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Foreword

Water is the world's most valuable resource. There is no doubt about it.
It has been stated by analogy, "If the all the fresh water of the world was represented as filling a one litre container, we are at present using the last unspoiled drop." If this seems hyperbole (an out of the ball park exaggeration) it is not.
In fact our future depends on how we manage our water resources and our aim is to get as many people involved in stream and catchment restoration as possible.

When designing and compiling the programme: **The Whitebait Connection — Stream and Catchment Restoration,** I have had the benefit of examining other programs existing in New Zealand and in Australia. I have integrated, I hope, some of the best and most germane ideas into it. Repeatedly I have been humbled and grateful for the immense helpfulness and cooperative spirit amongst those operating other programs (a unique experience in today's User Pays environment).

This manual has depended on the help and input of a number of sources.
I would like especially to mention, The Stream Sense Program (Environment Waikato); The Waicare Programme (Auckland Regional Council); Adopt a Stream (Environment Southland); Streamwatch (Sydney Water, Australia); SHMAK (NIWA); and Stephen Moore (Otago Regional Council).
Special thanks also to TJ Hanlon for some inspired editing.
Last but by no means least, I would like to thank Vince Kerr without whose original ideas and many hours of thought, discussion and hard work this manual might never have come into its present form.
Also I would like to thank all those community groups and schools that have already taken a part in the programme to date. Your efforts, commitment and enthusiasm have given me something that scientists often lack, the satisfaction of knowing the downstream effect of science will be a legacy - not a burden.

November 2001 — Stefan Seitzer.

It has been said that the day we successfully manage our freshwater resources, we would have solved all our land management issues in the process

Introduction

"Welcome to the Whitebait Connection,"

The way we use our land directly affects the health of our streams, rivers, estuaries and the sea. It affects us all.

By looking at the life in a stream, we can draw many conclusions, about the state of health of the stream and about the lands that surround it.

The name "Whitebait Connection" was chosen because these fish species connect us with the sea, through the streams and the rivers. And because of their distinctive habits whitebait tell us how well we are managing these bodies of water and the surrounding lands.

Whitebait is a collective term describing the juvenile stage of six species of native freshwater fish that migrate in large, mixed shoals from the sea to freshwater rivers and streams during the spring season. The species include inanga (Galaxias maculatus), banded kokopu (Galaxias fasciatus), koaro (Galaxias brevipinnis), giant kokopu (Galaxias argentus), shortjawed kokopu (Galaxias postvectis) and common smelt (Retropinna retropinna).

Schools and community groups that participate in the Whitebait Connection will also learn about freshwater bugs or macroinvertebrates, as they are known. The term invertebrate refers to life forms without spines. In this case they are basically insects whose larval stages occur in streams and rivers and that feed on algae, leaf litter or other invertebrates.

These creatures are not only indicators of water quality, (as some are more tolerant to pollution than others) but they also form the primary food source for our freshwater fish.

And the freshwater fish? Why they in their turn, are on the menu of the kahawai and the kingfish that swim into the estuaries to feed. Since the kahawai itself is an irresistible morsel for a hungry marlin you can see how in ecological terms, our world is one big food chain. Our actions on land are linked to the water quality, to what life can be sustained by it, then to the whitebait, to the coastal fish stocks and

even to the mighty marlin.
The Whitebait Connection offers concrete and specific ways in which ordinary people can come to understand and become involved in the future health of their local streams and rivers.
It offers them a chance to be part of a greater legacy for us all, now and in the future.

A Friendly Reminder.

In the course of our investigations, you will be travelling over some strange territory. You will come across terms you have never heard before, place names, and the names of the native inhabitants and scientific words used to denote and sort them. Don't be alarmed. Don't be put off or dismayed. We are providing you with roadmaps, with brief explanations, and a solid Glossary of terms. When you have read them, you will wonder at how much you have learned and how much we have still to find out!

Programme Contents:

The programme includes this manual, a CD ROM PowerPoint
Presentations, freshwater bug and fish monitoring kits, catchment and habitat assessments, curriculum-integrated activities and links to other programmes nationally and globally.
The Whitebait Connection Stream and Catchment restoration
programme was developed with the support of the Department of Conservation — Northland Conservancy.

Our Vision

Our vision for this programme is:

- to get schools, tangata whenua and community groups actively involved in stream and catchment restoration throughout the Northland region;
- To provide ongoing support for all participating groups and schools, creating links to similar programmes operating nationally and globally;
- To provide a better understanding of the distribution and the abundance of whitebait and other freshwater fish species in Northland
- and to strengthen the relationship between the Department of Conservation, schools, community groups and tangata whenua.

This manual will show you how:

- to carry out meaningful investigations into the state of health of your local catchment
- to feel the pulse of life in your streams and rivers through water bug (macroinvertebrate) surveys, freshwater fish and habitat assessment
- to use the clues that these activities will provide to take the first steps in restoring your catchment
- to integrate the Whitebait Connection Programme into your curriculum
- to get help or more inspiration via a comprehensive network of contacts and links.

If at any stage you encounter words or phrases you are unfamiliar with, please refer to the glossary section on page 60.

Our approach

The Whitebait Connection focuses on a biological/ecological approach. We look at all the life forms and their relationships in and around a stream. We investigate living things like types of water bugs, species of freshwater fish and the abundance of plants in a particular catchment. Information gained will assist us all in managing our land and natural resources more appropriately. It will provide a legacy to those seeking to better the planet and set new standards in our own areas.

We have also included references and contacts for groups or individuals interested in the physical and chemical aspects of water monitoring.

Note: As this programme and its manual are designed not only for community groups and tangata whenua but also for schools, you may come across sections or paragraphs referring to a curriculum, or school specific issues. If you belong to a group other than a school you may want to skip those paragraphs.

Another Dimension in New Zealand:

In Aotearoa we are fortunate enough to be able to add another dimension to water.

As water was seen as a great source and sustainer of life; a vital link and a messenger; so also was it seen as being able to “bite back”, wreak vengeance, havoc, flooding and in the worst cases dry up.

Our Maori culture incorporates spiritual realms for the different degrees of purity or impurity of water and this is significant. The water cycle and this awareness and knowledge base are born of a thousand years of experience.

He Timatanga

Waiora

Waiora is the purest form of water. It is the spiritual and physical expression of Ranginui, the sky father in his longed-for embrace with Papatuanuku, the earth. Pure water is termed Te Waiora a Tane, and to the Maori it contains the source of life and well being. Waiora is used in sacred rituals to purify and to sanctify. The rain is waiora, contact with Papatuanuku gives it its purity as water for human consumption. Water can remain pure, as waiora, only if its contact with humans is protected by (-) appropriate ritual prayers. Waiora has the potential to give life, sustain wellbeing and counteract evil. At particular wahi tapu (sacred sites), the sacredness of the prayers and the purity of the water reinforce each other. But if one is damaged, then so too is the other. At Waitaiki, Arahura, the mauri of the river, the mauri of the pounamu (greenstone) and the mauri of the Kai Tahu, the tangata whenua, are inextricably linked.

Waimaori

Water becomes waimaori when it comes into unprotected contact with humans. It becomes Waimaori in contrast to Waiora because it is normal, usual or ordinary and has no longer any particularly sacred associations. Waimaori is the term used to describe water running freely, or unrestrained, or to describe water which is clear or lucid. Waimaori has a mauri that is generally benevolent and can be controlled by ritual.

Waikino

As with other terms describing water, Waikino has both spiritual and temporal meanings. In the temporal sense Waikino is the term used to describe water, which is rushing rapidly through a

Gorge, or water where there are large boulders or submerged snags, giving the water potential to cause harm to humans. In the spiritual sense, Waikino is water, which has been polluted or debased, spoiled or corrupted. In Waikino the

mauri has been altered so that the supernatural forces are non-selective and can cause harm to anyone. Despite protests and warnings of the potential danger, sewage ponds were constructed at Whaingaroa (Raglan) on the site of one of the lairs of the guardian taniwha Te Atai o Rongo. That site is now considered debased and as a consequence the people there believe that the guardian mauri of Te Atai o Rongo has the potential to cause ill fortune or calamity, as does the Waikino of that place.

Waimate
Waimate means water that has lost its mauri, or life force. It is dead, damaged or polluted water, which has lost its power to rejuvenate itself or other living things. Waimate, like Waikino, also has the potential to cause ill fortune, contamination or distress to the mauri of other living or spiritual things, including people, their kaimoana 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. The waters of the Manukau have been described as Waimate because of extensive industrial contamination and sewage pollution.
Waimate has also a geographical meaning, it denotes sluggish water, a backwater to a main stream or tide, but in this sense
Waimate retains its mauri.

Waitai
Waitai is the name used to describe the sea, the surf, or the tide. Waitai has another meaning, rough, angry or boisterous, like the surf or the surge of the tide. The term Waitai is used to distinguish seawater from fresh water (Waimaori). Although Maori people did not fully comprehend the water cycle as taught in the elementary science syllabus, particularly the cycle of evaporation and precipitation, waitai is water that has returned to Tangaroa in the natural process of generation, degradation and rejuvenation. Such a notion does not seem to be antithetical to modern science.

Edward M. K. Douglas

The Whitebait Connection - Getting Started

Levels of Investigation

The Whitebait Connection catchment monitoring and assessment programme consists of three levels of investigation:

1) Catchment investigations focusing on research and documentation of the physical, biological, social and political features bearing on your catchment.

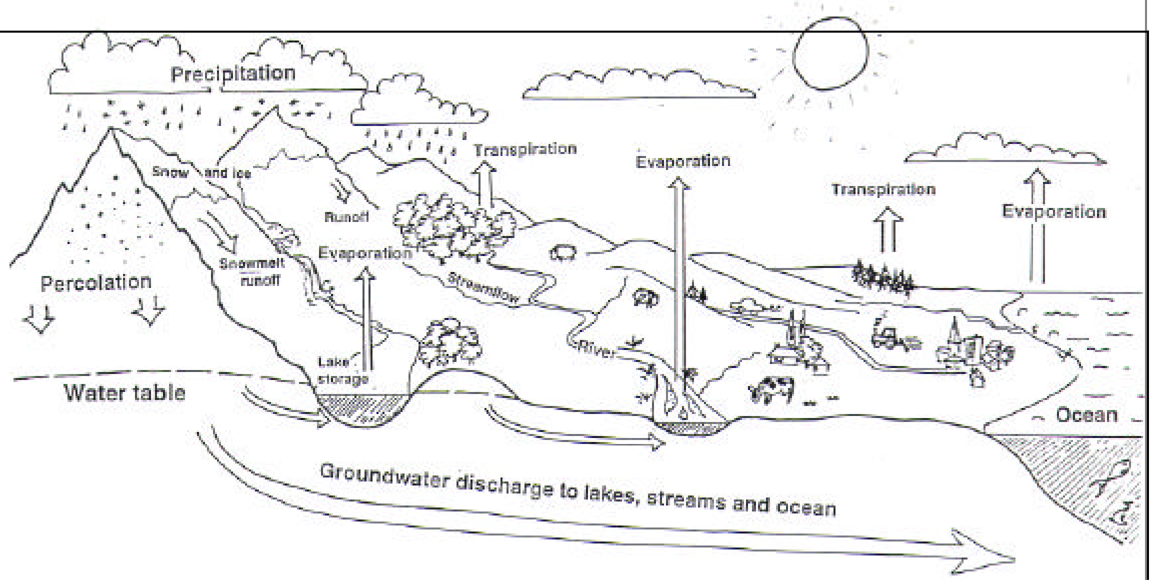
2) Habitat survey and assessment for an overview of the physical and biological setting of your monitoring sites. (Information gained is used to back up the interpretation of your monitoring data.)

3) Site investigations to assess the health of the stream through biological surveys at sample points along the stream (Site investigations can be used to gauge overall stream condition if the selected sites are a reasonable representation of the stream system.)

Catchment

CLEAN, FRESH WATER is something most New Zealanders take for granted. In our homes particularly, we expect water to be available in limitless quantities whenever we need it. But if we begin thinking about water in a global context, it's not hard to appreciate just how fragile this resource is.

All water is part of what's known as the "hydrologic cycle" which, in a simplified form looks like this:



The Hydrologic Cycle

The cycle could begin, for example, with rain or snow, falling in a mountainous region. Snow may be trapped for various lengths of time in snowfields and glaciers before it melts while rain water may run into small streams, which flow down to lower altitudes. Small streams can merge to form larger streams, rivers and perhaps lakes, while other water might sink into the earth to become groundwater that sometimes reappears as springs. Ancient water supplies still exist today trapped deep underground in natural rock basins or contained between various impermeable (non porous) strata. Rain is also retained in the soil where plants take it up and a proportion is transferred back to the atmosphere via plant transpiration[1]. Yet other water evaporates from surfaces such as rocks, standing water and leaves and goes directly back into the atmosphere.

The fresh water flowing in streams and rivers eventually ends up in the sea. Groundwater and lakewater also tend to move towards the sea, but much more slowly.

Major evaporation occurs from the vast area of the open ocean under the influence of global circulation patterns. Vast air masses move over the sea collecting water vapor and then move from areas of high to low pressure. When they meet any mountainous land mass the air is forced to rise, where it cools; any water in the air condenses into clouds and eventually rain ... and the cycle begins all over again.

The moment water vapor condenses into liquid and falls as rain on to the land it becomes a usable resource. We know also that it can also be contaminated, both on its way down and after it meets the land. Whilst at almost all stages of those parts of the hydrological cycle occurring on land, water may be intercepted or extracted for human use the proportion of the usable water at any given time is extremely small. The facts below will give you an idea:

Of all the water on Earth, 97.2% is seawater. Of the remaining (fresh) water, 2.24% is trapped in ice caps. Groundwater accounts for 0.61% and lakes for just 0.009%. The atmosphere holds about 0.001%. All this means that the amount of water flowing in streams and rivers at any one time is an almost negligible 0.0001% of the Earth's water (figures from Allan 1995).

Because our country is sparsely populated and its position, isolated in the middle of the ocean resulting in frequent rainfall, many parts of New Zealand seem to be disproportionately well off for fresh water. In addition, New Zealand's geological make-up has led to the formation of many lakes, which store large volumes of fresh water.

Nevertheless, the uneven distribution of the population and rainfall mean that even here we have water shortages and problems with water quality. In a global context our water crises are relatively minor, but we still cannot afford to take water resources for granted. Ideally we will manage our catchments so that rainwater flows through to

[1] Transpiration: water loss through pores (called stomata) on leaf surfaces.

lakes, rivers and streams with minimal degradation. Ideally we will also look after the water once it is in lakes and watercourses.

The most serious pressures on our water environment, according to the 'State o the N.Z. Environment' report released by the Ministry for the Environment (1997) are:

a) From pastoral agriculture and cropping/horticulture:

- Sediment, animal waste and nutrient contamination of surface water by agricultural run-off;
- Flooding and erosion caused by the removal of deep-rooted vegetation;
- Nitrate contamination of groundwater;
- Loss of natural character and habitat quality of stream environments through drainage, channelisation/diversions, and the removal of riparian vegetation;
- Invasion of plant and animal pests.

b) From urban areas:

- Increasing consumption of water,
- Sewage and storm water discharges. Storm water may pollute the receiving waterbody with sediment, toxic substances (e.g. heavy metals and hydrocarbons derived from motor vehicles). Contamination with human wastes may also occur when storm water gets into and floods sewage systems. Stormwater quality is often similar to that of secondary-treated sewage;
- The removal of riparian vegetation and destruction of aquatic habitat;
- Flow fluctuations caused by reduction of infiltration and increasing the amount of solid surfaces. (In cases of development, building structures and the surrounding services, tarmac etc, combined with the removal of the pre-existing soil types will completely alter the pathways and natural dispersal of water.)

