief Executive

Curriculum connections

Learning Area	Objective	Context
Science L3-5 Understanding about Science	Identify ways in which scientists work together and provide evidence to support their ideas. Understand that scientist's investigations are informed by current scientific theory.	The work of the Cawthron scientists eg. Food testing, Aquaculture research
Participating and communicating	Use their growing science knowledge when considering issues of concern to them. Draw evidence based conclusions from scientific information.	Waterways Ecology Habitat changes, natural and human induced Barriers to fish movement Results of algal blooms
Life processes	Recognise that there are life processes common to all living things and that these occur in different ways.	Stream organisms, Factors that affect life processes eg. Sediments, nutrients and oxygen Mussel anatomy
Ecology	Explain how living things are suited to their particular area and how they respond to environmental changes, both natural and human induced.	Native fish adaptations eg.Tuna, Koaro Selective breeding of mussels
Values and Environmental Guidelines	Valuing ecological sustainability. Learning about the environment. .	Cawthron's role in Biosecurity Sherry River Story
Science L6-8 Ecology	Investigate the impact of natural events and human actions on a New Zealand Ecosystem. Understand the relationship between organims and their environment.	Didymo, Aquaculture, Biosecurity Environmental monitoring by Cawthron
Mathematics L3/4	Conduct investigations using the statistical enquiry cycle.	Analysis of tables and graphs of Cawthron data
Technology L3/4	Understand how society and environments are influenced by technology. Investigate a context to develop ideas for potential outcomes.	Cawthron's research tools. Bridge apron (in his resource) Overhanging culvert (in exhibition)

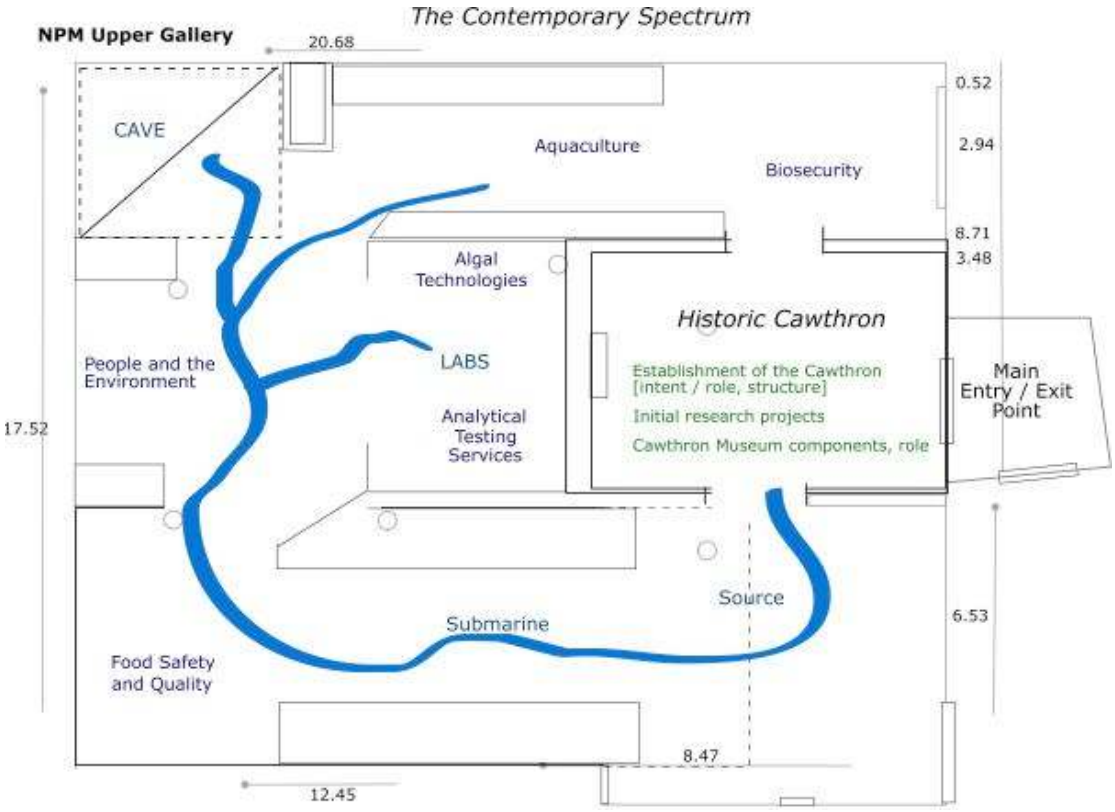
How to use this resource

This resource contains some of the text from the exhibition and activities for your students to do before or after they have visited the museum. The activities relate to the topics that are encountered at the museum but do not repeat the problems that students will solve during their visit.

The text is arranged according to the floorplan of the exhibition. A stream flows from its source to the sea. The contemporary activities of the Cawthron are showcased along the stream's route and the historic role of the Cawthron is discussed at the end of the resource.

Post-visit student activities related to stream contamination occur in two sections, The Submarine and Aquaculture, but should be undertaken together.

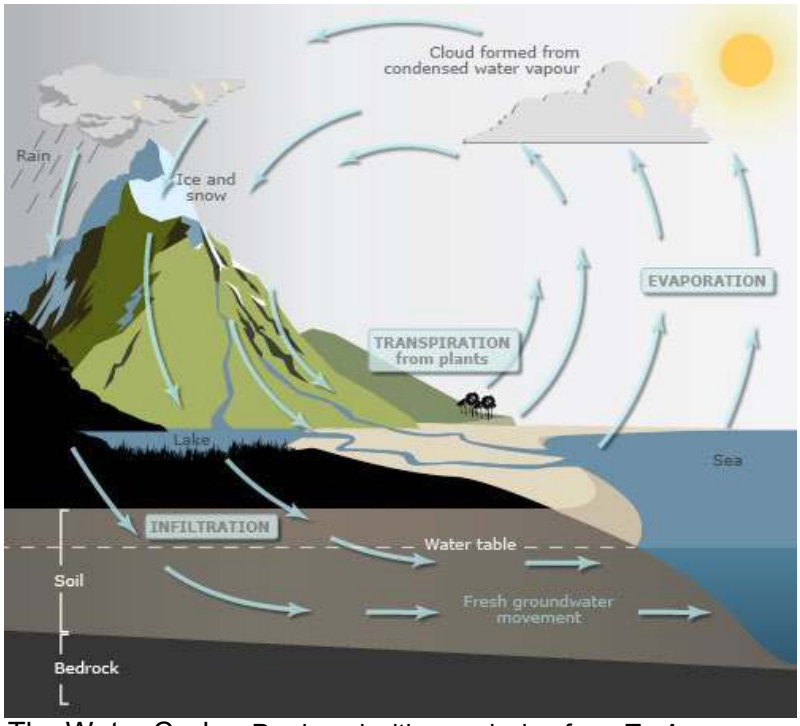
Floorplan of the exhibition



The Source

Ko au te awa, ko te awa ko au
I am the river, and the river is me
The source is where a river begins, but it is not the beginning of the story for this water.