The scope for finding a suitable issue in our 'backyards' is, unfortunately, virtually limitless; witness some sobering quotes:

"…some lowland rivers are unsuitable for swimming because of faecal contamination from farm animals, poor water clarity, and nuisance algae growths. The stream water in some intensive dairy farming areas is in such poor condition that it may be unsafe even for livestock to drink. The lower reaches of some rivers are also polluted by discharges of industrial wastes, urban sewage and stormwater run-off".
The State of New Zealand's Environment, 1997

By defining why we want to do water quality monitoring, decisions on which tests to conduct; where we will conduct the sampling and how often we will sample is made easier.
Most water quality studies are comparisons of one type or another. Perhaps the catchment inventory led us to suspect that a particular land use is adversely affecting our stream. We may want to carry out an impact analysis of that particular problem. How will we go about it?
Helpful Tip: Carrying out upstream/downstream assessments will enable us to deduce and compare the health of the stream before and after it was exposed to any alleged effects.

What is a catchment and what are some of its parts? (This section will help us to look beyond the stream, and learn about the land that surrounds it.)

The amount of water carried by a stream, the shape of the channel, the fish, water bugs and plants, living in and around the stream, are determined by its catchment. In that sense we may say, a catchment is the area from which the water gets its life and sustenance. We will see the size of catchments may vary considerably but regardless of that, bad practices in any area of a catchment will have considerable impacts. **Remember a stream is only as healthy as its surrounding catchment.**

Everybody lives in a catchment

A **catchment** is a basin shaped area of land, bounded by natural features such as hills or mountains from which surface and sub surface water flows into streams, rivers and wetlands. Water flows into and collects in the lowest areas in the landscape.

The system of streams, which transport water, sediment and other material from a catchment, is called a **drainage network**.

A catchment catches water as it falls to earth as precipitation (rainfall) and the drainage network channels the water from throughout the catchment to a common outlet. The outlet of a catchment is the mouth of the main stream or river and this may be where it flows into another river or stream, or a place where it empties into a lake, estuary, wetland or ocean.

Catchments may be quite large such as that of the Waikato, which begins in Tongariro National Park, includes most of the Waikato region and extends to the ocean just south of Auckland. Or they consist of a myriad of small catchments similar to those that drain Mt Taranaki.

Tributaries refer to small feeder streams that empty into larger streams or rivers. The catchments of tributaries are referred to as sub-catchments.
(Large catchments are often made up of a large number of smaller sub-catchments. For example, the catchment of the Buller River contains eleven major sub-catchments.)

Whatever happens in the smaller streams affects the overall well being of the main waterway.

What does your catchment look like? How do we find out?

It is quite a simple task to trace our catchment boundaries and drainage network from a topographical map onto tracing paper, and to examine the pattern of streams and rivers that cover the reaches of our catchment.

What will we notice?
No catchment is exactly like another. Each has a different size, shape, drainage pattern and features that are determined by natural processes, particularly geology and climate.

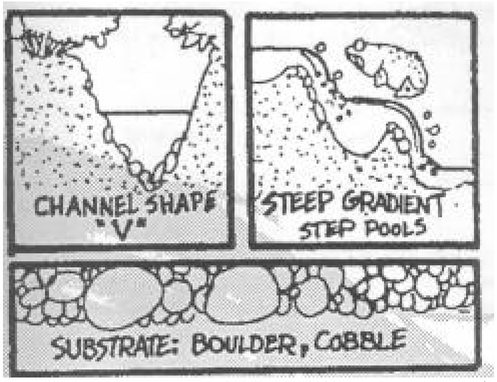
The geology of our catchment will influence many of its characteristics, from the stability of stream banks and streambeds to the natural pH of the water. (pH is a scale used to denote alkaline or acid levels.)

The climate and its processes have an enormous bearing on the land we live in. Wind and flowing water erode and shape the land. Rocks are broken down into smaller pieces by the wear and tear and are transported in the flow of water. Fine materials move as sediment throughout the catchment. The very soil that blankets the land and nurtures us was once rock and organic matter that has been transformed.

We will notice soils have different textures, mineral content, structure and drainage properties. The nature of the soils in our catchment plays a key role in the way water runs off the land and how likely that land is to erode.

Upper Catchment-

The Headwaters and the streams.



Streams begin their journey to the sea in the upper reaches of the catchment. Some may appear briefly, and flow only during periods of intense rainfall while some are intermittent, flowing during the wetter seasons of the year. Others are more permanent, having year-round flow.

If the stream is on a steep gradient it will be fast flowing and energetic. This energy permits it to carry large amounts of material and large pieces of rock and gravel which erode from the streambeds and banks.

In the upper reaches streams tend to be narrower and riparian vegetation almost completely covers the stream with its canopy. Very little sun reaches these points, so the water temperature remains cool throughout the year.

Low light levels restrict algal growth, and upstream plant eaters (herbivores) rely mostly on food material from outside the stream, example: leaves, fruit, seeds, twigs and bark. In time this coarser material is made fine by physical abrasion and microbial activity.

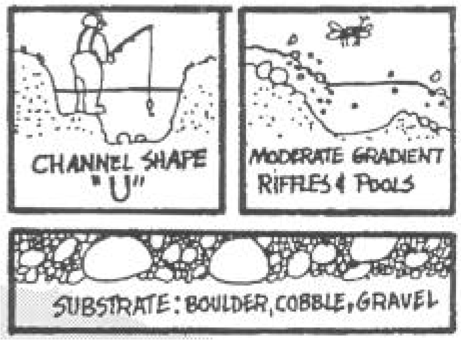
Still more processing might be done by macroinvertebrate 'shredders', but there are not many in New Zealand streams. It is the "collector-browsers" that tend to dominate in these upper reaches. But coarse organic debris, especially larger woody debris, also provides habitat for stream life.

In headwater streams that are not shaded by stream bank vegetation, attached algae and rooted aquatic plants produce most of the available food.

Headwater streams in unforested areas also tend to show greater seasonal and daily changes in water temperature. In these streams, sunlight and air temperatures have greater affects on water temperature.
Rocks, pebbles and bedrock are characteristic of fast-flowing headwater streams, and these substrates (surfaces where life is found, often referring to lake or streambeds) are usually well sorted here. The rocks, pebbles and the moss etc, growing on them provide many habitats for aquatic macroinvertebrates, as well as good cover for fish enjoying a diet of unwary or wandering forest i nsects.

The headwaters of a river system as we can see, are very important to the health of the entire river insofar as they are important areas of habitat for creatures, which provide food sources for life further downstream.
If we imagine now how the upper reaches are linked to the waters further down we might predict how dams and weirs could restrict the distribution of food and the movement of aquatic animals.

Middle Catchment



By the middle reaches of the catchment some tributaries have entered the stream and added to the flow. The land is generally flatter here and the flow of the stream is slower. There are frequent shallow areas of faster moving water called riffles, where rocks break the surface and deeper areas of water called pools. The bottom substrate here is mostly composed of gravel and cobble.

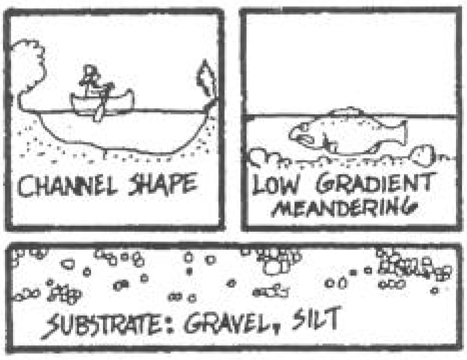
The channel has widened into a 'U' shape and we can usually detect a flood plain (a flat area beside the stream bank). The stream regularly overflows onto this area, slows, and then dumps its load of sediment.

We will notice the stream often flows across the flood plain in curves or meanders. Usually there is a combination of erosion on the outside edge of the bends, where the water flow is more rapid, and sediment in areas where the water flow is slower.

In these middle reaches the canopy no longer reaches across the stream to shade the entire water surface. Here the sun is able to warm the water, raising water temperature throughout the day. Slower flows, together with the murkier water in these reaches may also increase the heat. Seasonal changes in water temperature are usually the greatest in this middle section.

Organic debris still falls into the stream from the riparian zone but as the amount of light increases, algae become an important part of the food base. Now we begin to see the growth of periphytonic organisms (plants like algae found at the streambed) as the warmer temperature and slower flows favour them. Microscopic or tiny plankton are detectable too in upper, more lighted layers of the water and as the nature of the food base is changed there is also a shift in the kind of life we will expect to find. Grazer and collector macroinvertebrates dominate this section of the stream.

Lower Catchment



Moving downstream to the stream's mouth, more tributaries have entered and added still more flow. The wider, deeper channel meanders through a flat flood plain and broad valley. The stream travels very slowly and deposits the large quantities of sediment it has been carrying from further upstream.

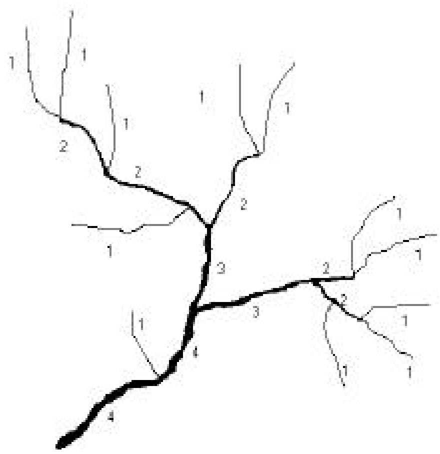
Although the water is unshaded, the murky water limits sunlight penetration, but some attached algae may grow in the shallows if stones or other suitable substrate are available. Fine particles may also replace organic debris and algae as the food source.

What else will we see?
The communities of small aquatic organisms are changed once again. "Collector filterer" macroinvertebrates are more common in this stretch of the stream, where they filter out accumulated minute particles suspended in the water and gather fine particles that have settled to the river bottom.
In slower stream reaches, there is less spread of atmospheric oxygen in the surface water. This causes even lower dissolved oxygen levels in the streambed sediments and slows down the breakdown of organic matter and reduces the dissolved oxygen levels in the sediments even more. Organisms that tolerate lower oxygen levels and that prefer slower flowing water are consequently more common in the lower section of the stream.
At its mouth the stream or river empties into another body of water and (since it is often carrying undeposited sediment, debris and other substances) lakes and estuaries, which it meets, may be damaged by them. Estuaries particularly are sensitive environments and their role as a nursery for fish is easily disturbed.

Stream Order

We often classify streams by their sizes. Within any catchment the smallest streams that have year round flow and no tributaries are called "**first order**" streams. When two, first order streams meet they form a "**second order**" stream. A "**third order**" stream is formed when two, "**second order**" steams join, and so on…

Stream order only changes when two streams with the same classification meet. For example, when a first order stream meets a second order stream the resulting stream remains a second order stream. (See following diagram.)



The above diagramme shows a drainage network for a fourth order watershed

Understanding our Catchment

Learning about a stream and its catchment can be quite an adventure.

As we investigate our catchment, we will discover information about its natural and cultural resources, history, its use (and abuse) by people and wildlife. Moreover we will discover facts about the health of its waters. Getting to know our catchment is an important step in our Whitebait Connection programme. Investigating it will enhance our sense of connection to the catchment and its watercourses.

Since everything that happens in the catchment affects the stream in some way, by making a catchment inventory we will get the "inside line" on what's really happening on the land that drains into our streams. We will get raw data and be able to piece together how the various activities may be affecting it.
The inventory process will help us better identify and design our stream monitoring objectives and give us some great experiences.

Investigating our catchment is best done in three parts:

1. Firstly, we will identify the boundaries of our catchment and make a working (base) map

2. Then, we'll gather all of the available information we can about our catchment.

3. Next, we will get "out there" and conduct a "field" assessment of the catchment.

If we choose to work on a larger stream or river system it will be best to focus on the sub-catchment that is in our 'neighborhood'. By combining our research and findings with other groups working upstream and downstream we may be able to create a more comprehensive picture of the "total" catchment.

Catchment Maps and how to use them.

There are many types of maps that might be useful to us but the most important tool to start with is the **topographical** map.

Topo' maps can be used to determine catchment boundaries. The most detailed topo' maps are from Terralink and have a scale 1:50,000 (2 centimeters on the map equals one kilometer on the ground)

Terralink topo' maps convey basic information on land surface features, such as elevation, location of water features, transport routes, vegetation, and some on land usage. Topo' map code numbers and grid references are commonly used in reports to describe locations within the catchment.

Some councils are able to create sub-catchment maps from their GIS (Geographical Information System) computer database. Many **GIS systems** can superimpose requested data on top of topographical information – different land uses; industrial, urban and commercial areas; stormwater drainage systems; sewerage systems and sewerage treatment plants; roads, railways and power lines; parks, playing field and golf courses; rubbish dumps. The available information depends on what is contained in the GIS database and as things change quite rapidly they can never be totally up to date,

Aerial photographs too are often very useful for determining the type and extent of agricultural activities. By comparing aerial photographs made on different dates, we can see land use changes occurring between photographs. Aerial photos taken of our stream or river's outlet to the sea following a storm can be very revealing. **Landstat images** may show more broad-scale features of catchments and the wider landscape.

Other types of maps may be helpful with our catchment inventory. The Department of Conservation has maps that show areas of special ecological value and the distribution of flora and fauna. Some local councils have maps that show similar features, such as 'significant ecological sites', 'significant natural areas', and reserves.

Property titles may be useful if we want to determine the boundaries of properties.

Creating our Own Catchment Map

The following exercise will help us become familiar with our catchment and its boundaries. We need to cut and paste several topographic maps together if the stream system we are studying has an extensive catchment.

Determining The Boundaries of our Catchment — the first steps.

1. **Finding the outlet point to our catchment.** To do this we look for the lowest elevation in our catchment and in most cases will be the mouth of our stream.

2. **Tracing the stream from its mouth to its tributaries**

3. **Identifying the boundaries,** (The boundary of the catchment, will be located on the ridgeline above the smallest streams that drain into our stream.)

4. **Drawing a line along the ridges so that the ridgelines join** will give us the boundary of the drainage basin.

Highlighting Features on our Map

If we highlight our stream and its tributaries, we will be able to see the pattern of the stream network. Counting off the number of tributaries we will try and classify the various streams into their orders. (See section above on Stream Orders.)

We can work out the length of our stream by laying a piece of wet string along its length. Using the scale on the map to calculate the length of the stream/s. (We must remember to make scale adjustments if we change the size of the map when we photocopy).

We will show the position and size of other surface water features, such as lakes and wetlands.

We will trace out roads and tracks, the outline of settlements/towns/cities and district boundaries.

Drawing the area marking off various land-uses on our base map we will **Create a key**, such as a specific symbol or color, to identify each type of land use on the map and then name them.

Pinpointing other features of significance on our map such as dams, areas of ecological significance and historical sites we will be sure to include recent changes that have taken place in our catchment, such as new housing developments.

The following catchment inventory sheet contains an extensive list of features that we could research and add to our map. By building up this detailed picture of our catchment through our own observations, local knowledge and collaboration with government agencies and special interest groups, we will have a clearer understanding of the pressures and influences on our watercourse. Moreover we will be in a position to anticipate threats to its health. This will enable our group to select the most appropriate and useful site(s) to monitor depending upon our interests and purposes.

It is always a good idea to make some photocopies of this catchment map. These copies will be working maps. We can label or mark the copies with different features, land uses or structures or make clear overlays to layer onto a base map. We should take one of the copies into the field to check some of the map's features and include a copy of our map in our field trip report.
We will need to write a summary of the disturbances to the watercourse, riparian zone, flood plain and wider catchment since settlement. We will list the current sources of potential and actual pollution on a catchment basis and in particular those upstream of our site.
Clues relating to the above may include dead upright trees in the water, unhealthy looking aquatic plants (pale green or covered in a brown furry coating). They may include bare banks, eroding banks, stock access to the water, increased sedimentation, drains and effluent pipes. We may

detect unpleasant odors, unusual water coloration or clarity, black smelly sediment, surface scum or film, white sewage fungus, plenty of algae (either surface algal blooms or stream bottom filamentous algae).

The land use catchment map we compile might become a very valuable resource for our local council, government agencies and community groups, and not just for our group. It could later form a "historical base map" upon which future changes can be plotted or overlaid.

What a catchment inventory consists of, and what the Catchment Inventory check sheet looks like…you will find at the following page.