The water we see on Earth today is almost as old as the planet.
We are drinking and washing with the same water that the dinosaurs used.
There is a fixed amount of water on the planet and it is impossible to create any more.



The Water Cycle - Produced with permission from Te Ara

The source of the river is usually in high altitude, isolated, mountainous areas and often not a location that you would expect to find fish. Some of NZ's most isolated streams are alive with native fish species like the kōaro and longfin eel.

These are the things fish need in order to live happily:
1. Oxygen
2. Good visibility
3. A supply of invertebrates as food
4. Stable Water temperature
5. Clean environment
6. Stable river levels
7. Access to breeding and feeding grounds

.

Who lives here?

Student Activity

More than half of New Zealand's native freshwater fish species are diadromous, meaning they must have access to the sea at some stage in their life to be able to reproduce. They are very vulnerable to any kind of barrier that stops them from reaching, or their offspring from returning from, the ocean.

This picture shows a bridge with a concrete base. The water drops away on the downstream side leaving a little waterfall that is impossible for fish such as small eels and native trout to climb.

At times when the creek is nearly dry it is impossible for fish to use the edges to climb up and move upstream.
Your task is to design a method that will enable access for fish. It needs to be made from materials that are in keeping with the environment. It is however, possible to alter the bridge base.

Draw up your solution with a well-labeled diagram.

Tuna - The Longfin eel - *Anguilla dieffenbachii*

The old man said 'Once upon a time there were huge eels in the rivers round here!'

Collect some giant eel stories from your family and friends. Just short ones like this.

'When our family first came here in the 1970s we caught an eel in the Motueka River that was longer than Grandad was tall. We know that because he nailed it onto a post for skinning and when its tail was on the ground its head was higher than his.'

It would be great if you could get some photos to go with your story. Cawthron would love to see any pictures you get. Did you know that these giant eels are all girls? Where do you think all those giant eels have gone?

Eel life

Eels are secretive, mainly nocturnal and prefer habitats with plenty of cover. They have lived in New Zealand waters for 80 million years.

Small longfin eels living among the river gravels feed on insect larvae, worms and water snails. When they get bigger they begin to feed on fish. They will eat trout smaller than themselves, mice, rat and occasional duckling dinner or even other eels.

During the day eels are secretive, hiding under logs and boulders or under river banks. Most of their hunting goes on at night.

Eels hunt using a very developed sense of smell rather than by sight. They have tube nostrils that protrude from the front of their head above their upper lip. Eels have hundreds of tiny teeth all pointing backwards into their mouth that helps them grip their prey.

Eels, known as Tuna, are taonga [treasure] to Maori as they have a high food value. Migratory eels are particularly tasty, and a rich, nutritious, energy source, because they are rich in oil. This oil is needed to provide the energy for them to swim to the tropics for spawning.

Maori studied tuna to determine life cycles, ages, habitat and migration patterns. This knowledge helped determine how many tuna could be caught in a season, ensuring that they weren't fished out.

The eel's life story

ref www.doc.govt.nz/conservation/native-animals/fish/facts/eel/

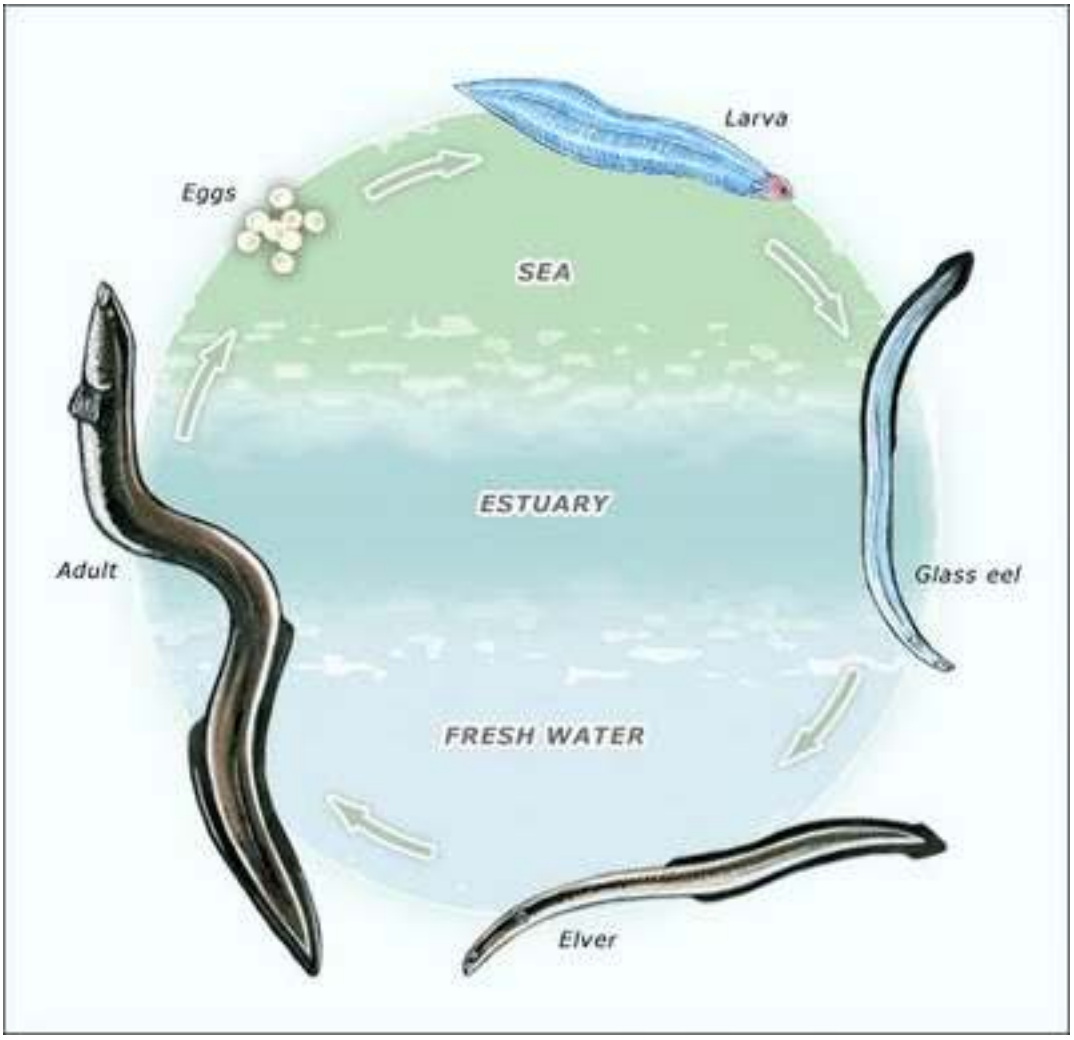
The longfin eel is the largest and longest-living eel in the world and it occurs only in the rivers and lakes of New Zealand. The biggest longfin eels reported have weighed as much as 40kg and estimated to be 60 – 90 years old. Today eels are seldom over 10kg.