Catchment Inventory Assessment Sheet

Discovering information about our catchment – the stream, the land surrounding it and the activities that may affect it.

Catchment Location

Catchment name ________________________ Topo, map number/s _____________________________

Begins in ________________________________ Flows through ___________________________________

Ends in _______________________________ *(name town, district, region, etc.)*

Drains into _____________________________ *(name body of water e.g. lake or river)*

Catchment area _________ km^2 Approx. length km__________ Width km_________________

Highest point ____________________________ Lowest point ___________________________________

Climate

Average annual precipitation_________ mm Most precipitation occurs (months) _________________

Flood frequency (month/s, year/s) ____

Coldest month of year ___________ Warmest month ____________ Yearly temp. range ____________

Geology/Topography

Describe briefly the geological history that shaped your catchment _________________________________

____

Describe the physical characteristics of different reached of your catchment: _______________________

____

	Upper Reaches	Middle Reaches	Lower Reaches
Valley shape ('V', 'U' or wide flat U shape			
Gradient (steep, medium, gentle)			
Channel sinuosity (straight, meandering)			
Bottom substrate (cobble, gravel, etc)			

Predominant rock types present: igneous ✍ metamorphic ✍ sedimentary ✍

Name the most common type of rock:

Fish

Native species (circle if endangered or threatened) ______________________________

____

Abundance ____

Introduced species (circle if presence threatens native species) ______________________

____

Abundance ____

Any suspected barriers to fish migration? ____________________________________

____

Wildlife

Native species (circle if endangered or threatened) ______________________________

____

Introduced species (circle if they should be threatened!)___________________________

____

Key wildlife habitat areas____

____

Location of 'Protected Natural Areas'[1] and/or 'Areas of Ecological Significance'[2] ______________

____

Significance of these areas____

____

[1] Contact the Department of Conservation. [2] Contact your local council.

Historical

The earliest human inhabitants were ____________________ Date ______________

Reasons for settlement____

Describe the subsequent settlement of your catchment_________________________________

____

Significant cultural and historical features of your catchment___________________________

____

Demographics

Population of your catchment __________________ Projected population in 10 years __________________

Population 10years ago____________ 50 years ago___________ 100 years ago_______________

Land and Water Uses

Estimating the percentage of our catchment zoned for each land use and the activities that are permitted.

Rural residential _____________% densities (average size of blocks) ____ ha.

Urban/suburban residential_______% densities (house per ha.)____________

Commercial _____________% ✍ light commercial ✍ heavy commercial

Industrial _____________% ✍ light industry ✍ heavy industry

Agricultural _____________% ✍ grazing ✍ crops ✍ feedlots ✍ dairy

✍ Other (state)

Forestry ______________ % ✍ clear-cut ✍ selective ✍ farm forestry

Quarrying/mining ________________ % type of activity__________________________________

Parks/open spaces_______________ % ✍ swimming ✍ boating ✍ fishing_________ ✍ other

Other recreation ______________ % ✍ golf course✍ skiing ________________________ ✍ (

Percent of the catchment that is: public land _____________ % public land_______________ %

Percent of catchment covered with impervious surfaces_______________ %

Sources of domestic water supply for catchment residents ____

Location of sewerage treatment plants (if any) ____

Areas that rely on septic tanks ____

Altered hydrology (dams, diversions, culverts, drained wetlands etc.):

Type of alteration	**Location**	**Purpose**

Water quality

List any sources of pollutants ____

Are they emanating (coming) from a single identifiable (point) source or diffused? (spreading from somewhere else)____

Habitat Assessments

As the diversity and abundance of stream life is limited by the quality of the habitat so also is the in-stream and riparian habitat influencing the structure and functioning of your stream community.
For example: if the habitat is already poor it may make it more difficult for us to determine or evaluate the effects of pollution on the stream. Biological communities may be responding to two different sets of adverse circumstances. It would be essential if this were the case, that we use a reference site.

(Assuming you were trying to determine the effect of a particular stormwater outlet, you would have to carry out habitat and biological surveys at an upstream reference site, with characteristics closely matching your study site. And compare those with the survey of the downstream study site.)

The habitat features used for this assessment activity are separated into two groups:

?? within the stream *(instream cover; riffles, pools and bends; embeddedness,)* and
?? adjacent to the stream channel *(bank erosion and stability and riparian zone vegetation)*

Stream habitat has the greatest direct influence on the structure of the stream community. Features of the riparian zone and stream bank are important but have less direct impact on stream life. These factors usually influence the quality of the stream habitat in the long term and this relationship is reflected by the score range (1-4).
In the following pages we will see a definition and explanation of the above mentioned habitat features. Each one is significant and well worth keeping an eye out for.
Remember, "The more you look the more you will see. The more you begin to understand, the more you will notice."

In-stream cover

Fish and other aquatic organisms require stable natural features such as rocks or cobbles — areas and places where they can shelter from predators and swift currents. In-stream cover is also important for reproduction, particularly spawning and nursery functions. Large aquatic plants (macrophytes) and undercut banks may also be very important to the fish in our streams, particularly if other forms of cover or refuge are not available.

Helpful tip: You will be looking for useful forms of cover, including snags and logs under the water, undercut banks, cobbles and rocks, and plants in and overhanging the waterway.

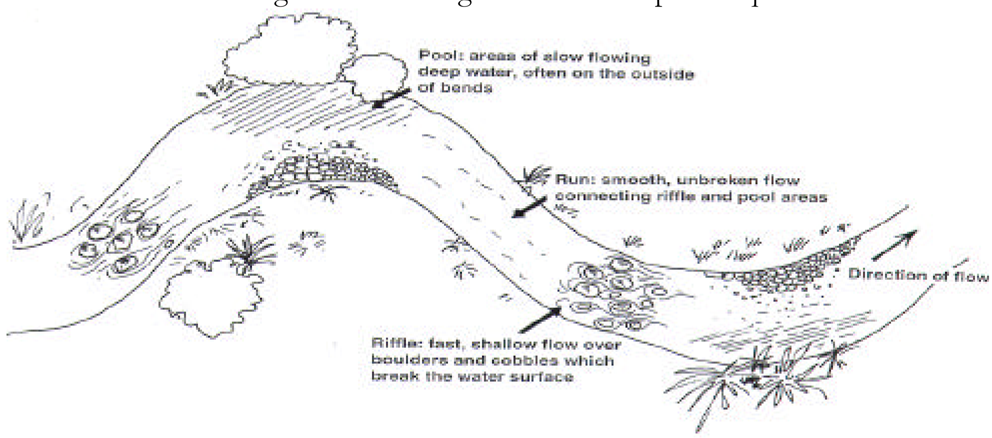
Riffles, pools, runs and bends

Riffles are important for aerating the water and providing habitat for many of the more sensitive invertebrates. Streams that have a number of pools and riffles are able to support more life and greater variety of species than those that do not vary much in their character.

Slower flowing streams without riffles may provide habitat diversity through bends, creating areas with different depths and current speed.

Tip: Look for variety in flow types - riffles (water running over rocks, cobbles etc.), pools of varying depths and the presence of bends.

Diagram illustrating the run–riffle–pool sequence in a stream



Embeddedness

This is the extent to which rocks (gravel, cobble, and boulders) are buried or surrounded by fine sediment. Rocks may become smothered when large-scale sediment inputs occur upstream. Reduced stream flow may in turn speed up deposition.
As rocks become embedded there is less space between and under rocks for colonisation and the stream community will become dominated by groups such as worms and midges.

Look for how much of the streambed is buried by silt or fine sediment.

Observations of embeddedness should be taken in the middle of rocky/cobbled areas. Reaching into the stream and unplugging a few rocks is a good way to estimate the covered depth when we find it difficult to estimate by sight alone.

Bank erosion and stability

Stream banks naturally erode, particularly on bends. However, changes in adjacent land areas can cause a stream to become unstable, resulting in continuous erosion along its channel. Such changes include increased run-off from impervious (hard) surfaces and piped 'streams', stock access, or direct interference such as straightening or channelling the stream. Steep banks are generally more likely to collapse and suffer from erosion than are gently sloping banks. Streams with banks in poor condition will often have poor instream habitat and introduce sediment into the stream.

The soil on banks is held in place by plant roots. Deep root systems offer greatest bank protection but shallow root mats also protects the surface of the bank against the abrasive effects of water. The more diverse the plant community on the banks the better. Young plants, which grow and reproduce rapidly, are better than old plants. The depth of plant root systems becomes more important as height and slope of the stream bank increases.

Make assessments of bank stability and notice the kinds of plants on the bank.

Riparian zone vegetation

The vegetative zone serves as a buffer to pollutants entering the stream from runoff, controls erosion, provides habitat and contributes nutrients, in the form of plant matter such as leaves and twigs, to the stream. Grasses and small shrubs next to the stream also provide escape cover or refuge for fish.

Streams in urban settings often have little or no riparian vegetation. These areas are often 'cleaned up' during the construction parking areas, housing or roading and never restored afterwards. In this way the effectiveness of the riparian zone is diminished as vegetation is removed, and the width reduced.

Tip: Keep an eye open for how vulnerable the stream is, to input from adjacent land users, and the amount of vegetation on the banks.

We can find out how good the habitat is in and around a stream by looking at the features on the following page.

Habitat Record Sheet

Investigating the opportunities for different types of stream life to colonize and live successfully in your stream.

Score **stream habitat** from 8 to 2, and the **stream bank features** from 4 to 1.

Stream Habitat Features

Stream Habitat Features	**Excellent** **8**	**Good** **6**	**Fair** **4**	**Poor** **2**
1. Instream Cover *Does the stream provide protection and 'cover' to stream life?*	More than half of the stream has cover, including snags and logs under the water, undercut banks, cobbles and rocks of various sizes. Many plants in and overhanging stream.	One half to one third of the stream has cover of snags, logs, cobbles or rocks. Some plants in and overhanging stream.	Less than a third of the stream has cover from snags, logs, cobbles and rocks. Few plants in or overhanging stream	There is very little or no cover provided in the stream and no plants in or overhanging stream. The stream may have been cleared or altered by humans.
2. Riffles, Pools and Bends *Does stream flow vary?*	Wide variety of flow types: riffles (water running over rocks, cobbles etc.) and pools present of varying depths. Bends present.	Some variety of flow types: e.g., riffles and pools. Variation in depth of riffle and pool.	Only slight variety in flaw: e.g., occasional riffle or bend. Some variation in stream depth.	Uniform depth and flow e.g., channelised stream.
3. Embeddednes *How much of the stream bed is buried by silt or fine sediment?*	The gravel, cobbles and rocks on the bottom of the stream are not surrounded by fine sediments.	The gravel, cobbles and rocks on the bottom of the stream are less than one quarter buried or surrounded by fine sediments.	The gravel, cobbles and rocks on the bottom of the stream are between one quarter and one half buried or surrounded by fine sediments.	The gravel, cobbles and rocks on the bottom of the stream are more than one half buried or surrounded by fine sediments.

Stream Bank Features

Scoring the entire length gives us one view of the stream. Often though, stream habitat is highly varied from one end of the stream to another, so the same exercise can be done for segments of the stream or for different stream order segments to meet the aims of the group. Often to start with it's best to focus on one finite segment of say a couple of hundred meters to get the hang of it.

Stream Bank Features	**Excellent 4**	**Good 3**	**Fair 2**	**Poor 1**
4. Bank Erosion and Stability *How stable are the banks of the stream?*	The stream bank is stable with little or no erosion (slips) seen. Banks almost completely covered with different types of trees and shrubs.	Stream bank appears stable, some evidence of past erosion which may now have new plants growing. More than half of the bank is covered with different types of trees and shrubs.	Stream bank unstable and examples of erosion easily seen. Half to one quarter of the bank is covered with different types of trees and shrubs.	Unstable stream bank which may crumble when walked on. Less than one quarter of the bank is covered with larger plants
5. Riparian Zone Vegetation *Is the stream open to inputs from land users?*	Wide, well-vegetated margin that is undisturbed. No visible human or stock impacts.	Well-vegetated margin but some signs of human disturbance or stock access.	Modified vegetation. Little forest/wetland. Some signs of human activity and/or stock access.	Highly modified or no vegetation. No forest/wetland. Clear signs of human activity and/or stock access.

Add up your total scores for each of the factors. Compare you score to those in the rating table:

Stream habitat features		
Stream bank features	Left bank	
	Right bank	
	TOTAL	

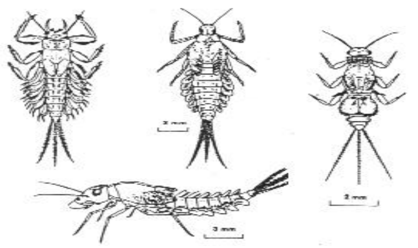
SCORE	**RATING**
33-26	Good
40-34	Excellent
25-17	Fair
25-18	Poor

Does it add up? Does that habitat reflect your score/rating?___________________ (Y/N)
Comment ____
What factors (if any) act as limiting factors? ____

Before you go – have you:

- ✍ Taken a photo that is representative of your site (position and direction should be at the same each time)?
- ✍ Completed a substrate survey (closely linked to this survey)?
- ✍ Made your impairment/impact assessment and identified limiting factors?
- ✍ Updated the stream reach map and survey form?

When you return:
Map your habitat results on to your catchment map.



Mayfly larvae

Invertebrate Monitoring.

Introduction

If we turn over a few rocks in a shallow, fast flowing section of any New Zealand stream we will soon notice movement. Small, dark, insect-like shapes scuttling for cover. We may well also discover some of the surprisingly large members of the mayfly, stonefly, caddisfly or dobsonfly groups. These insects are in their larval (juvenile) stages and are just a few of more than 100 species widely distributed around the country.

In addition to insects we may find crustaceans, snails, worms and leeches in stony or weedy stream habitats. Collectively these creatures are known as "invertebrates," (animals without backbones).

Invertebrates are a vital part of the freshwater ecosystem. They include grazers, plant shredders, filterers and predators. Many of them feed on plant matter (algae, leaf litter and aquatic "weeds") and in turn they provide the most important food source to almost all of the freshwater fish found in New Zealand. Without the invertebrates we would have none of the native eels, bullies or "whitebait" species and no introduced trout, salmon or perch in our freshwater habitats. Without any of the above we would have less kahawai, kingfish and marlin.

Invertebrates tell us a great deal about the "state of health" of our water bodies. The presence of many invertebrate species indicates clean water, cool temperatures and generally natural conditions. **A stream, which lacks any invertebrate life, has a major habitat problem.** Possibly it has recently been polluted or maybe it has dried up. The monitoring of invertebrates, therefore, is of critical importance.

Sampling for Invertebrates

Two methods are generally being used to take invertebrate samples. One is the 'kick sample' the other the 'sweep sample'.
Regardless which method we decide on we must always start at the lowest downstream site, working our way upstream. (If we start sampling upstream first, the current will carry some dislodged water bugs to our other potential sampling sites, thus producing incorrect results.)
Kick sampling is used mainly in streams with a stony, rocky bottom, while sweep sampling is done in slower, deeper parts of streams. In sweep sampling, we sweep through beds of waterweeds or along the bottom of the stream, which is likely to be soft and silty.

For example, if we want to sample 6 sites in a stream catchment and we want to establish whether the freezing work's (abattoir's) waste outlet, has an impact on the invertebrate community and the water quality, we will have to stick with one sampling method. Either kick samples or sweep samples, otherwise it could be argued that we were sampling entirely different habitats. The reason for strict compatibility of sites is simple: Bugs that live in a bed of watercress are likely to be different to those living in amongst and under rocks.
So it is essential we refer to our catchment and habitat assessments. Essential that if we start with kick samples in the upper area we have to use compatible methods in sites in the lower reaches.

1. Kick Sampling

Kick sampling is a simple but effective method used to dislodge animals living in or on the rocky bottom of the stream allowing the current to sweep them into the net. Two sampling areas within the riffle or run are needed, each about 1m 2 (one square metre) in area and preferably with different flows: one with a fast current and the other in an area of slower current.

Equipment

- Kick sampling net (preferably with a mesh size of 250 µm)
- "Bug box", ID sheets, score sheets, "bug suckers," and

magnifying glass
- Suitable footwear, to protect your kicking foot,
- Sorting tray

Taking A Kick Sample — method

1. Select a shallow riffle area with a depth of 10-30cm and stones that are gravel or cobble sized.
2. Mark the position of your sampling site on the site map and note any reference points.
3. Sampling begins at the downstream edge of the selected site and moves upstream, covering a predetermined area, of say $0.25m^2$. The area decided on for sampling will vary with bug density. Adjust your sampling area to enable you to collect a minimum of 50 bugs.
4. Position the net about 0.5m downstream of your foot, with the bottom edge lying firmly against the streambed.
5. Using the toe or heel of your foot (whichever is best protected!), dislodge the upper layer of cobble or gravel and scrape the underlying bed.
6. Use a forward scooping motion to lift the net from the water to prevent any of the organisms escaping.
7. Carefully empty the net contents into a bucket containing about 5cm depth of water. (Rinse clinging organisms off the net by splashing with water from the stream.)
8. After each sampling, wash the net in the stream to remove any debris (this is important for accuracy).
9. Transfer some or the entire collected sample into the white tray for sorting. If you get lots of stones in the sample, swirl the water in the bucket to dislodge and separate any bugs clinging to them.
10. Note conditions at the time of sampling, such as higher than usual flows that may influence the results and interpretation. Also record observations of fish or other fauna and make sure you note down the method of sampling, i.e. kick or sweep.

Larger substrate may not be moved by kicking. (See below for an alternative method for large substrate.)

Where riffle or run habitat with coarse gravel or cobble bottom is not available, other submerged fixed structures such as snags can be used.

Invertebrate Identification

Please use laminated ID chart in bug box for initial identification

And refer to the literature provided to assist you with further ID

There is also a 'mystery' box into which you place the insects you are not sure about. The mystery box has four compartments, each compartment correlates to the basic four major groups as outlined in the invertebrate guide from the Otago Regional Council (page 3, left column at the bottom).

Sort insects accordingly and transfer results to the score sheet (appendix I)

Familiarise yourself with the ORC booklet.

2. Sweep Sampling

We use this method to collect organisms living in and around vegetation or edges of the stream. When rocks or other fixed substrates are unavailable macroinvertebrates may be collected from submerged vegetation, bottom sediments or piles of leaves.

Equipment

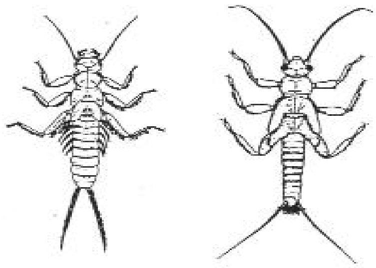
(Same as for kick sampling)

Taking A Sweep Sample

1. Decide the length of stream margin to be sampled. As a rule of thumb, three individual samples of 1m in length should be enough.
2. Mark the position of the sampling site on the site map and note any reference points and mark (?) near the base of the plants.
3. Beginning from the downstream end of the sampling site sweep the net around and through the vegetation. Avoid disturbing sediments where possible. A jabbing or bumping rather than scooping motion usually results in less plant material being gathered in the net. Always move in one direction so that any animals caught are forced towards the bottom of the net.
4. Use a forward scooping motion to lift the net from the water.

Invertebrate Identification

As for kick sampling



Stonefly larvae

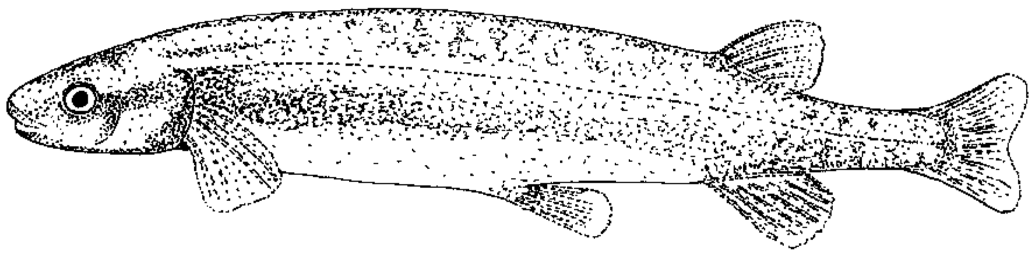
Invertebrate Score Calculation

Please refer to Invertebrate Score Sheet Appendix I

The following quality grading is suggested:

30 <	poor
31 - 40	fair
41 - 55	good
55 >	excellent

"Give a man a fish and he'll eat for a day.
Teach him how to fish and he'll eat for a year.
Teach him how to look after fish and he'll eat forever."



Inanga

Freshwater Fish

Note: We suggest participants read R. M. McDowall's book, "New Zealand Freshwater Fishes". A copy of this book is provided in the equipment package. It is very comprehensive, has great photos, identification hints and habitat and distribution descriptions. A great addition to your home library. *(All page numbers in the paragraphs below will refer to the above named book.)*

Introduction

Fish are at the top of the food chain in freshwater systems. Because of this they have suffered more than most and focusing on freshwater fish species is thus a very good way to learn about the whole stream system.

It is a sad fact that in New Zealand we have lost much of the abundance and productivity that was once a feature of our freshwater systems. Damage to the habitat (the specific area in which a type of plant or animal lives) and over-fishing has caused immense losses.

In some cases whitebait runs of today may be only 10% of what they were in the past and in ecological terms, the levels of decline many streams have experienced is so great that many species face extinction in their locales or have already become extinct. What these losses mean to the food chains in the harbours and coastal areas we can only guess at, but we do know they are considerable and in some cases catastrophic.

It is for this reason, we highly recommend you try and reconstruct the ecological history of your stream by interviewing “locals” who might remember the conditions in the past or, if you can, seek put and examine any historical accounts. Even if the evidence you glean is “anecdotal”, (based on oral lore or recollection) regarding the old levels of now lost or depreciated species, we can use it for our goal for future restoration efforts.

The “good news” is that much of the former abundance of such stocks can be restored. Natural systems are very resilient. They can restore themselves given sufficient care and attention. Streams and rivers in North America and Great Britain have already been brought back to health from a virtually dead condition. It is our aim that investigations of our catchments and the life within them will be the first step in restoring the wonderful diversity of life back to our streams.

New Zealand's geographic location as an isolated set of islands in the middle of the South Pacific, is partly responsible for producing some of our extraordinary 35 native freshwater fish species. Today it is known that 30 of them are not found anywhere else in the world and are endemic (found in only that locale) to New Zealand.

Note: The general public's awareness and understanding of our freshwater fish has up to now been very limited. Many people still believe our streams and rivers to be void of *any* fish life apart from eels, whitebait and the introduced species of trout. If we take into account the relatively small size of most of our freshwater fish, the fact that they are nocturnal in feeding habits and are easily spooked into hiding places, it becomes clear how the above perception came into being. Another curiosity of our freshwater fish fauna is that about half of the species spend some part of their life cycle at sea.

Threats from rural Land Management

Land Management Practices & Adverse Effects.

A good example of how land management practices can affect our fish species is the inanga. Inanga make up the bulk of any whitebait catch. Their spawning grounds are the riparian margins of tidal river flats, at the upstream end of the salt-water intrusion zone. It is here the females deposit eggs at the base of grasses or flax bushes at a spring tide in autumn.

All too commonly cattle and other livestock have free access to these riparian areas and consequently damage or destroy deposited eggs and spawning habitat. These vital areas are also often sprayed with herbicides and are channelised by diggers with the intent of "improving drainage" of surrounding lands. In Northland consequently there are very few of these spawning grounds remaining in an "unmodified" condition.

Tip: A simple electric fence at the right place could make a significant contribution to a species that is declining rapidly.

Northland Freshwater Fish

Common Native Fishes

Reading R.M. McDowall's "New Zealand Freshwater Fishes," you will note that possibly the most common and widely known freshwater fish in our streams is the eel (page 35 ff) followed by the common smelt (page 44), the common bully (page 181) and the banded kokopu (page 56). And the last named, the banded kokopu is only found in bush clad catchments.

The koaro (page 62), you will see is an accomplished climber, but due to loss of habitat is becoming scarce.

Two additional species are worth a special mention here, and they are the giant kokopu (page 53) and short-jawed kokopu (page 59).

If you found and positively identified one of these during your investigations, you could well earn yourself a place in the "Hall of Fame".

In appendix III you will find a laminated fish ID chart with the most common Northland species. This chart is designed for you to take out on survey work as it is not always practical to take a book. However, you may want to take both.

Introduced Pest Fish Species

The introduction of large, northern hemisphere, predatory, fish species like trout, perch and catfish to New Zealand, has had an undoubted impact on the native fauna. Although we focus primarily on the impacts of land and freshwater management practices in this programme, we encourage you to take note of any introduced fish species. When doing surveys, we also suggest you include those species released by aquarists. (See also below)

Unfortunately, Northland with its subtropical climate is proving to be a new home for a number of aquarium fish, carelessly and sometimes illegally released by their keepers. Mosquitofish *Gambusia affinis*, (page 157) for example are being blamed worldwide for damaging native fish populations by eating their eggs and young. *Gambusia's* breeding potential has been estimated to expand from a population of 7000 to 120,000 in only five months! Other pest fish include perch *Perca fluviatilis* (page 172), caudo *Phalloceras caudimaculatus* (page 169), grass carp *Ctenopharyngodon idella* (page 151), rudd *Scardinius erythrophtalmus* (page 147), tench *Tinca tinca* (page 143), European carp *Cyprinus carpio* (page 140), goldfish *Carassius auratus* (page 137), brown bullhead catfish *Ameiurus nebulosus* (page 134)

If you catch or observe any of the above pest fish in your catchment please notify your Whitebait Connection coordinator or the Department of Conservation.

Fish Monitoring Methods

Three methods are commonly employed to monitor inanga or any other freshwater fish populations.

1. Electric fishing

Professional researchers often use electric fishing to assess freshwater fish populations. Via a portable generator an electric fishing circuit is put into the water to stun the fish within the immediate vicinity of a hand held electrode. Because of the possible dangers inherent in a combination of electricity and water, electric fishing operators need to be licensed and qualified.

2. Netting

Catching our target species in nets, set in our catchment, is a viable option. Netting is relatively safe and can be carried out by a wide range of age groups. There are several different net designs available.

?? Fyke nets, NZ Freshwater Fishes p. 24
?? baited box nets, killwell nets
?? scoop nets

Note: Some of the disadvantages of netting are:

?? they are subject to damage by vandals
?? possible theft of nets
?? they are subject to damage or loss by flooding
?? And <u>some native fish species are "escape artists" they are really skilled in getting out!</u>

3. Spotlighting

Shining a powerful spotlight into a clear stream at night opens up a whole, new, world. It is an experience that will provide us with an exciting and rare view of what is happening in our catchment.

A stream, apparently devoid of any fish life during the day, is suddenly full of activity.

Everything is out feeding under the cloak of darkness. The fish are seemingly mesmerized by the light and sometimes are so amazed by it; they can actually be touched!

In many ways, this method is by far to be preferred to all the others. As a rule it is safer, provided we carry a backup torch and batteries and best of all, it is "non-intrusive", because we just "look and observe" rather then 'electrically fry' or take out.

Most of all it is spectacular, for we will see things with a spotlight we have never seen before.

Spotlight Fishing Protocol

You will need the following equipment:

net;
spotlight with battery;
torch;
a bucket;
a clear plastic container;Fish identification guide.

Firstly we illuminate a section of the stream with the light taking care to move slowly and cautiously. Once we have spotted our target good teamwork will be required. The spotlight operator (he/she) will try and herd the fish (with a stick or second net) towards the person with the first net, rather than attempt to scoop or "catch" the fish.
Once the fish are in the net, we will empty it very carefully into a bucket, or into a clear plastic container containing water. (Clear plastic containers will enable us to have a good look at our catch to assist in identification.)
As with water bug surveys we will need to start downstream and work our way up so we are always working in previously undisturbed water. **Tip:** Take your time and get your 'eye in'. This is something most people get very good at in a relatively short time.

It is also a good idea to scout the stretch of stream we are spotlighting in before it gets too dark so as to be totally familiar with the terrain and habitat.
Make sure you have your fish ID chart and fish record sheet ready.

Note: most of the fish species actually migrate within the stream during certain times of year, although all of their behaviour is not fully understood. *The banded kokopu for* *example, have a time in autumn when they can be found in the middle and lower reaches. Most of the remainder of the year you may find them mainly in the upper reaches or up tributaries in forested areas.* Eels also are quite mobile in the stream system, with a general pattern of small elvers (baby eels) travelling up through the stream and maturing in the middle and upper catchment areas. (Later, at a certain stage of their adult life, eels form great migrations downstream and out to sea for their journey to the spawning grounds, which are believed to be somewhere near Tonga. *See eel warning below.*

Daytime Killwell trap protocol for surveying Inanga:

Through recent fish surveys in the Waipoua River we have learned that Killwell box-traps baited with Marmite produce good results for Inanga during the daytime. Baiting is done by placing a teaspoon of Marmite in an old film canister with little holes punched in the lid. The best months to use this method are from December through to May/June. The traps should be placed in a stream or river run and **left for one to two hours** before checking. If the traps are left any longer the fish in the trap will make moves to escape with an astounding success rate.

Warning: eels unfortunately are also attracted to the traps and will mainly enter the traps at night. If you find you are getting eels in your traps, then you should disregard the results for other fish species as the eels will have eaten some of them. **Don't leave your traps for longer than two hours and never overnight** if you are targeting Inanga.

Since bigger, mature Inanga have been observed moving in the early morning hours, an “early bird” will have a chance of getting some excellent results around dawn and shortly after. In general maturing inanga and adult inanga are shoaling in little groups from December until April and sometimes into June.

It is very important that we in Northland and throughout the country begin to measure the health of our inanga populations. Although there are countless recollections of the past abundance of inanga in our streams, there is little hard evidence of their suspected demise. Regular monitoring can start to create an

accurate picture of what is happening in our stream. As we start to get involved with our community in restoring our stream, we can use our inanga monitoring to gauge how successful our efforts have been.

Suggested Monitoring Methods

Three methods are described below. They look at different parts of inanga's lifecycle and utilize quite different methods. Of the three methods, we feel the Summer Adult Survey is the simplest and the most suitable for trying to get a quantitative (how many) measure of inanga populations. Summer Adult Surveys give reliable, relative, population abundance figures for our stream, and these can be compared from year to year and later on with figures from other streams.

Now the word "relative" is the key word here. Relative used in this way refers to a number that is descriptive, but not absolute. In other words we do not have an actual count of the inanga in our stream, but we will have a number which *relates* to that actual or absolute number in a precise way.

Note: Sometimes it is possible with other methods to learn how to translate a relative population measure to real, absolute population numbers and in ecological monitoring this is called "indexing". In our case it would be very difficult to count the *absolute* number of inanga in the stream.

The other two methods are harder and less precise, but they yield very important information. In a best case scenario we would have the luxury of using all three and then comparing what was learned over time from all the three methods. But let's stick with what we have discussed…

Summer Adult inanga Survey: procedure

1. Practice the baited Killwell trap method to see if you can

get consistent results i.e. numbers of fish/(per) trap. Focus on the lower 2—5km of your stream. You can expect to get a 10%—30% variation between traps in a site although variation between sites in the stream may actually be more that that.

2. Select 3 to 5 permanent monitoring sites, (try to select gentle reaches with quiet eddies or pools). Record the exact location of these sites. **Map the coordinates for future reference.** (You may also be able to have some sort of mark on the bank, or on a fence, or a tree etc. to mark the site.)

3. Use at least three traps in each site.

4. We should aim for three monitoring times too, if possible, through the summer, but if we can only manage one it will still be very worthwhile.

5. Record the following:

a) Number of fish caught over a two-hour daytime net set.

b) Size range and average size,

c) Other species of fish caught,

d) Time of day and date,

e) Weather,

f) Moon phase,

g) Condition of stream flow, (low flow, clearing following flush, normal etc.)

h) Any other observations.