Longfin eels breed only once, at the end of their life. When they are ready to breed, they leave New Zealand and swim 5000 kilometres up into the tropical Pacific to spawn, probably in deep ocean trenches somewhere near Tonga.The average age at

which a longfin eel migrates is 23 years for a male and 34 for a female. The adults never return as they die after spawning.

When they reach their destination, the females lay millions of eggs that are fertilised by the male. The larvae are called leptocephalus and look nothing like an eel – they are transparent, flat, and leaf-shaped. The larvae reach New Zealand by drifting on ocean currents with probably some directional swimming.

Before entering fresh water, the leptocephalus change into a more familiar eel shape, although they remain transparent for up to a week after leaving the sea. These tiny "glass" eels enter fresh water between July and November each year, often in very large numbers.



Eel life cycle by Bruce Mahalski, reproduced with permission from Te Ara

Elvers [young eels] swimming up river will climb waterfalls and even dams by leaving the water and wriggling over damp areas. They do this by clinging to the rock surface and slowly wriggling their way upwards. This usually happens at night during summer months. A local name for these tiny eels is ‘bootlaces’.

An eel can climb a waterfall of up to 20 metres in search of a long term home. The spillway from the **Maitai Water Reserve Dam is a good place to see elvers**

migrating en mass during the summer. You can see them by torch-light clinging to the vertical left hand wall (looking upstream just above of the bridge). You can see them at the water intake weir further up the South branch of the Maitai River

After about 25 years, and sometimes up to 80 years, they migrate back to the Pacific Ocean to breed and die. The biggest eels in our rivers are usually old females that have been slow to reach maturity and for reasons that are not yet understood have not migrated to sea to breed.

Student Activity

- On a map, trace the journey of the longfin eel as it leaves New Zealand to breed. Work out how far it travels.

After your visit to the musem

- Design a board game “eels and ladders”. Players move around the board winning points for their actions that protect the longfin eels and losing points for actions that harm the eel eg squares could read: you go to the Environment court to stop a company discharging toxic effluent into the river, move 5 squares ahead, or you drain a wetland for watering your crops, move 5 squares back.

Tale of Tuna-Roa-

The father of all eels was Tuna-roa and he lived in the swamp on the back of Maui's great fish.

Every day Maui's wife Hina went to the swamp to fill her calabash with water.

One day she was startled by a great swirl of water and Tuna-roa shot up above the surface. Hina was terrified and tried to run but Tuna-roa used his powerful tail to hit her on the back so that she fell over in the mud.

Hina didn't tell Maui that morning but the next day Tuna-roa got her again and she complained to Maui. Maui was angry so he went to the forest and made peace with the trees so they would give magic to whatever they made from them.

He cut trees down to make spades that would dig faster than any man, knives with hard, keen cutting edges and spears with the sharpest points.

He took this gear off to the swamp and put it to work. The spades dug a deep ditch that connected the swamp with the sea. Maui stretched a great net across the ditch and sat down to wait.

The rain started and the water poured into the swamp. The swamp filled up and water started to run down the ditch. Tuna-roa couldn't hang on to the rushes in the swamp, he couldn't bury himself in the mud, it was on the move, he got washed down towards Maui's net.

He was caught, he reared up to defend himself but Maui used his sharp knife and cut off his head. He cut the rest of his body up into tiny bits and they were swept out to sea.

This was the end of Tuna, his tail turned into the conger eel that lives all its life in the sea, his head turned into a fish and all the little bits of his body into the freshwater eels in the creeks of today.

Student Activity

Organise your group into characters. Remember eels, trees, spades, knives and the net can all be characters too.

Act out the story as a narrator re-tells it.

Kōaro - Native Trout - *Galaxias brevipinnis*

Kōaro are New Zealand's second most common whitebait species. They can be found in waterways far inland at high altitudes, including in northwest Nelson, where they live at an altitude of almost 1500m.

In streams where native bush abounds, kōaro can be plentiful. Elsewhere they are rare. The fish usually live in the swifter rapids of streams, under logs, or more usually under and amongst boulders.

Kōaro prefer cool water less than 13°C; however, they are able to survive at temperatures up to 23°C. They grow to an average length of 16-18cm, although some have been found up to 30cm long.

Kōaro can climb! They use their flattened fins to scramble up waterfalls in order to reach shady forest streams.

Kōaro feed on stream invertebrates, mostly insect larvae. Sandfly (simulid) and midge (chironomid) larvae form the base of their diet but the also eat mayfly, stone fly and caddis fly larvae and worms.

Kōaro in lakes have also been found to eat manuka beetles, caddis, various beetles and wetas and even smaller kōaro.

Lifecycle

During autumn and early winter, when streams are flowing strongly kōaro lay their eggs along stream edges. When the water flow drops, the eggs are left stranded. There they develop over the next few weeks, until water flows are once again high enough to cover them. They hatch into larvae and are carried out to sea.

Kōaro live in the sea for several months before returning as whitebait to freshwater, and begin their journey upstream for their adult life.

Kōaro appear to reach maturity at about two or three years of age, can spawn several times, and probably live for six to eight years or even longer.

Student activity:

Create a diagram to illustrate Kōaro's life cycle.

The Submarine

The Cawthron team investigate the contaminants entering New Zealand¹s freshwater environments and their affects on the ecosystem.