Spring Inanga & Whitebait Monitoring

All whitebait fishermen will have a story to tell you about how the "runs" have been going in your stream. It is well worth trying to construct a history and an annual update of this local knowledge as it will be our best source of knowledge regarding numbers of whitebait. It is especially important to go to the kaumatua and kui of your catchment to ask your questions as Maori hold a vast history and knowledge about freshwater life in general, but specifically they were careful observers of the inanga and whitebait.

Note: Although there have been many attempts to put in place scientific monitoring methods for whitebait and compiling catch records it is not an easy task. Today catch records are being assembled on only a few, large, South Island, West Coast rivers.

If your groups want to attempt to have an annual "whitebait run" monitoring program, the best approach is to interview whitebait fisherman throughout the season and record their catches. *Please be careful to emphasise your study aims and goals before asking to see the catch or do the interview. Sensitivity and good public relations are paramount in getting cooperation and lack of cooperation is often what has been lacking in the past.* You might note down amounts caught, hours fished, moon/tide information, condition of stream flow dates and locations. You can of course fish too, but consider throwing back the catch as breeders for your stream.

A second approach is to record observations made of the catch in the bucket. This can be our catch or the catch of "friendly" whitebaiters. (You will need to refer to the Identification of whitebait — handout.)

Things we could record are:

a) The percentage of smelt that we capture compared to the whitebait.

b) The number of inanga, compared to the number of other whitebait (which in Northland will mainly be banded kokopu); distinctions can be made by observing the swimming behaviour of the fish in the bucket. (see

Appendix IV)

Note: The information above can make up a very important picture of the health of our inanga and whitebait population over time. It can also offer a number of important clues to what is happening in our catchment. For instance if we notice that the percentage of smelt in the whitebait catch is very large and/ or increasing, this may be a result of deteriorating water quality in our stream or disruption of the spawning area. Sometimes these "problems" can be fixed with a simple fence. If we find that the percentage of banded kokopu is very large this may be a sign that the lower reach of our stream (or spawning grounds in particular) have a problem. On the other hand if there are very few non-inanga, whitebait in our bucket, especially late in the season, this is a sign there might be problems in the upper catchment.

Tip: *to learn more about inanga, whitebait and our stream, it is helpful to broaden our experience and investigations by further study. Because after all inanga are part of a very big system which includes the ocean. For example here are some inanga "happenings" you learn to 'see':*

Each year in the months of August to November the juvenile forms of the inanga and the other species that comprise what we collectively refer to as whitebait **make their way to the river mouths and stream entrances to move into the freshwater world.** If we know what to look for it is possible to 'see' the signs. **The first signs will be in the ocean or estuary near where our stream meets the sea. We will notice schools of fish, especially kahawai, surface feeding, and terns and gulls diving overhead.** *What does this mean?* **It means the whitebait are congregating near the stream or estuary entrance and the kahawai are herding the whitebait to the surface where they are easier to catch.** *This congregation period is often triggered by heavy rains and/or the moon, and large tides, and typically lasts about 5-7 days. The runs up the streams are often timed with very large tides so the fish* *are helped along on the first leg of the trip.*

A great exercise is to try to make your own observations of these dramatic events, recording rain, weather, moon phase, date etc. and then to compare your information with historical and traditional ecological knowledge existing in your community.

Autumn Inanga Spawning survey

In this investigation, observation of the actual spawning and egg-laying of inanga is the aim. We can compare from year to year the amount spawning activity that takes place in order to get a feel of things and also highlight any problems, which may exist in the spawning area.

In small streams or streams with only very small remnant inanga populations it may be quite difficult to observe spawning. *Spawning is very much easier to 'discover' where the numbers of fish are great.* Even if we are not successful in observing the actual spawning, we will learn much from observing the stream and habitat during the search. The following information will guide our efforts…

a) **From February on adult inanga start to shoal in the lower reaches of the stream.** As March approaches typically these shoals can be seen closer to the freshwater/saltwater mixing zone of the stream.
b) **Spawning usually takes place between March and May and is typically timed to occur on or 2 days either side of the largest high tides, often in association with the full moon**
c) **Spawning occurs at night.**
d) **The preferred spawning locations are rushes or grasses on banks just above the highest reach of the salt water at the highest tide.**
Note: We should walk or inspect this part of the stream in advance during a very big high tide and mark where this point is for our stream.
e) When spawning is occurring we will see the fish in shoals writhing and squirming around the banks of the stream and wriggling in the vegetation. The male fish release sperm *en masse* in the area and often the water has a milky appearance.

f) If we do witness a spawning activity, we must record an estimate of the number of fish involved, make an accurate map of the area and detail the actual area and vegetation types used for spawning. We should also record moon phase, weather and stream condition.

Another good approach involves carefully searching the suspected spawning area for eggs at low tide following the spawning time. This method is difficult and requires a bit of time. Any eggs will be found sticking to the bases of vegetation where the highest level of the high tide has reached. The eggs are about 1mm in diameter and clear in appearance. It is a good idea, to have someone experienced verify the identity of any eggs found because they can be mistaken for snail eggs. We suggest you notify your stream coordinator or the Department of Conservation if you do find eggs.

Given the reduced size of inanga populations generally, *it is significant if you find evidence of a spawning area and it should be reported.* The immediate aim is to have a number of sites that can be identified and monitored annually. This is especially valuable where restoration activity is already taking place or is contemplated in the future.

Note: While you are involved in inanga spawning or breeding ground searches it is a good idea to record collateral information about the surveyed areas, for this information will guide future ideas for restoration action. Note down the types of vegetation, or stream bank characteristics you see. (For example, is it sloping? Is there much cover? Are there any fences, stock-access points or any other relevant observations you can make?)

"Care for your catch" — this is very important!

Try avoiding contact between fish skin and human skin. Many of our freshwater fish have no scales and are prone to catching fungal skin infections. If you have to handle fish make sure your hands are wet and please be careful.
Put your catch back into the stream as soon as possible after identification. Remember that fish are fragile. Especially avoid fish coming into contact with abrasive material.

Water Clarity

The quality of our water contributes greatly to our economy, particularly through tourism. The Resource Management Act specifically mentions water clarity because it recognizes how much water clarity affects our perceptions and enjoyment of our waterways.
Water clarity is an indirect measurement of the amount of suspended solids in water. In New Zealand it is the preferred method for assessing water turbidity (or 'murkiness'). In other words, high water clarity means low turbidity and vice versa.
There is a natural condition for your stream — you can imagine how adding significant nutrients and/or soils could drastically upset the ecology and life of a stream.

In their natural condition streams at the top of the catchment are very pure. The system is feed by forest leaf fall and the ecology is based on that. There is low light and nutrients at this point so the planktonic system is poorly developed. As we go down stream, nutrients start to be released into the water column and more light penetrates into the stream. A plankton and benthic (bottom dwelling) algae community starts to develop and continues growing and developing around this basic layer of the food web. By the time the stream is nearing the ocean the planktonic system is well developed.

Note: If nutrients and/or soil enter the stream in unnatural quantities the whole system is quickly thrown out of balance. As the situation worsens eutrophication (over supply of nutrients resulting in high algal growth, low dissolved oxygen levels and adverse effects of most stream life) is the result. This can be fatal to many species of freshwater species.

As run-off occurs within any catchment, tiny particles of clays, silts or organic material are washed into waterways. Depending on water velocity these tiny particles can be supported in the water column and are termed suspended solids. *The faster the water is flowing the better its ability to keep solids in suspension.*

Our Northland streams are mostly small with short flow paths and muddy rather than stony embankments and bases. In slow-flowing lowland streams, high levels of turbidity may persist for long periods. This is due to the low rate of flushing and the fact that very fine particles are held in suspension almost indefinitely.

Measuring the murkiness of a stream under a variety of flow conditions is one way of measuring catchment condition.

The Causes of Reduced Water Clarity

There are many possible causes of reduced water clarity. Stormwater run-off from urban areas may carry heavy sediment loads due to earthworks from subdivision or redevelopment. Increases in impervious area (ie, tarmac, concrete, removal of water holding topsoils) due to urbanisation results in greatly accelerated run-off during rainfall. Higher stream flows lead to greater water velocity leading to streambed and bank erosion and so the cycle goes on with more damage over time; each stage exacerbating (making worse) the next.

Wastewater discharges from residential and industrial processes have the potential to adversely effect water clarity, regardless of flow condition. You can imagine the list of contaminants produced in the ordinary day to day existence of modern society. Add to that the various industrial or detergent substances and you have a powerful effect on water clarity. Contaminants such as paint, concrete-cutting wastes etc, are all potentially negative in influence on water clarity.

Microscopic algae also can contribute to turbidity when too much nutrient and sunlight increase their numbers. This can be imagined where development has removed vegetation, exposing water to extra light and combined with detergent or fertiliser related substances.

The Effects

Suspended material restricts light passing through the water column. Reduced light limits natural and healthy plant growth, which in turn affects the aquatic life relying on those plants for food. Higher levels of sediment lead to habitat destruction or direct effects on the stream life in the following ways:

?? Where there is less light penetrating the water, there will be less photosynthesis (the process where light is converted into "food energy" by plants with a by product being oxygen) and this reduces the level of oxygen in the water;

?? The water becomes warmer because suspended materials absorb heat from the sun. This also decreases the amount of oxygen present in the water (cold water can hold more oxygen). Shaded waterways are therefore less affected.

?? Sediments settling out of the water column may cover bottom dwelling creatures or the places where they would ordinarily live. (*The gill-structure of many aquatic creatures is easily clogged by sediments. This reduces their ability to take up oxygen.)*

?? Poor water clarity has direct effects on fish and birds that rely on their sense of vision to find and catch their prey.

?? Turbid waters may indicate the presence of contaminants, such as paint in solution or absorbed into sediment particles. These contaminants may directly result in (acutely) toxic effects on aquatic life or build up over time, and result in longer term (chronic) toxicity.

The Solutions

We can minimise reduction or loss of water clarity in the following ways:

?? Retaining or improving vegetation along stream banks would stabilise them.

?? Providing water velocity dissipation structures (things that would take the "punch" out of the arriving water) where stormwater pipes enter natural streams. (This would prevent scouring.) Streambed or bank protection in the form of rock baskets (gabions) can be useful too, in ensuring that flow velocity within the stream does not worsen existing problems.

?? Slowing stormwater run-off from urbanised areas by using 'natural' systems such as grassed swales (drainage channels) rather than concrete lined channels. Flows within waterways can also be managed by using ponds and/or wetland systems.

?? Controlling stormwater run-off from areas of disturbed land using sediment control devices such as silt fences, sediment traps, rock filters, etc.

?? Avoiding discharge of pollutants into waterways from poor 'housekeeping' practices. Especially regarding material spillage and wastewater disposal.

Expected Levels of

Water Clarity/Turbidity

To understand the water clarity results we obtain we need to get information on the natural levels in our area at various times of the year.
Natural variations within an area may be related to soil types and events such as flooding. We usually only assess water clarity during "low flow" conditions. Interpretation of variation and baseline levels should take into account, not only the natural features of the area but also information about local land use practices and riparian management. **Note:** We need a sound knowledge of our catchment before we can decide what might be causing elevated turbidity.

To give an example, water clarity data collected within the Auckland Region as part of baseline monitoring programmes over the past 15 years shows considerable differences between land use types. Water clarity (turbidity) ranges for the various land use types are shown in the table below. All units are expressed as nephelomtric turbidity units (NTU). You will find a graph at the end of this section to show you how to convert the water clarity tube readings collected into NTU's for comparison with data below.

Note: As we might expect, turbidity levels in catchments with substantial areas of riparian vegetation were significantly lower than those without.

Land Use	Minimum	Median	Maximum
Native Bush	1.2	2.2	44.0
Exotic Forestry	1.3	12.0	38.0
Agriculture	6.5	13.0	54.0
Urbanising	7.8	36.0	260.0
Urbanised	3.8	16.0	58.0

Visually assessing the clarity of the water.

You will notice the clarity assessment apparatus supplied, consists of a 1-metre-long, 50-mm-diameter (44-mm-inside diameter) clear acrylic tube, graduated along its length in centimeters. One end is clear (for viewing); the other is open but can be stoppered with a pipe cap. A 20-mm diameter black semicircle (cursor) is fixed onto a magnet so that it is centred in the tube. This can be slid along inside the tube using another magnet on the outside.

Care of your clarity tube

It is important to keep the viewing window of the tube free from scratches. An acrylic ring projecting beyond the window protects the surface to some extent, but it is advisable to cover the end of the tube when not in use. **Tip:** you could use a strong plastic bag secured by a rubber band. Keep the disk and magnet set separate from the tube when not in use. (Then you don't risk dropping them onto the viewing window inside the tube.)

Taking a clarity reading

Two measurements are made of distance traveled by the magnetic cursor using the graduations marked.

Read these instructions carefully before taking your first readings!

1. Use the container provided to take a 2-litre sample of stream water. Take the water from a place, which has not been disturbed by anyone upstream while you are at the site. *Sample from the main flow of the stream* (where the flow is swiftest). Make sure you don't stir up any sediment on the stream bottom that might get into the sample and alter the reading.
2. Fill the tube completely with water then place the black (cursor) disk magnet inside, held in place by the external magnet. Place the tube cap firmly on the end.
3. We suggest that you always take clarity readings in diffuse sunlight or shade, but avoid patchy light with shadows. If it is impossible to avoid bright sunlight, work with the tube perpendicular to the sun's plane: any shadow should be cast to the side of the tube, not directly along it. Be aware that in bright sunlight there will be a reflection from the top of the black disk – you should try to ignore this when taking a reading.
4. Do not take readings in conditions where the light is not intense enough for full color vision. Avoid very shaded conditions (e.g., thick tree cover) or taking reading close to sunrise or sunset. For heavily shaded sites, take the sample and tube to a more open location before making your observations.
5. Always check that the viewing window is free of condensation before taking a reading.
6. Place the tube horizontally on a level surface, e.g., on a vehicle roof. Alternatively, hold the tube horizontally.
7. Move the black disk to the window end of the tube.
8. View through the clear end with your eye close to the ring protecting the acrylic surface.
9. Move the black disk away from you until it disappears. Note this distance. Then slowly move the disk along the tube back towards you until it re-appears. Note this distance too.
10. On the outside of the tube: read the distance measured from the front of the disk to the clear viewing end.

11. Repeat steps 5 to 10 to obtain at least two further readings. Get another person to take a reading if possible. Before each reading, gently agitate the water column to ensure that any sediment stays in suspension. (Don't shake so hard that lots of bubbles are produced in the water, because these will reduce the sighting distance.)
12. Take the average of all the readings to obtain the average clarity.
13. Enter the clarity measurement onto your data sheet.

Limitations of the clarity tube

?? The most accurate readings in the tube will be up to about two-thirds of the tube length. Readings beyond that will be less reliable (in other words less reproducible) because of the decreased length of water column between the disk and the black background at the end of the tube. However these longer readings are still useful for indicating clarity changes.

?? Water that gives a "clear to end" reading is still far from crystal clear! The New Zealand clarity standard for recreational use of fresh water (e.g. swimming) (MfE 1994) is a conventional black disk measurement of 1.6 meters. Experience so far shows that the readings from the clarity tube and the black disk may be similar. Therefore, a 2-metre-long tube would enable comparison with this standard, but would be quite cumbersome for routine use. *(A 2-metre version of the tube may be tested for possible introduction at a later date.)*

A water clarity guideline for New Zealand, in addition to the standard for swimming mentioned above, is a standard for relative change in clarity as a consequence of any activity:

"For Class a waters (where visual clarity is an important characteristic of the water body): The visual clarity should not be changed by more than 20%.

"For other waters: The visual clarity should not be changed by more than 33 – 50 % depending on site conditions."