What people do on the land can have some major effects to the river and the ecosystems within it. These effects may be carried all the way out to sea.

We can reduce the impact of our actions by changing the way we do things.

Sedimentation

Sedimentation is muddy material or debris that settles on the riverbed. Too much sediment can damage fish directly by clogging up their gills, fill up suitable hiding places within the riverbed so there¹s nowhere to hide from predators, and lower the food value of the algae growing on the rocks.

Earthworks and roading connected with the forest timber industry can cause sedimentation. Removing trees, particularly around river edges, can affect water quality and stream habitats. It can also increase flood risks, as more water runs into the river from the cleared land.

Challenge: Can you find out what measures are taken by forestry contractors to reduce sedimentation?

Nutrients and Oxygen

Nutrients are necessary for the healthy growth of plants, animals and people.

The two primary nutrients in rivers are nitrogen and phosphorus. Nutrients enter waterways naturally in rainwater, from soil and rock weathering and from natural processes such as the breakdown of leaves and wood.

Dissolved oxygen in the water is a key factor affecting what lives in a river or stream. A large amount of organic waste encourages decay organisms that use up the oxygen in the water.

Gases are exchanged in river ecosystems. During the day algae and other plants can photosynthesise and produce oxygen. At night all the river life uses up oxygen from the water.

A healthy stream in a forest will not have a big daily change in oxygen levels. This is because there¹s lots of shade and not many nutrients so photosynthesis that produces oxygen is slow and the number of organisms depending on oxygen are in balance with the plants that produce it.

Fertiliser, stock wastes, wastewater and effluent discharges can run off into the waterways during rain and cause nutrient overload. In a stream polluted in this way

algae and other plants grow really fast .This creates high oxygen levels during the day and low levels at night. Eventual decay of these plants causes oxygen to be used up and the stream becomes stagnant. The resulting low oxygen levels kills all aquatic life. We call this process eutrophication.

Faecal matter

Faecal matter is waste matter from cows, humans and other animals. Faecal matter enters rivers directly through discharge of animal waste from pets, birds, farms and human sewage. Faecal pollution in water can carry bacteria such as Escheridia coli (E.coli) and can make humans very ill if they come into contact with heavily contaminated water.

The decay of faecal matter can reduce oxygen levels in rivers, sometimes lowering it enough to kill fish and other aquatic life.

When waterways become contaminated with faeces, the first step in dealing with the problem is to identify the source of the pollution. Is it from a farm, domestic or wild animals, humans, or birds?

The Cawthron team use Microbial Source Tracking (MST) that identifies the source of faecal matter through analysing the biological material in a water sample. DNA is extracted from the sample and it is examined for source-specific organisms. MST uses genetic markers found in gut bacteria and viruses of certain animal hosts.

The Sherry River Story

The Sherry River flows from its catchment east of the Hope Range and flows north to join the Wangapeka River that then joins the Motueka River. (Can you find this on the map? Try Google Earth.)The Sherry River catchment land uses are a mix of forestry and pastoral farming including dairy, beef and deer.

In 2001 the Integrated Catchment Management Programme (ICM) scientists reported to the farming community that high levels of bacterial contamination made swimming unsafe. Increased sediment was also identified as a problem.
The farming community decided to work together with ICM to address the problem.
Bridging creeks and the river to prevent cows crossing directly had the following results.

Student Activity

1.Draw a graph to illustrate the data in the table below

E .coli is measured as colony forming units per 100ml
Concentration of E. coli at 4 sites along Sherry River

	km dist. from confluence with Wangapeka R	E.coli (cfu/100ml) before bridging	E.coli (cfu/100ml) after bridging
Cave Creek	18	50	10
Granity Creek	15	210	50
Matariki Bridge	7	650	225
Blue Rock	2	525	275

Guidelines for safe E.coli levels for recreation = 110cfu/100ml

2. What % improvement was made in bacterial counts at the four sites?
3. Suggest any further steps that might be taken to lower the count.

Temperature and shade

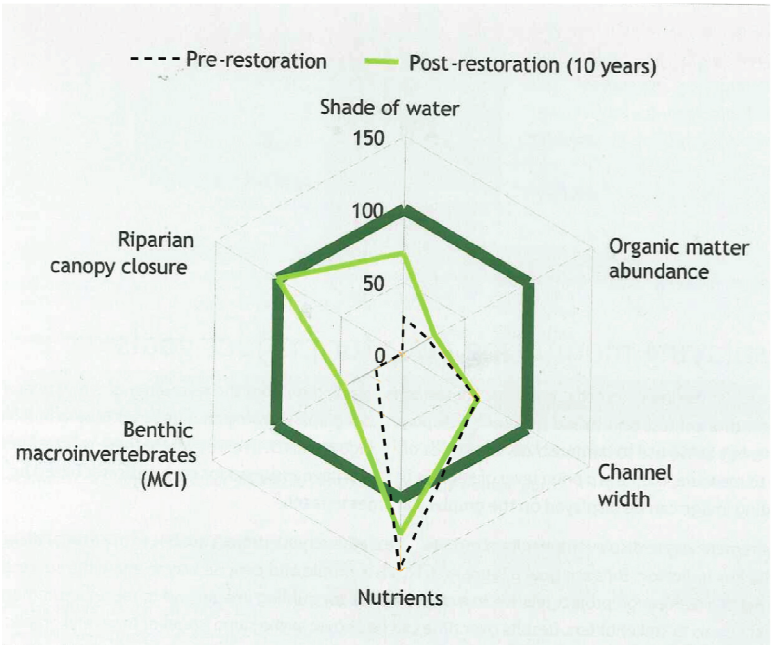
The water temperature of a river has a large influence on what can live in it. High water temperatures can be stressful to aquatic animals including native fish and invertebrates, and kill them. The increase in natural temperature of a river can be caused by lack of shade due to the removal of native plants and trees.

Riparian (the area between land and a river) native planting is vital for shade and habitat for aquatic life.

Student Activity

The pasture stream represented by the graph below has been fenced and planted with native vegetation. (ref The Restoration Indicator Toolkit, NIWA 2010)

Ten years ago the nutrient levels were higher than they were when these measurements were taken. The goals were to move towards natural habitat and water quality. The darkest line shows the goal and the vertical access refers to % of goal attained.