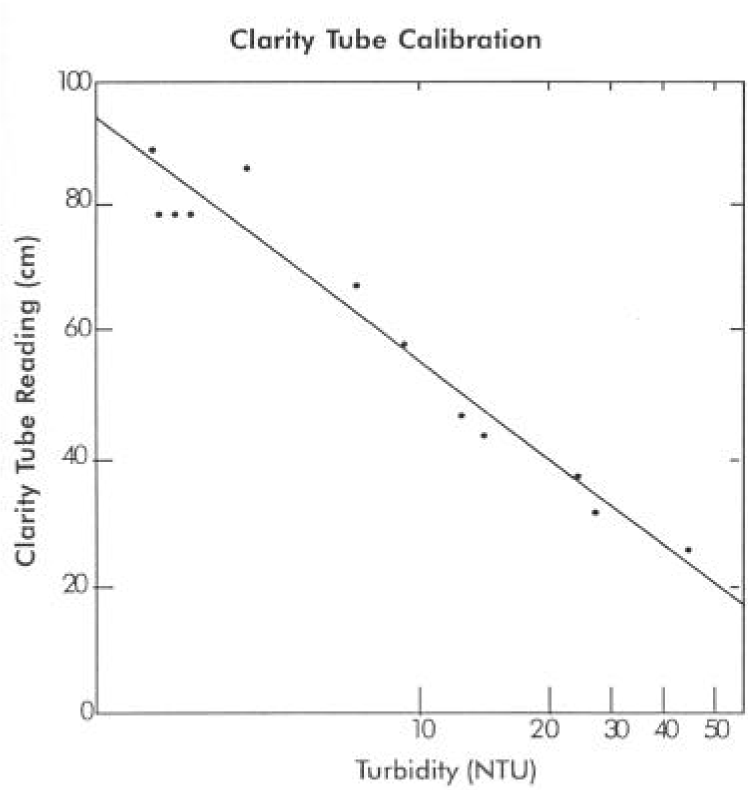
NTU Conversion

Converting water clarity tube readings to turbidity values.

Turbidity is a measure of light scattering, which is proportional to the quantity of suspended particles in a water sample. It is measured on a laboratory instrument in nephelomtric turbidity units (NTU).

The water clarity guideline New Zealand has adopted roughly relates to being able see submerged objects when people are about waist deep (1.6m) in the water.

Water clarity is related to turbidity but not exactly. This graph can be used to approximate turbidity values from water clarity tube readings.



Whilst the clarity of stream water has a powerful influence on people's perception of stream health, clarity is also an important feature of the habitat for stream life because it affects the amount of light that gets through to the stream bottom. Plants (in this case, periphyton – algae) need light for photosynthesis, and hence growth. If algal growth is strongly inhibited by low water clarity and if the problem persists for long enough, there may be flow-on effects. For example, invertebrates that consume algae may die out.

Water clarity generally reflects the amount of fine suspended sediment in the water. The size of the sediment load depends on underlying rock type and the amount of erosion or streambed disturbance going on upstream. On farms, a range of activities may contribute to the problem; cultivation too close to the stream edge; stock moving in and out of the stream; a bank is near collapse. Recent rainfall may cause sediment input to increase as well. In slow-flowing streams, sediment may settle on the streambed and possibly smother invertebrate and periphyton habitat.

Clear to bottom

Note: apparatus provided with this kit ("clarity tube") is based on a scientifically accepted method for measuring water clarity. It is called the black disk method (Davies-Colley 1988). The clarity tube was designed for use on farm streams that are fairly turbid. The following is a commentary on the range of readings that may be obtained.

Clarity Results

70 to 100 cm

55 to 69 cm

Comment: For a farm stream this represents nice, clear water! Note that the New Zealand clarity standard for recreational use of fresh water (e.g., swimming) (MfE 1994) is a conventional black disk measurement of 1.6 meters which is beyond the scale of the current clarity tube design, but which is very clear water indeed.

35 to 54 cm

"Slightly turbid" water. This may inhibit plant growth and the suspended solids could settle on the streambed.

Less than 35 cm

"Moderately turbid" water. It would be difficult to see the bottom in pools and at this level it is probably starting to affect stream life, both through light restriction for photosynthesis and through settlement of sediment on the stream bottom. An examination of what is happening upstream would be well advised.

"Very turbid" water is likely to silt up the streambed and be detrimental to most stream life. Again a review of what is happening upstream is needed. **Note:** This level of clarity will almost certainly be caused by some fairly obvious disturbance.

"Extremely turbid" water will undoubtedly result in a silty streambed and be detrimental to most stream life. An immediate look at what is happening upstream of this reading is needed. This clarity will almost certainly be caused by an obvious disturbance.

Water Clarity Score Sheet

Clear to bottom
Rating: excellent
Score: 10

70 to 100 cm
Rating: good
Score: 8

55 to 69 cm
Rating: fair
Score: 5

35 to 54 cm
Rating; poor
Score: 5

Less than 35 cm
Rating: very poor
Score: 1

Curriculum Tips.

Planning A Teaching Programme

Water quality monitoring provides many opportunities for enhancing the curricula and it does so in challenging and interesting ways. You can develop programmes which:

?? Explore personal, social and natural environment

?? Satisfy curriculum requirements

?? Use modern technologies in the classroom and in the field

?? Link learning to the realities of local and global communities.

The Whitebait Connection incorporates learning strands from the Science, Social Studies, Biology and other areas of the New Zealand Curriculum Framework. Integrated throughout the package are many of essential learning skills and many of the Education Outside the Classroom goals and outcomes. In addition we provide copies of activity sheets, (outlining instream activities and required resources.)

Instant adventure - just add water!

Aims

The Whitebait Connection aims to develop community awareness and 'ownership' of problems in the management of natural and physical resources, in particular those involving water quality.

This is not a 'traditional' school programme. The underlying philosophy of the Whitebait Connection is that the learning experiences draw students out of the classroom and into the community. Students are challenged to use their skills and knowledge in a real-world context, and to become fully engaged in problem-solving activities relating to the whole community.

Environmental studies provide excellent opportunities for integrating different strands within curricula, as well as linking different subject areas.

Cross Curricula Linkages

There are many opportunities for cross-curricula linkage, from combined field trips, to sharing data and interpretations. The benefits that can be gained from sharing resources and expertise can be huge.

Interactions are not limited to the experiences of a shared field trip either. Each class can develop separate management plans, each focusing on different issues from the same data (in line with the focus of the subject area). Later, the classes could be brought together again for a student forum to outline their management plans. Experts from the regional and district/city councils could be invited to assist students with the development of these plans, and later on to comment on their reports.

Linking the different curriculum areas can have many positive spin-offs:

?? Combined units of work with each subject area taking a different focus. Biology students could analyse the biological, chemical and physical aspects of the stream while Geography students could interpret the data for patterns, processes and regions.

?? The skills in the programme will be common to several subject areas

?? The development of enhanced investigative skills, focus and planning, information gathering, processing and interpreting information, and finally reporting.

- ?? The teaching of practical skills, in mapping, field-work and measurement and collection of meaningful data.
- ?? The needs of two or more subject areas can be met in one field trip, with less disruption and reduced costs.

  The quality of reporting, and the ability to grapple with larger issues is greatly improved when the different perspective and skills of different subject areas are brought together.

Social Studies

Some of the complexities of the relationship between people and the environment are explored in this programme, which will broaden students' insight into significant issues and developing an appreciation of our responsibilities as members of society.

Learning Strands	**Achievement Objectives**	**Suggested Studies**
Place and Environment (Level 6)	?? Investigate ways in which interactions between people and their environment have been regulated and explain the implications of this for people and the environment, now and in the future. ?? Describe how people's values can influence their perceptions of places and environments, in New Zealand and beyond.	Applying the Resource Management Act (1991) in New Zealand. Environmental Issues.
Place and Environment (Level 8)	?? Analyse, debate and convey points of view on specific issues that arise when people perceive places and environments differently. ?? Explain how interactions between people and the environment have global implications for the present and future, propose possible solutions to problems, and evaluated the effectiveness and consequences	Use of water from a local stream. Land management practices within a catchment. Water degradation.

	of each proposed solution.	

Sixth Form Biology Programme

Some aspects of the Whitebait Connection programme are particularly suitable for use within Sixth Form Biology classes (Level 7 of the New Zealand Curriculum document).

Context	Achievement Objectives	Skills	Assessment	Unit Standards
LOCAL WATERWAYS (10 weeks including fieldwork)	7.1(a) Investigate and identify interrelationships and possible patterns within populations and communities, using New Zealand examples. 7.3(a) Process information to enable informed debate on the impact of human activities within ecosystems.	**Knowledge** Recall and understanding of biological concepts of ecology. **Carry out an Investigation** Select and use equipment to make qualitative and quantitative observations and measurements with appropriate precision. **Interpreting Information** Analyse recorded data using statistical and graphical procedures as appropriate to identify trends, relationships and patterns. Communicating Information	**Written Test** 1 hour at end of topic. **Field Report** On fieldwork to local waterways. Investigate skills to be assessed – ?? Carry out an investigation ?? Interpret information ?? Communicate information **Role-Play and Written Submission** On resource consent process and pre-hearing meeting. Skills to be assessed –	**6309** Evaluate practices used for managing a resource to ensure ecological sustainability. **8929** Identify biological population patterns through investigation. 8930 Identify biological community inter-relationships and patterns through investigation.

		Report in a well-reasoned concise manner, using appropriate media, with conclusions that are justified and supported by relevant data.	?? Communicate information. ?? Interpret information	

Biology Curriculum

Biology is the study of life. If its aim is to involve people in investigating the variety and complexity of living organisms, the examples below can be integrated into a unit of work to enrich each student's experience of biology, and demonstrate the application of biological principles to solve problems.

Achievement Objectives	Possible Learning Experiences
7.1 (a) Investigate and identify interrelationships and possible patterns within the populations and communities, using New Zealand examples. 7.1 (b) Investigate diversity in animals and plants by comparing aspects of their structure and function above the cellular level of organisation.	?? Sample a stream to show the diversity of macroinvertebrates. ?? Relate the distribution of macroinvertebrates to current velocity, cobble/stone size and water depth. ?? Identify the plants and animals found in different parts of the stream. ?? Use a binocular microscope to observe structures (the gills and mouth parts of aquatic invertebrates) associated with feeding and gas exchange.
7.1 (c) Investigate the structure and function of cells, including cell organelles to identify their similarities and difference.	?? View slides under a compound microscope, of aquatic plant stems, roots, and leaves, to observe the structure of their cells (and compare to terrestrial plants).
7.2 Examine scientific evidence for evolution, and explain how genetic variation and natural selection can lead to genetic changes within populations.	?? Write an essay to explain the importance of maintaining biodiversity (and therefore improving/maintaining stream health and restoration of riparian vegetation as habitat and wildlife corridors)
7.3 (a) Process information to enable informed debate on the impacted of human activities	?? Role-play a consent hearing involving a Resource Consents Officer, a NIWA scientist, other land users, and the applicant who wants to take water from a local

within ecosystems.	stream. ?? Invite a Resource Consents Officer from your Regional Council to speak to the class about the Resource Management Act and how this relates to the sustainable use of local streams. ?? Debate the principle of sustainable land and management taking into account the impact of this local stream, and the cultural practices of Maori, European and other ethnic groups. ?? Carry out biological, chemical and physical tests to investigate the quality and health of a local waterway.
7.3 (b) Investigate examples of processes or techniques used in applied biology that meet human needs or demands.	?? Visit a sewerage treatment plant to observe the biological processes involved in the secondary treatment of wastes. ?? Investigate the creation of artificial/created wetlands to treat wastes from agricultural processing plants, and their role in stripping nutrients (particularly nitrogen) from effluent. ?? Research the application of tolerance/sensitivity ratings for macroinvertebrates to pollution monitoring.

Junior Science Programme

The Whitebait Connection programme can be used also with Junior Science classes. The example provided below has been developed for a year 9 class based on Level 5 Achievement Objectives.

Context	**Achievement Objectives**	**Specific Learning Outcomes**	**Skills**	**Assessment Examples**

OUR TOWN - OUR STREAM (10 weeks including fieldwork)	*Planet Earth Beyond 5.1* Research a national environmental issue and explain then need for responsible and co-operative guardianship of New Zealand's environment. *Material World 5.2* Apply their knowledge of chemical and physical properties of substances to investigate their safe and appropriate use in the home and community. *Science and Technology 5.1* Relate interpretations of the results of their investigations to their original ideas, questions and predictions. *Living World 5.1* Investigate and classify in broad terms, the living world at a microscopic level. *Living World 5.2* Investigate and describe structural, physiological and behavioral adaptations which ensure the survival of animals and plants in their environment	**Water Resources** 1. Explain the importance of water to people and living things. 2. Describe the water cycle and explain where your water comes from. 3. Investigate the way your catchment functions, using simulations and collected information e.g. The Catchment Inventory. **Field Study** 4. Investigate and describe the features of the stream reach, including habitat qualities. 5. Investigate water quality by conducting a range of chemical/physical tests. 6. Collect and identify samples of stream life, gathered from a variety of habitats. 7. Process and interpret data and information gathered from the field trip to produce an overall assessment on stream health. 8. Carry out extended study on a macroinvertebrate and/or aquatic algae, leading to an understanding of the structural, physiological and behavioral adaptations	?? **Information Gathering** Select and use equipment to make qualitative and quantitative observations and measurements with appropriate precision. Carry out procedures to systematically observe and record information and measurements . ?? **Processing and Interpreting** Identifying trends, relationships and patterns in recorded data by analysing data using statistical and graphing methods as appropriate. ?? **Reporting** Present well reasoned, complete reports	**Information Gathering** Test ideas anc predictions about pollution (ir the lab). Collect anc record data and othe relevant information during the water monitoring field trip. **Reporting** Students make individual contributions to poster presentations of findings for display at school and/or the local library. Report tc your local council anc industry/business sponsor outlining findings anc recommendations for improving your local

	Living World 5.4 Investigate and understand tropic and nutrient relationships between producers, consumers and decomposers. *Science and Technology 5.3* Investigate how knowledge of science and technology issued by people in their everyday, e.g. using findings from an investigation to justify the selection of products such as detergent.	of which enable it to survive in the stream environment. 9. Explain the nature of the tropic and nutrient relationships that exist in your stream. 10. Communicate findings and other information to other students and the local council. **Local Action to Improve Stream habitat and/or Water Quality** 11. Identify some achievable local action that the class can undertake to help look after the waterway being monitored. 12. Develop an action plan to achieve this.	supported by relevant data in ways and forms appropriate to nominated audiences.	environment. Use the internet to communicate your results and findings to other schools/ groups.

Things to keep in mind

Before you begin your Stream Health project, there are a few things to keep in mind:

Courtesy

- ?? If you must cross private property to reach your monitoring site, first seek the property owner's permission.
- ?? Whenever crossing any farmland remember to close all gates after you. If you need to climb a fence, do this at a post to avoid damage.
- ?? Provide property owners with a copy of the results.

Your environment

- ?? Minimise damage to stream banks and beds at monitoring, entry and exit points.
- ?? Return all live sample organisms to the stream.
- ?? Take away more litter than you brought in.
- ?? Avoid sampling macroinvertebrates from any site more than four times a year.
- ?? All chemical waste used in water quality tests should be collected in a leak proof bottle and disposed of into a sanitary sewer system.

Safety and health

at Sampling Sites— sensible precautions:

- ?? When selecting a site, choose one that has safe and easy access.
- ?? Check that banks are not slippery or unstable. Floods often damage banks – check for changes regularly.
- ?? Complete a safety/hazard checklist for each site and include these with your record sheets, as a reminder of site-specific safety considerations.
- ?? Do not enter the water barefoot and be careful of hidden objects, holes, prickly vegetation etc. Never put your feet in places where you cannot see.
- ?? Conduct macroinvertebrates sampling in water less than knee deep.
- ?? Wear gloves so you don't contaminate yourself with polluted water or with chemicals used for testing. Some procedures also require safety glasses.

- ?? Wear suitable clothing and footwear, including sturdy waterproof shoes with a good grip and waterproof gloves. Dress for the weather and don't forget your hat and sunscreen in summer.

?? Bring a fully stocked first aid kit with you including sterile saline eyewash.