1. The canopy has closed to meet the goals set. By approximately what percentage has the shade been increased?
2. Give a possible reason for the drop in nutrient levels.
3. Benthic macro-invertebrates include mayfly and caddisfly larvae. Give two ways in which increase in canopy closure has contributed to rise in the number of benthic macro-invertebrates.

Food safety and Quality
A picnic beside the river

The Cawthron laboratory team provide analytical testing services for a variety of food products, from drinking water and wine to honey.

Why do we test food and drink?

What is in the food and is it on the label?
Ask students to suggest things that Cawthron might test for.
Get them to think about what is on the labels of food packaging and how we can be sure that the things they say are true.
One of the things the Cawthron scientists check is the % of food types in a product. These are described as ‘proximates’ and should add up to 100.

Student Activity:

Here is a sample of a Superwine biscuit packet label. We are interested in the column 'Quantity per 100g'.

	Quantity per 100g
Energy	1970KJ
Protein	5.4g
Fat total	16.6g
-saturated fat	9.6g
Carbohydrate total	72.5g
-sugars	25g
Sodium	340mg

You need to add the weights of the food types. The traps here are Energy- not measured in grams; saturated fats and sugars – just part of the total.

Sometimes a packet label omits the weight of water. (Look at a yoghurt packet. It looks as if yoghurt is about 80% water.)

1. Working in groups calculate the proximates for four different food packages.
2. Why do you think energy has been recorded differently?

People and the Environment

What is Microbiology?

Microbiology is the study of micro-organisms, which are tiny (single celled) organisms such as algae, fungi, bacteria .

Algae are plants. They are not always green and they don't have roots or flowers. Some algae are so small that they can only be seen with a microscope.

Algae produce more oxygen than all the other plants in the world put together and at the same time use the greenhouse gas carbon dioxide to grow.

Algae are extremely important for all life because they make their own food by photosynthesis and produce oxygen. It is estimated that between 70-80% of the oxygen in the atmosphere is produced by marine plants.

They are a very important food source for tiny animals such as shrimp and huge animals like whales. Algae are at the bottom of the food chain and many living things depend upon them.

An algal bloom is a rapid increase in the population of algae. Algal blooms can occur in freshwater and marine environments. Usually only one or a small number of species are involved, and some blooms may be recognized by change in colour of the water. Algal blooms are often green but they can also be other colours such as yellow-brown or red, depending on the species of algae.

A toxic algal bloom is a bloom of microalgae that contains toxins. About 2% of marine microalgae are known to be toxic. A biotoxin is a toxin that has been formed by a biological organism.

As algae is the basis of the food chain in freshwater and marine environments, a toxic algal bloom can have devastating impacts on an ecosystem.

Not all algal blooms are toxic but when they die they decay and the decay organisms suck the oxygen out of the water system. Harmful algal blooms have been known to cause negative effects to a variety of marine mammals and sea turtles, with each toxic algae creating specific reactions in developmental, immunological, neurological, and reproductive systems.

Student activity

Solving the Jenkins family's mystery illness

Read these three pieces of information and write a possible explanation for Marama's vomiting, Bozo's disappearance and William's itches.

1. On Monday Mrs Jenkins got a ring from her children's school. Marama's teacher was worried because Marama was vomiting and needed to go home.

   'Where are you Bozo?' she called, needing to put the dog in its kennel before she went out. Bozo didn't come when called and Mrs Jenkins couldn't find him anywhere.

   After school William came home complaining of an itchy neck and wrists.

2. On Sunday the Jenkins family had been to the river. It was a bit cold so William, who wanted to swim, wore his wetsuit.

   Marama played with Bozo in the shallow parts of the river. They jumped in and out of the water tumbling about and emerged spluttering.

   Dad noticed that the river looked pretty scummy and there were mats of algae drying on the edge of the river.

3. Algal blooms can happen when the river is warm, the water level is low and there is a plentiful supply of nutrients available.

   Some blue green algae produce toxins (poisons).

   It is important not to drink or eat shellfish from water with an algal bloom. The toxins can cause eczema or dermatitis.

   The drying mats of algae smell earthy and are attractive to dogs.

Aquaculture

Aquaculture started in New Zealand in the late 1960s. It is dominated by mussels, oysters and salmon. In 2007, aquaculture generated about NZ$360 million in sales on an area of 7,700 hectares. $240 million was earned in exports.

There are three main species in the New Zealand aquaculture industry: the green-lipped mussel, the Pacific oyster and king salmon. In 2006 these three species generated $357 million in sales. Mussel accounted for 63 percent of this value, Pacific oysters 9 percent and king salmon 28 percent.

Student Activity

Making sense of text. Read the following history of the Mussel Industry. There are a lot of words and a few dates!

- Create a timeline with the dates 1960s, late 1960s, 1971, 1974, 2006 on the right side of the page and the information about the mussel industry on the left.

'Until the early 1960s, mussels were harvested by hand from intertidal rocks. Dredging was then introduced, and within a few years the mussel beds in Tasman Bay and the Hauraki Gulf were dredged clean. In the late 1960s, following this collapse, the aquaculture of the New Zealand mussel began. The endemic green lipped mussel was used to trial growing mussel spat (young mussels) on ropes suspended from rafts. The Hauraki Gulf and the Marlborough Sounds provided sheltered environments, with clean water rich in plankton. The cultured mussels were ready for harvest after 12 to 18 months, and first went on sale in 1971.

More growers entered the industry. The labour-intensive raft method was replaced with a modified Japanese longline system. Biodegradable stockings were packed with spat and tied to parallel rows of looped ropes, supported by buoys. Young mussels grow through the stockings, anchoring themselves to the ropes with their strong byssal threads (beards). The farms are usually located in sheltered or semi-sheltered areas where there is sufficient depth of water at low tide to keep the longline droppers off the bottom. Recent research has been investigating offshore mussel farming in exposed areas several kilometres from shore, such as farms offshore from Napier and Opotiki.

Initially the ropes were allowed to reseed naturally, after harvest, from the spat already present in coastal waters. However, this method was unreliable. In 1974 a marine scientist discovered mussel spat encrusted on drift kelp on Ninety Mile Beach. Locals collected the seaweed and air freighted it to mussel farmers. Kaitaia spat, as it became known, is now the prime source of seed mussels. There are some experimental hatcheries.

Improved techniques have led to rapid production increases, and bulk handling methods have been introduced to meet growing demand for export to more than 60 countries. By 2006 there were over 900 mussel farms in New Zealand covering about 6500 hectares, and worth about $224 million in annual sales.'

Problems for the Mussel Industry

The Motueka River drains a catchment area of 2075 km^2 and flows into Tasman Bay. Following rain events, the river plume is conspicuous largely due to a shallow layer of fine sediments derived from the catchment. The river plume during flood events extends into some of New Zealand's largest Aquaculture Management Areas (AMAs), which are currently being developed for GreenshellTM mussel (Perna canaliculus) production.

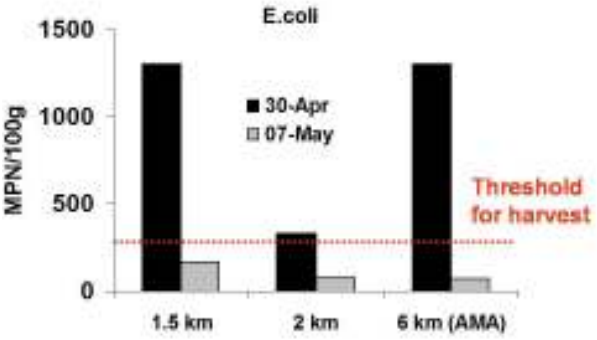
The graph below left shows elevated concentrations of faecal indicator bacteria in mussels collected during the plume survey and a week later. Here E.coli are calculated as the most probable number (MPN) per 100g of mussel tissue.
The E.coli present contained genetic markers that show they come from cattle, sheep or deer.

Student Activity

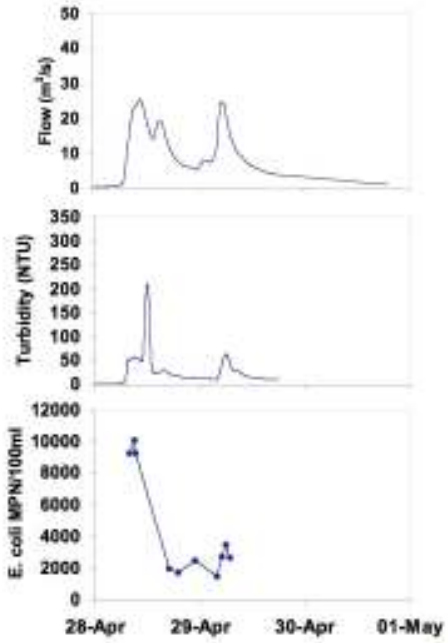
The graph below right shows the relationship between increased flow (due to high rainfall), turbidity and E.coli presence in the Sherry River over four days

With reference to the graphs below and the Sherry River story write a paragraph in which you discuss the significance to recreation and marine farming of community action taken in the Sherry River catchment.

E.coli in mussels



E.coli in Sherry River during flood



Biosecurity

Biosecurity New Zealand is a branch of the Ministry of Agriculture and Forestry. They are constantly on the look out for introduced animals or plants that might damage our environment, flora and fauna, marine life or Maori resources.

Student Activity: Didymo - also known as Rock Snot

Didymo, *Didymosphenia geminata,* looks and feels like a layer of dirty wet cotton wool over a riverbed.

It was first detected in the Waiau River in 2004. Didymo has not yet been found in any North Island rivers.
Didymo was a new and invasive species in our water ways and it was critical the impact on the NZ aquatic invertebrates, fish and native algae was understood. Cawthron is involved in looking at these effects.

.

This is an example of signage intended to inform and advise people about the spread of Didymo.

1.Which groups of people pose the biggest risks as transporters of Didymo?

2.How might these groups be educated by Biosecurity New Zealand?

3.Design a pamphlet or media release to be given to whitebaiters explaining the problem and how they can help minimise the risk of spreading Didymo.

Biofouling

Biofouling is the growth of plants, algae, animals or micro-organisms on wet surfaces. It is a problem with commercial ships, recreational boats, wharf pilings, oil rigs and potentially any object in water.

Marine biosecurity works to prevent marine pests arriving in New Zealand, detecting them if they have arrived and managing them if they become established.

A good place to observe biofouling is on pleasure-boats moored in the Nelson marina. You can sometimes see boats being cleaned while on cradles.

www.biosecurity.govt.nz/biosec/camp-acts/marine/cleaning

Historic Cawthron

About Thomas Cawthron:

Thomas Cawthron is buried at the Wakapuaka Cemetery. He has a fine headstone decorated with columns. He was a wealthy man because his businesses in Nelson had done well. He was also a philanthropist.

He helped out in many individual cases of hardship and distress and contributed to causes such as relief funds, church organisations and educational and recreational schemes. In his later years, he made larger and more public gifts, including the Cathedral steps, the Rocks Road chains, Cawthron Park (in the hills to the east of the city), contributions towards a public hospital and nurses' home, and smaller donations to the Nelson Institute, and the Nelson School of Music and its pipe organ.

Thomas Cawthron died on 8 October 1915. He bequeathed £231,000, practically the whole of his estate, for the development of an Industrial and Technical School, Institute and Museum to be called the Cawthron Institute. This was officially opened in 1921 with Thomas Easterfield, Emeritus Professor of Chemistry at Victoria University College, as its first Director.

Thomas Cawthron's money was an investment into the region that allowed the economy to grow through science. Easterfield, the first Director of the Cawthron, when discussing the aims and ideals of the new institute, said

'The fruit industry, which has risen so rapidly in the Nelson district, and which if suitably fostered may become one of our national assets, may on the other hand, be stamped out if means are not discovered for combating the natural enemies of the fruit tree.'

Ref:
www.cawthron. org.nz
www.theprow.org.nz

Teacher led activity: Defining philanthropy

To help students define philanthropy, discuss the meaning of these words and their relationship to Thomas Cawthron's actions.

Time: The moment that something happens, the time it takes, the time we have to do something.

Talent: How good we are at something, a characteristic ability of someone.

Treasure: Things we own; money and other valuable things.

Community benefit: Working together to benefit the community.

Give: To donate, contribute, to present something.

Share: Divide up into equal parts, to distribute evenly.

Volunteer: Someone who offers to do something for nothing.

Your students need to come up with a definition. It could be something like 'Giving time, talent and treasure and taking action for the benefit of the community.'

Then you can give them some words to sort out. They need to separate out the words that they think describe a philanthropist. You might like to put the words on cards and ask students to place them in two columns. Ask the students to rank the words in the philanthropist column from most important to least important.