?? When sampling near water, which is deep or fast flowing wear a life jacket. If you do fall in, swim across the current to safety, not against it.

Buddy system:

?? Never survey alone. It is best to work with at least two others. If one of you is injured, one person can go for help and one can stay with the injured person.
?? Let someone else know where you will be sampling and approximately how long you expect to be gone.
?? Do not allow children to sample without adult supervision.

Other advice.

?? *Carry water with you to drink. Do not drink water from the water sources you are testing as it may be polluted. Warning: In particular, when sampling in urban areas, do not put your hands near your mouth, or eat or drink while testing the water.*
?? *Do not sample if you have broken skin (cuts etc.).*
?? *Carry a cell phone or know where the nearest phone is located and carry coins/phone cards in case you need to make an emergency call.*
?? *Put all solid waste such as used gloves, empty reagent containers and any other rubbish from the day into a rubbish bag.*

If many of these risks are not easily overcome then consider using the visual/smells check method as your main form of assessment. You may be able to link in with another monitoring group or agency to obtain other kinds of data.

Protecting property owners

Under the Occupational Safety and Health Act (1992) all landowners (e. g. industrial or commercial operators and farmers) have a duty to warn visitors of any significant hazards that they know of on their property. This Act has led to most landowners having much more stringent rules about visitors and makes them unwilling to allow non-work-related visitors to their properties.

For site owners to fulfil their obligations under the Act and safely allow groups and individuals to visit their properties the owner will need to complete a hazard checklist. This is one reason why many property owners may be reluctant to allow you or your group access to their properties unsupervised. **Note: If contact has been made before and it is okay for your groups to come it is always advisable to contact the property owner a day or two before the trip to ensure that no additional hazards have cropped up since your last communication.**

Field trip checklist

Date				

Field Handbook				
Data Record Sheets				
First aid kit				

Pens, pencils				
Marker pen(waterproof)				
Waste container				
Clean water				
Rubbish bag				
Paper towel				
Sun cream and hat				
Camera and film				
Mobile Phone				
Drinking water and food				
Water clarity assessment equipment				
Macroinvertebrate ID material Macroinvertebrate equipment				
Fish ID material				
Fish survey equipment				
Emergency telephone number:				

Before you leave the site, check the following:

? Is the equipment cleaned?

? Is there any rubbish left behind?

? Has the stock in the kit been checked?

? Is any equipment broken or lost?

Glossary of Terms

algae Any of various primitive, mostly aquatic, one or multi-celled, non-flowering plants that lack true stems, roots, and leaves, but usually contain chlorophyll. Algae convert carbon dioxide matter through photosynthesis and form the basis of the marine food chain. Common algae include dinoflagellates, diatoms, seaweeds, and kelp.

algal bloom	A condition which occurs when excessive nutrients levels and other physical and chemical conditions help rapid growth of algae. Algal blooms may dissolve oxygen levels in the water.
alkalinity	Refers to the quantity and kinds of compounds present (usually bicarbonates, carbonates, and hydroxides) that collectively shift the pH below 7.
autotroph	Organisms which require their energy from the sunlight and non-living materials
baseline study	Collecting data to document existing conditions and establish a database for planning or future comparisons (see impact analysis and trend analysis).
benthic	Living in or on the bottom of a body of water.
benthos	Collectively, all organisms living in, on, or near the bottom substrate in aquatic habitats (examples are oysters, clams, burrowing worms).
(BOD)	The quantity of largely organic, materials present in water samples as measured by a specific test. Although BOD is not a specific compound, it is defined as a conventional pollutant under the federal Clean Water Act.
bioindicators	Organisms that are used to detect changes in environmental pollutant levels.
biota	The animals, plants, and microbes that live in a particular location or region.
buffer strip	A barrier of permanent vegetation, either forest or other vegetation, between waterways and land uses such as agriculture or urban development, designed to intercept and filter out pollution before it reaches the surface water resource.
carcinogenic	Potentially capable of causing cancer.
catchment area	The geographical area served by an institution.
(COD)	Quantitative measure of the strength of contamination by organic and inorganic carbon materials.

clinometer Instrument for measuring angles of slope. Most geography departments have sets (if not try the maths department).

cold water fish Fish such as trout salmon; preferred water temperature ranges between 7-18 degrees C (45-65 degrees F); cool water fish, such as striped bass, northern pike, and walleye, have a range between that of cold water and warm water fish.

coliform bacteria See Faecal Coliform bacteria.

Colloidal A suspension of finely divided particles in a dispersing medium; particles do not rapidly settle out of suspension and are not readily filtered.

colorimetry Process of measuring the concentration of a known solution constituent by comparison with colours of standard solutions of that constituent.

(CSO) A pipe that discharges water during storms from a sewer system that carries both sanitary wastewater and stormwater. The overflow occurs because the system does not have the capacity to transport, store, or treat the increased flow caused by stormwater run-off.

combine sewer system A wastewater collection and treatment stem where domestic and industrial wastewater is combined with storm run-off. (Although such a system does provide treatment of stormwater, in practice, the systems may not be able to handle major storm flows. As a result, untreated discharges from combined sewer overflows may occur.)

contaminant See Pollutant.

covariates Explanatory variables, such as climate, hydrology, land use, or additional water quality variables, that change over time and could affect the water quality variables related to the primary pollutant(s) of concern or the use impairment being measured. Specific examples of explanatory variables are season, precipitation, stream flow, groundwater table depth, salinity, pH, animal units, cropping patterns, and impervious land surface.

critical area Area or source of non point source pollutants identified in the project area as having the most significant impact on the impaired use of the receiving waters.

cumulative effects The combined environmental impacts that occur over time and space from a series of similar or related individual actions, contaminants, or projects.

cyanobacteria Photosynthetic bacteria; often referred to as blue-green algae.

decomposition The breakdown of complex organic substances into more simple organic substances.

denitrification Reduction of nitrate-yielding gaseous nitrogen.

deposition The settling out of a soil particle or aggregate of particles fom the water column.

designated use A beneficial type of use established by a state for each water resource and specified in water quality standards, whether or not it is being achieved.

detritovores Organisms that feed on fresh or partly decomposed dead organic matter; the term usually applies to detritus-feeders other than bacteria and fungi.

detritus Fresh to partly decomposed organic matter.

disposal Methods by which unwanted materials are relocated, contained, treated, or processed. Unless contaminants are converted to less harmful forms or removed from the material before disposal, they may be released again into the environment.

dissolved oxygen The amount of oxygen present in the water column. More than five parts oxygen per million is considered healthy; below three is generally stressful to aquatic organisms

ecosystem Interrelated and interdependent parts of biological system.

erosion Wearing away of rock or soil by the gradual detachment of soil or rock fragments by water, wind, ice, and other mechanical, chemical, or biological forces.

estuary A coastal water resource where fresh water from rivers mixes with salt water from the ocean.

eutrophic Usually refers to a nutrient-enriched, highly productive body of water.

eutrophication A process by which a water body becomes rich in dissolved nutrients, often leading to algal blooms, low dissolved oxygen, and changes in community composition. Eutrophication occurs naturally, but can be accelerated by human activities that increase nutrient inputs to the water body.

facultative Organisms that flourish in the presence of oxygen, but can also survive in the absence of oxygen, (in an anoxic environment).

anaerobes

faecal coliform Bacteria from the colons of warm-blooded animals which are released in faecal material. Specifically, this group comprises all of the aerobic and facultative anaerobic, gram-negative, non-spore-forming, rod-shaped bacteria that ferment lactose with gas formation within 48 hours at 35 degrees Celsius.

feeding groups: Freshwater animals can be classified as shredders, browsers, predators and filters according to the nature of their food and the way they obtain it.

Shredders – are mainly large insect larvae, which chew up dead leaves. As a group they are relatively uncommon in our streams, compared with many other countries.

Browsers – consume fine particulate matter, algae and associated bacteria, fungi and slimes that are the main components of biological films on the surfaces of stones and plants. They are by far the largest and most diverse feeding group.

Predators – feed on other living animals.

Filterers – sieve food from the water using a range of devices, including snares, nets, brushes and filtering hairs.

Collector-browsers – macroinvertebrates, which don't restrain {as do?} collector-filterers.

geographic information systems (GIS) Computer programs linking features commonly seen on maps (such as roads, town boundaries, water bodies) with related information not usually presented on maps, such as type of road surface, population, type of agriculture, type of vegetation, or water quality information. A GIS is a unique information system in which individual observations can be spatially referenced to each other.

groundwater The water that occurs beneath the earth's surface between saturated soil and rock and that supplies wells and springs.

habitat A specific area in which a particular type of plant or animal lives.

hazardous Any solid, liquid, or gaseous substance which, because of its source or measurable characteristics, is classified under national law as hazardous and is subject to special handling, shipping, storage, and disposal needs.

impact analysis Monitoring activities that aim to determine adverse effects of a particular land use on a stream or river.

impaired water Surface and ground waters that are negatively impacted by pollution resulting in decreased water quality.

impervious surface A surface such as pavement that cannot be easily penetrated by water.

intermittent stream A watercourse that flows only at certain times of the year, conveying water from springs or surface sources; also, a watercourse that does not flow continuously, when water losses from evaporation or seepage exceed available stream flow.

lake A man-made impoundment or natural body freshwater of considerable size, whose open-water and deep-bottom zones (no light penetration to bottom) are large compared to the shallow-water (shoreline) zone, which has light penetration to its bottom.

land use The way land is developed and used in terms of the types of activities allowed (agriculture, residences, industries, etc.) and the sizes of buildings and structures permitted. Certain types of pollution problems are often associated with particular land uses, such as sedimentation from construction activities.

leachate A solution or product obtained by leaching.

lentic Still or standing (water)

limiting nutrient The plant nutrient present in lowest concentration relative to need: limits growth such that addition of the limiting nutrient will stimulate additional growth.

load The volume or mass of a substance; derived by multiplying the concentration by the flow rate over a specific period of time.

loading The influx of pollutants to a selected water body.

lotic Flowing (water)

macro - invertebrate Invertebrates visible to the naked eye, such as insect larvae and crayfish.

macrophyte A macroscopic (large) vascular plant; a multicellular aquatic plant, either free-floating or attached to a surface.

metabolic waste Waste products formed as a result of metabolic processes.

metabolism The chemical changes in living systems by which energy is provided for vital processes and activities and new materials are assimilated.

mineralization The conversion of humus and soil organic matter into inorganic substances by microbial breakdown.

mitigation Actions aimed at reducing the negative effects of a particular land use or activity.

mitigation bank Habitat protection or improvement actions taken expressly for the purpose of compensating for unavoidable, necessary losses from specific future development actions.

natural community A distinct and reoccurring assemblage of populations of plants, animals, bacteria, fungi, and viruses naturally associated with each other and their physical environment.

nitrate A form of nitrogen which is readily available to plants as a nutrient. Generally, nitrate is the primary inorganic form of nitrogen in aquatic systems.

nitrification The oxidation of ammonia to nitrate and nitrite, yielding energy for decomposing organisms.

nitrogen An element which in living organisms is a component of protein structures.

nitrogen fixation The conversion of gaseous nitrogen to ammonia or nitrate.

non point

source controls General phrase used to refer to all methods employed to control or reduce non point source pollution.

non point pollution (NPS) Pollution originating from run-off from diffuse areas (land surface or atmosphere) having to well-defined source.

nutrients Chemicals that are needed by plants and animals for growth (e. g., nitrogen, phosphorus). In water resources, if other physical and chemical conditions are optimal, excessive amounts of nutrients can lead to degradation of water quality by promoting excessive growth, accumulation, and subsequent decay of plants, especially algae. Some nutrients can be toxic to animals at high concentrations.

oligotrophic Usually refers to a nutrient-poor body of water with low productivity.

oxygen-demanding materials Materials such as food waste and dead plant or animal or animal tissue that use up dissolved oxygen in the water as they decompose through chemical or biological processes. Biochemical oxygen demand (BOD) is a measure of the amount of oxygen consumed when a substance decays.

particulate matter Very small, separate particles composed organic or inorganic matter.

parts per million (ppm) A volume until of measurement; the number of parts of a substance in a million parts of another substance. (For example, 10 ppm nitrate in water means 10 parts of nitrate in a million parts of water.)

perennial stream A watercourse that flows throughout the year or most of the year (90 percent), in a well defined channel. (Same as a “live stream”.)

periphyton small plants like algae, found at the bottom of streams (autotrophs)

pesticides Chemical materials that are used for the control of undesirable insects, diseases, vegetation, animals or other forms of life.

PET Polyethylene terephthalate.

pH The negative log of the hydrogen ion concentration

(-log 10 [H+]); a measure of the acidity or alkalinity of a solution, numerically equal to 7 for neutral solutions, increasing with increasing alkalinity and decreasing with increasing acidity. The scale is 0-14.

phosphorus An element essential to the growth and development of plants, but which, in excess, can cause unhealthy conditions that threaten aquatic animals in surface waters.

phytoplankton Free-flowing microscopic aquatic organisms capable of photosynthesis.

plankton Mostly microscopic (some are barely visible to the naked eye) aquatic organisms found in the lighted upper layers of the water column. Includes photosynthetic (phytoplankton) and hetertrophic (zooplankton) organisms.

point source Any confirmed and discrete conveyance from which pollutants are or may be discharged. These include pipes, ditches, channels, tunnels, conduits, wells, container, and concentrated animal feeding operations.

point source pollution Water pollution that is discharged from a discrete location such as a pipe, tank, pit, or ditch.

pollutant A contamination that adversely alters the physical, chemical, or biological properties of the environment. The term includes nutrients, sediment, pathogens, toxic metals, carcinogens, oxygen-demanding materials, and all other harmful substances. With reference to non point sources, the term is sometimes used to apply to contaminants released in low concentrations from many activities which collectively damage water quality over time.

protozoan Single-celled, free living, animal-like micro-organisms that occur in aquatic environments.

reservoir A constructed impoundment or natural body of freshwater of considerable size, whose open-water and deep-bottom zones (no light penetration to the bottom) are large compared to the shallow-water (shoreline) zone, which has light penetration to the bottom.

restoration The renewing or repairing of a natural system so that its functions and qualities can be compared to its original, unaltered state.

revetment — Facing of stone or other material either permanent or temporary, placed along the edge of a body of water to stabilise the bank and/or protect it from erosion.

riffle — Area of a stream or river characterised by a rocky substrate and turbulent, fast-moving, shallow water.

riparian — Relating to the bank or shoreline of a body of water.

river — A watercourse that flows at all times, receiving water from ground or surface water, for example, from other streams or rivers. The terms, 'river' and 'stream' are often interchangeable, depending on the size of the water resources and where it is.