Caring, bully, bequest, charitable, conceited, concerned, generous, giving, greedy, helpful, humanitarian, irresponsible, kind, mean, partner, respectful, selfish, selfless, stingy, supportive, understanding, volunteer, vain

Student Activity

1. Write a definition of 'philanthropy'.
2. Find some examples of philanthropy today?

These links may help you

Bill and Melinda Gates :
http://en.wikipedia.org/wiki/Bill_%26_Melinda_Gates_Foundation

Colin Toop :
www.philanthropy.org.nz/knowledge/study3

Roy McKenzie
http://en.wikipedia.org/wiki/Roy_McKenzie

Murray Sturgeon
www.stuff.co.nz/nelson-mail/news/3074994/Music-school-gets-Steinway

Tom Sturgess
www.stuff.co.nz/nelson-mail/272907/Nelsons-Tom-Sturgess-chips-in-100-000-for-medals-return

Social entrepreneurs create an exhibition
www.dialogue-in-the-dark.com/about/ (use side bar of the link to navigate)

3. Celebrating philanthropists and starting the process in ourselves.

- TVNZ celebrates local philanthropists in their programmes in Good Sorts on TV1 on Sundays. http://tvnz.co.nz/national-news/one-good-sorts-2672527

Create a Wall of Fame in the school with pictures and stories of NZ philanthropists. These people can include sports coaches, the Christchurch student army, St John's officers, volunteer fireman, anyone who gives their time or money to the community.

4. Random acts of kindness day is becoming a New Zealand tradition.

http://www.stuff.co.nz/sunday-star-times/entertainment/more-entertainment-stories/603614/Random-Acts-of-Kindness-day-its-a-kinder-magic

Plan a random act of kindness activity with your class.

The Basic elements of Life

Like all living things, humans depend on four basic elements for survival – earth, wind, fire and water. Humans derive these four elements from the natural environment, an environment which we are destroying and at the same time destroying these essential elements. It is not that we necessarily set out to destroy the environment, or these elements but we do so neither-the-less. This is an inadvertent consequence of our desire to "make things better" for humanity and because of our increasing population.

The reasons these four elements are important is as follows:

Earth: "Every bit of food we eat for our nutrition was once alive, and most of it comes from the soil" (Suzuki 2010). Green plants grow in the soil and become food for plant eaters, who in turn become food for predators, who are food for other predators and when they die they all return to the soil as food for micro-organisms. The remains of living things disintegrate into disorder, becoming part of the soil, and are returned to purity once again by plants that grow stronger with the nutrients and thus the cycle begins again. *"We are Earth and whatever we do to Earth we do to ourselves"(Suzuki 2010)*

Wind: Air is fundamental to our survival and that of all other species on the planet, it give *"life to all terrestrial organisms, linking all life in a single matrix, and joining past, present and future in a single flowing entity"* (Suzuki 2010). We breathe the same air that was breathed by the dinosaurs, by Jesus and by our grandparents. At the point the air molecule in our lungs is absorbed by the blood stream, the air molecule

becomes one with the blood, the two cannot be delineated. *"We are air, so whatever we do to air, we do to ourselves"* (Suzuki 2010).

Fire: We need energy to exist and our fundamental energy source is the sun. Plants feed off the sun and provide the suns energy to plant eating animals, humans also feed of plants and animals thus obtaining the suns energy to move and grow. Indigenous peoples talk in reverence about the animals that they killed so people might live. People that depend on the goat are the goat and the goat is them. Without the goat the people could not survive therefore they will look after the goat to ensure it lives so they may live.

Water: Without water humans would survive around 8 days. We are *"at least 60 percent water by weight. We are basically blobs of water with enough organic thickener mixed in to prevent us from dribbling away on the floor"* (Suzuki 2010). We depend on water and the hydrological cycle and *"every drink we take has water molecules that evaporated from the canopies of every forest in the world, from all the oceans and plains...We are water and whatever we do to water, we do to ourselves"* (Suzuki 2010).

How are we destroying these elements?

We depend on these elements in yet we destroy them. *"We say we are intelligent, but what intelligent creature, knowing that water is a scared, life-giving element, would use water as a toxic dump?"* (Suzuki 2010). Science has shown that at the broadest level, there are four things humans are doing to the either the planet, or each other that is impacting on these essential elements. These are as follows:

1. We are allowing material to accumulate that we have extracted from the Earth's crust. Chemicals and other material extracted as a by-product, is then inadvertently being allowed to spread into natural systems we depend on.

2. We are producing material and chemicals that nature has not experienced before and cannot assimilate when they spread into natural systems we depend on.

3. We are destroying other species and the natural ecosystems that we depend on by removing it, damming it and paving over it.

4. We are putting barriers in front of people, preventing them from meeting their own needs or using too many resources so future generation cannot meet their needs.

Berlin Wall: the wall one day after it opened. [Photograph]. In *Encyclopædia Britannica*. Retrieved from http://www.britannica.com/EBchecked/media/92031/People-from-East-and-West-Berlin-gathering-at-the-Berlin

While our impact is usually inadvertent, we have sufficient understanding in the laws of science to know what is likely to happen as a result on these activities and therefore to understand that they cannot continue in their current form. The laws of science tell us:

- That matter and energy cannot be created and cannot disappear, instead they change form. The Earth has the same mass today as it did 4.5 million

years ago, so coal burnt to generate electricity does not disappear it changes into ash or gases. This means it is not possible to dispose of matter and our use of a material can make it a threat, as in the case of carbon dioxide, released during the burning of coal, and its impact on climate change.

- That energy and matter tend to spread spontaneously. The law of entropy dictates that disorder increases in a closed system thus organic matter decays. But on Earth, which is an open system, living processes return disorder to order, the decayed organic matter becoming food for plants. An obvious example of entropy in action is the 2010 oil spill in the Gulf of Mexico. Although the slicks were sprayed with chemical dispersants it did not disappeared but become more water soluble, so the slicks separated and the smaller molecules sank and spread across the ocean in the currents. Eventually micro-organisms will return disorder to order and use the oil particles for food. This is not the end however, for the micro-organisms will become food for shell-fish, which is food for other animals and thus the oil will work its way up the food chain potentially to humans.

- That the purer and better organised something is the more valuable it is. Thus fresh food has more value to people than decomposing food and petrol, in its liquid state, has more value than petrol in its gaseous state. There is a close link with entropy in that disorder follows order, so a newly constructed house will start to decay once complete, the paint will

wear, the nails will rust and timber will rot. If left to its own devises the house would eventually collapse. In terms of our use of material, we therefore need to ensure we use them efficiently and not waste them in a less pure, disordered form.