Runoff (run-off) — Water that is not absorbed by soil and drains off the land into bodies of water, either in surface or substance flows.

salinity — The amount of dissolved salts in water, generally expressed in parts per thousand (ppt).

saprobe — An organism that feeds on non-living organic matter.

sediment — Particles and/or clumps of particles of sand, clay, silt, and plant or animal matter carried in water.

sedimentation — Deposition of sediment.

siltation — The deposition or accumulation of fine soil particles.

source control — A practice, method, or technology used to reduce pollution from a source; for example, best management practices or end-pipe treatment.

species — A class of individuals having common attributes and designated by a common name; a particular kind of atomic nucleus, atom, molecule, or ion.

stadia rod — Graduated, upright rod used for measuring gradient, or elevation. Paint a wooden dowel or metal rod with alternating 15cm-long sections of red and white. Mark with black lines at 2.5cm intervals.

storm drain — A system of gutters, pipes, or ditches used to carry stormwater from surrounding lands to streams or lakes. In practice storm drains carry a variety of substances. Sediments, metals, bacteria, oil, and antifreeze enter the system through run-off, deliberate dumping, or accidental spills. This term also refers to the end of the pipe where the stormwater is discharged.

stormwater Rainwater that runs off the land, (usually paved or compacted surfaces in urban or suburban areas) and is often routed into drainage systems in order to prevent flooding.

stratification Division of an aquatic community into distinguishable layers on the basis of temperature.

stream A watercourse that flows at all times, receiving water from groundwater and/or surface water supplies, such as other streams or rivers. The terms, 'river' and 'stream' are often used interchangeably. (see river.)

stream order Streams are often classified by size. First order – the smallest streams that have year round flow and no tributaries. Second order – formed when two first order streams meet. Third order – formed when two, Second order streams join, and so on. Stream order only changes when two streams with the same classification meet.

stream reach A section of stream used to evaluate overall stream condition or health. Each of these sections is called a stream reach. Reach boundaries may be defined by a topographic feature or other permanent structure, and are typically 50-100m in length.

submerged aquatic vegetation (SAV) Vegetation rooted in the substrate of a body of water (usually no deeper than 10 feet), that does not characteristically extend above the water surface and usually grows in associations or beds. It serves as nursery area for juveniles and supports adult populations of economically important seafood species. SAV beds also enhance water quality by reducing cloudiness and stabilising sediments. Also referred to as sea grass.

substrate The surface with which an organism is associated; often refers to lake or streambeds.

substrate sampling Sampling of streambeds to determine the percent of fine particle material and the percent of gravel.

suspended load Sediment that is transported by suspension in the water column of a stream or river.

suspended solids Organic and inorganic particles, such as solids from wastewater, sand, clay, and mud, that are suspended and carried in water.

sustainable use Conserved use of a resource such that it may be used in the present and by future generations.

swale A low place in an area of land, usually more moist and often having ranker vegetation than the adjacent higher land. Grassed swales are often used beside roads to act as a filter strip, removing pollutants from surface run-off.

thermal pollution A temperature rise in a body of water, sufficient to be harmful to the aquatic life.

thermo cline Zone of rapid temperature and density change in a stratified water body; marks the transition zone between the epilimnion and the hypolimnion. Also known as the metalimnion.

total alkalinity A measure of the titratable bases, primarily carbonate, bicarbonate, and hydroxide.

total suspended solids (TSS) The weight of particles that are suspended in water. Suspended solids in water reduce light penetration in the water column. They can clog the gills of fish and invertebrates and are often associated with toxic contaminants because organics and metals tend to bind to particles. (Differentiated from total dissolved solids by a standardised filtration process, where the dissolved portion passes through the filter.)

toxic, toxicant or toxin Poisonous, carcinogenic, or otherwise directly harmful to life. Refers to any substance or mixture which has the potential to cause death, disease, behavioural abnormalities, cancer, genetic mutations, physiological malfunctions, or physical deformities in organisms or their offspring. Organisms are vulnerable to toxicants either directly from the environment or indirectly by ingestion through food chains.

transport The movement of a soil particle, nutrient, or pesticide from its original position. This movement may occur in water or air currents. Nutrients and pesticides can be attached to soil particles or dissolved in water as they move.

trend analysis Comparing recently collected data with past or baseline data to detect changes in stream condition.

tributary A stream or river that flows into a large stream or river.

turbidity A measure of the amount of light intercepted by a given volume of water due to the presence of suspended and dissolved matter and microscopic biota. Increasing the turbidity of the water decreases the amount of light that penetrates the water column. High levels of turbidity are harmful to aquatic life.

upstream/ downstream design A water quality monitoring design that uses two water quality monitoring sites. (One station is placed directly upstream from the area where the testing will be done and the second is placed directly downstream from that area.)

variable A water quality constituent (for example, total phosphorus pollutant concentration) or other measured factors (such as stream flow, rainfall).

warm water fish Prefer water temperatures ranging between 18-29 degrees C (65-85 degrees F); include fish such as small-mouth bass, large-mouth bass, and bluegill.

water management The practice of limiting the amount of water used in activities such as animal waste flushing systems or milking operations in order to reduce the amount of run-off and therefore, decrease the probability of polluting nearby surface water.

water quality standards Established limits of certain chemical, physical, and biological parameters in a water body; water quality standards are established for the different designated uses of a water body.

water table The depth or level below which the ground is saturated with water.

watershed The area of land from which rainfall (and/or snow melt) drains into a single point. Watersheds are also sometimes referred to as drainage basins or drainage areas. Ridges of higher ground

	generally form the boundaries between watersheds. At these boundaries, rain falling on one side flows toward the low point of one watershed, while rain falling on the other side of the boundary flows toward the low point of a different watershed.
zooplankton	Free-floating or weakly-swimming planktonic organisms not capable of photosynthesis.

NB: See the on-line *'Water Words Dictionary'* for a more comprehensive list of terms:

(http://www.state.nv.us/cnr/ndwp/dict-1/waterwds.htm**)**

Useful Contacts

DEPARTMENT OF CONSERVATION ADDRESSES

NORTHLAND CONSERVANCY OFFICE

P O BOX 842

149-151 BANK STREET

WHANGAREI
Phone: (09) 430 2470 Fax: (09) 430 2479

WHANGAREI AREA OFFICE
P O BOX 147
8A KAKA STREET
WHANGAREI
Phone: (09) 430 2133 Fax: (09) 437 4551

TAREWA PARK VISITOR INFORMATION CENTRE
92 OTAIKA ROAD
WHANGAREI
Phone/Fax: (09) 430 2007

RUSSELL FIELD CENTRE
P O BOX 134
THE STRAND
RUSSELL
Phone: (09) 403 9005 Fax: (09) 403 9009

KERIKERI AREA OFFICE
P O BOX 128
LANDING ROAD
KERIKERI
Phone: (09) 407 8474 Fax: (09) 407 7938

WAIPOUA FIELD CENTRE
PRIVATE BAG
WAIPOUA FOREST PARK
DARGAVILLE
Phone: (09) 439 3011 Fax: (09) 439 3016

TROUNSON KAURI PARK
R D 9
DARGAVILLE
Phone/Fax: (09) 439 3017

KAITAIA AREA OFFICE
P O BOX 569
127 NORTH ROAD
KAITAIA
Phone: (09) 408 6014 Fax: (09) 408 6019

TE PAKI FIELD CENTRE

PRIVATE BAG 2007
KAITAIA
Phone: (09) 409 7521 Fax: (09) 409 8104

Central Government

Ministry for the Environment	phone:	(04) 498 7493
PO Box 10-362	fax:	(04) 471 0195
WELLINGTON	website:	http://www.mfe.govt.nz

Note: The role of the Ministry for the Environment in environmental education is to set overall national directions; establish a framework within which other sectors can develop their own strategies and plans; and to provide funding (according to certain criteria) through the Sustainable Management Fund for those initiatives, which improve the understanding of the environment.

Ministry of Education	phone:	(04) 473 5544
PO Box 1666	fax:	(04) 499 1327
WELLINGTON	website:	http://www.minedu.govt.nz

Ministry of Education	phone:	(04) 568 7547
Learning Media Ltd.	fax:	(04) 568 3584
PO Box 39-055		
Wellington Mail Centre		
WELLINGTON		

Note: The Ministry of Education sets policy, aims and objectives for the education sector. It also provides the framework for curriculum documents for schools.

Ministry of Agriculture and Forestry	phone:	(04) 474 4100
ASB Bank House	fax:	(04) 474 4244
101 The Terrace	website:	http://www.maf.govt.nz
PO Box 2526		
WELLINGTON		

New Zealand Qualification Authority	phone:	(04) 802 3000
PO Box 160	fax:	(04) 802 3110
WELLINGTON	website:	http://www.nzqa.govt.nz

Note: The NZQA sets standards/criteria for assessment for unit standards and school qualifications (e. g. School Certificate, Sixth form certificate, University Entrance and bursary — Note also: These standards are undergoing review).

Crown Research Institutes

National Institute of Water and	phone: (07) 856 7026
Atmospheric Research	fax: (07) 856 0151
PO Box 11-115	website: http://www.niwa.cri.nz
HAMILTON	

(Provides scientific expertise on rivers and streams, identification of macroinvertebrates, information on water monitoring techniques and equipment. Also produces a bimonthly newsletter and magazine on water issues.)

AgResearch Ruakura	phone: (07) 856 2836
Ruakura Research Centre	fax: (07) 838 5012
Private Bag 3123	website: http://www.agresearch.cre.nz
HAMILTON	

AgResearch undertakes research programmes for the pastoral sector including sustainable land management. Developer of the Waterway Self Assessment Scale for rural landowners.

Landcare Research	phone: (03) 325 6700
Manaaki Whenua Press	fax: (03) 325 2418
PO Box 69	email: domestic@landcare.cri.nz
LINCOLN	website: http://www/landcare.cri.nz/mwpress

Publishes a vast array of material on environmental issues relating to land and biodiversity management and research.

Terralink New Zealand Ltd	phone: (07) 838 6250
PO Box 123	fax: (07) 838 6260
HAMILTON	website: http://ww.terralink.co.nz/

Provides maps (topographic, terrain, park and track, electoral and others) and geospatial information.

Local Government

Environmental Waikato (Waikato Regional Council) PO Box 4010 HAMILTON EAST	phone: fax:	(07) 856 7184 (07) 856 0551
ARC Environment (Auckland Regional Council) Private Bag 92-012 AUCKLAND	phone: fax: website:	(09) 379 4420 (09) 366 2155 http://www.arc.govt.nz
Environment BOP (Bay of Plenty Regional Council) Box 364 WHAKATANE	phone: fax: website:	(07) 307 2545 (07) 307 2544 http://www.boprc.govt.nz
Canterbury Regional Council Box 345 CHRISTCHURCH	phone: fax: website:	(03) 365 3828 (07) 365 3194 http://www.crc.govt.nz
Hawkes Bay Regional Council Private Bag 6006 NAPIER	phone: fax: website:	(06) 835 3164 (06) 835 3601 http://www.hbrc.govt.nz
Manawatu-Wanganui Regional Council Private Bag 11-025 PALMERSTON NORTH	phone: fax:	(06) 357 9009 (06) 356 7477
Northland Regional Council Private Bag 9021 WHANGAREI	phone: fax: email:	(09) 438 4639 (09) 438 0012 mailroom@nrc.govt.nz
Otago Regional Council Private Bag 1954 DUNEDIN	phone: fax:	(03) 474 0827 (03) 479 0015

Southland Regional Council	phone:	(03) 215 6197
Private Bag 90-116	fax:	(03) 215 8081
INVERCARGILL		

Taranaki Regional Council	phone:	(06) 765 7127
Private Bag 713	fax:	(06) 765 5097
STRATFORD		

Wellington Regional Council	phone:	(04) 384 5708
Box 11-646	fax:	(04) 385 6960
WELLINGTON	website:	http://www.wrc.govt.nz

West Coast Regional Council	phone:	(03) 768 0466
Box 66	fax:	(03) 768 7133
GREYMOUTH		

Finding sites; initial networking with landowners, schools and community groups; providing information, expertise and advice on water monitoring and environmental issues. Providing contacts for the purchase of water monitoring equipment.

City District Councils

Contact your local city/district council for networking and possible funding/sponsorship.

Environmental Groups

New Zealand Landcare Trust

The New Zealand Landcare Trust has a steadily increasing number of facilitators throughout New Zealand. The trust can help people to set up community-based landcare groups, and assist them to find the resources and contacts needed to plan and implement successful projects.

Don Ross	phone:	(03) 349 2630
National Co-ordinator	fax:	(03) 349 2630
Landcare Trust	email:	wdr@xtra.co.nz
PO Box 16-269		
CHRISTCHURCH		

Greg Blunden | phone: (09) 407 5243
Far North Regional Coordinator | fax: (09) 407 5246
P.O Box Kerikeri | email greg@landcare.org.nz

Helen Moodie | phone (09) 436 3170
Northern Regional Coordinator | fax:
Waikaraka, RD4, Whangarei | email: helenm@landcare.org.nz

Queen Elizabeth II National Trust | phone: (04) 472 6626
PO Box 3341 | fax: (04) 472 5578
WELLINGTON
Networking to provide information about areas of native bush, which could be the subject of water monitoring programmes.

Royal Forest and Bird Protection Society of New Zealand | phone: (04) 385 7374
fax: (04) 385 7373
PO Box 631 | email: office@wn.forest-bird.org.nz
WELLINGTON | website: www.nzwwa.com/conserve/treebird/

Kiwi Conservation Club | phone: (04) 385 7374
Royal Forest and Bird Protection Society | fax: (04) 385 7373
Freepost 669
PO Box 631
WELLINGTON
Contact head office for information about local branches and members who have an interest in environmental issues and the conservation of flora and fauna.

Friends of the Earth | phone: (09) 303 4319
PO Box 5599 | fax: (09) 630 7121
AUCKLAND | website: foenz@kcbbs.gen.nz
website: http://www.foe.co.uk

Greenpeace Community Education Centre | phone: (09) 630 6317
Private Bag 92507 | fax: (09) 630 7121
Wellesley Street | website: http://www.greenpeace.org.nz
AUCKLAND

Keep New Zealand Beautiful Inc.
PO Box 76089
AUCKLAND
phone: (09) 296 1382
fax: (09) 296 1383

Trees for Survival Trust
PO Box 51-684
Pakuranga
AUCKLAND
phone: (09) 576 8168
fax: (09) 576 8168

World Wide Fund for Nature
Education Resource Centre
PO Box 6237
WELLINGTON
phone: (04) 499 2930
fax: (04) 499 2954
website: http://www.panda.org

Education Groups

New Zealand Association for
Environmental Education
PO Box 2199
WELLINGTON
phone: (04) 499 4444
fax: (04) 801 3001

Networking, sharing ideas and encouraging groups to get involved with environmental education. Promoting environmental initiatives and increasing awareness of environmental issues.

New Zealand Association of
Science Educators
PO Box 598
WELLINGTON
phone: (04) 472 7421
fax: (04) 473 1841

Provide support to science teachers and networking.

Education Advisory Service
61 Higgins Road
HAMILTON
phone: (07) 846 9055

Geography Resource Centre
Christchurch College of Education
PO Box 31-065
fax: (03) 348 4311

CHRISTCHURCH

Marine Education Society of Aotearoa (MESA)
PO Box 8
Portobello
DUNEDIN

phone: (03) 479 5842
fax: (03) 478 1825
email: sally.carsen@stonebow.otago.ac.nz

Similar Freshwater Programmes

Wai Care, Auckland http://waicare.org.nz

Wai Care is in partnership with community groups and councils to care for the waterways in their immediate area or catchment.

The Kaipatiki Ecological Restoration Project http://kaipatiki.org.nz

The Kaipatiki Ecological Restoration Project is a community-based group in Auckland, New Zealand, restoring the Kaipatiki Stream and its forest margins by ridding it of plant and animal pests while encouraging natural regeneration to take place.

Stream Sense, Environment Waikato www.ew.govt.nz/streamsense/.

Note: Stream Sense is a water quality catchment monitoring programme for years 9-13.

Schools are welcome to get involved in the monitoring of the water quality in their local stream and record the changes that occur.

This unit is curriculum linked to Geography, Biology and Science within the resource, but could be linked to other areas, for example Information Technology. It covers a range of essential skills, especially communicating and problem solving.

Adopt a Stream, Environment Southland http://www.envirosouth.govt.nz

Another water quality monitoring programme for schools, with detailed activity sheets

Streamwatch New South Wales http://www.streamwatch.org.au

Streamwatch is a dynamic environmental action network, educating and empowering communities to work together for healthy catchments. Streamwatch is (quite simply) the world's most remarkable school and community water quality monitoring and action program.

Global Rivers Environmental Network
GREEN http://www.earthforce.org/green/

The Global Rivers Environmental Education Network (GREEN) provides opportunities for young people to understand, improve, and sustain watersheds in their community. GREEN empowers young people to learn more about water quality within their watershed and use their findings to create solutions.

This award-winning program is aimed at teaching middle and high school-aged youth essential academic skills including critical thinking, teamwork, problem solving and decision-making. GREEN teaches young people how to assess watershed health with the proper tools and then undertake projects to improve environmental quality based on their findings

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Stapp W. and Mitchell M. (1995). *Field Guide for Global Low-Cost Water Quality Monitoring.* Thompson-Shore Publishers, Dexter, Michigan, USA.

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