- That sun driven processes enable quality to be restored. While the Earth is a closed system in terms of matter, it is an open system in terms of energy, the Earth receiving energy from the sun and releasing excess energy back to space. Plants use the suns energy to create chemical energy for themselves and become food for animals in the process. Plants create structure and order by using the sun and are a net-producer of quality. Animals in the other hand are a net-consumer of quality. The relevance of this is that to ensure this quality continues we should not use natural resources faster than they can regenerate.

To summaries therefore, neither energy or matter disappear, they change form and spreads instead. As energy and matter spreads they become disordered and of lesser quality and the only thing on Earth that can return order from disorder are plants using the suns processes. It is in ignoring these laws that we come to be destroying the very system we rely on.

What can we do to stop this?

To really make a difference and therefore enable us to reduce our impact on the planet and each other we need to take action at an individual and family level. Individual actions may seem like it has little impact but an army is a collection of hundreds of individuals. By each person making a difference, it will add up to significant collective action. Below are some simple examples of how we can do this:

1. Reduce our contribution to the accumulation of material extracted from the Earth's crust, by:
    a. Driving our cars less and biking and walking more.
    b. Buying energy efficient products, such as LED light bulbs and appliances.
    c. Reducing waste by using rechargeable batteries etc. and closing the loop

2. Reduce our contribution to the production of man-made material and chemicals, by:
    a. Using natural products instead of synthetic ones where possible (cloth shopping bags instead of plastic).
    b. Buying products that use more natural materials instead of synthetic ones.
    c. Reducing the frequency with which we use synthetic chemicals.

3. Reduce our contribution to the destruction of other species and natural ecosystems, by:
    a. Supporting companies that reduce their impact on ecosystems, for example only buying certified sustainably produced timber.
    b. Planting trees, lots of them.
    c. Reducing waste so we use less landfills

4. Reduce our contribution to putting barriers in front of people and preventing them from meeting their own needs or the needs of future generation, by:
    a. Using resources efficiently today so we leave some behind for future generations.
    b. Support fairtrade and sustainably produced products when we buy imported goods.

c. Buy local goods from farmers markets or local shops, if possible, to support our local community.

ACKNOWLEDGEMENTS

Suzuki D 2010. **The Legacy An Elder's vision for our sustainable future**. Greystone Books, Vancouver, Canada.

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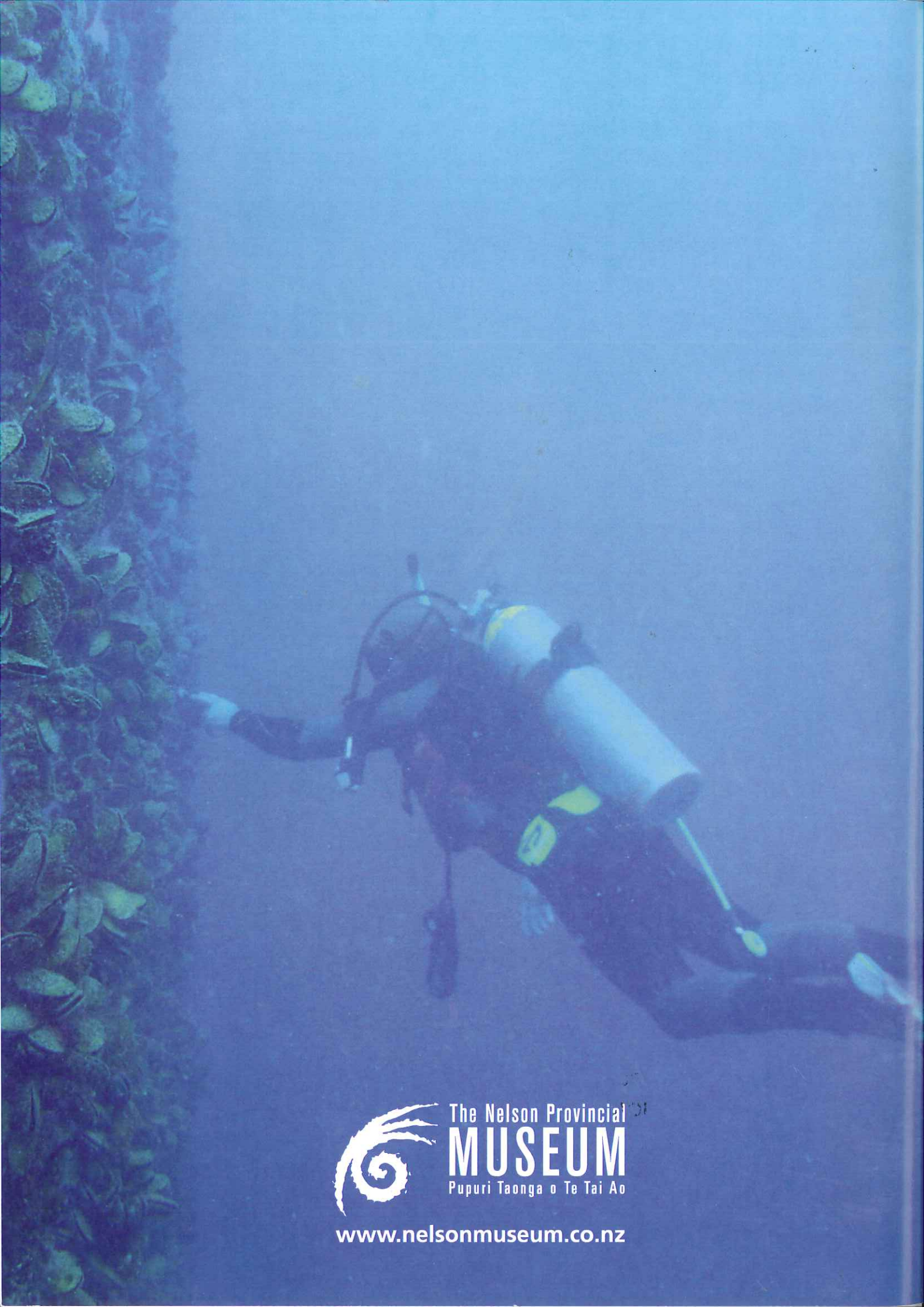

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MUSEUM
Pupuri Taonga o Te Tai Ao

www.nelsonmuseum.co.nz