CHAPTER 2

DESIGNING YOUR MONITORING PROJECTS

CONTENTS

WHERE DO I BEGIN?

To design a successful stream monitoring project you will need to consider the why, who, where, what, when and how of monitoring. This chapter provides a process to help you decide why you want to monitor, who you want to use your data and how to design a monitoring plan that fits your goals and your users' needs.

Designing a monitoring project will involve some back and forth. Work through the questions in this chapter, and when you have identified the stream health indicators you are interested in monitoring, read Chapter 3 to get a deeper understanding of what each indicator can tell you. A site visit may show you that some of the indicators you considered are not possible to monitor at your site and you may need to rethink your monitoring plan.

You can build your monitoring project by considering the following:

- Why do you want to monitor? Define your monitoring goals.
- What sort of background information is available for your catchment?
- Where, what, when and how will you monitor? This is the core of your monitoring plan.
- How will you document your monitoring activities and keep track of your monitoring schedule?
- What quality procedures and checks do you need so that your data can be used as you hope?

DEFINING YOUR MONITORING GOALS

Probably the most important step in developing a monitoring project is clearly describing why you want to monitor. Knowing your goals helps you plan all the other steps.

Why do you want to monitor?

Your reasons for starting a volunteer monitoring project might be to:

- **Educate and raise awareness.** To introduce a group to stream ecology or monitoring methods, so people discover the wonders of freshwater ecosystems and learn how to protect them.
- **Describe the current state.** To compare your stream with stream health standards or guidelines. This type of monitoring gives you baseline data for comparing to future changes, and can help to identify potential problems for further study.
- **Assess an impact.** To find out whether land-use activities (e.g., forestry, pastoral farming, horticulture, urban development) or a point source of pollution (e.g., sewage treatment facility) are having an impact on stream health. This might include assessing the effect of your own farm on a stream that flows through your property.
- **Investigate an issue of concern.** To find the cause of a known problem in a stream (e.g., lots of algae).
- **Evaluate a restoration project.** To assess the effect of activities (e.g., riparian fencing or planting) on stream health.
- **Detect trends.** To know whether stream condition is improving or getting worse over time, in response to changes in land use, land or riparian management, other activities (e.g., riparian fencing or planting) on stream health.
- **Contribute to regional monitoring and scientific research.** Volunteer data, especially when collected carefully and consistently through time, may be able to supplement data collected by councils and research organisations.

You might have more than one reason for monitoring. However, it is important to identify no more than three top reasons and develop the project around those. Your goals may change over time as you gain more information about your stream. Revisit the original questions you wanted to answer. Ask yourself if the background information answered your question(s), or changed the question(s) you want answered.

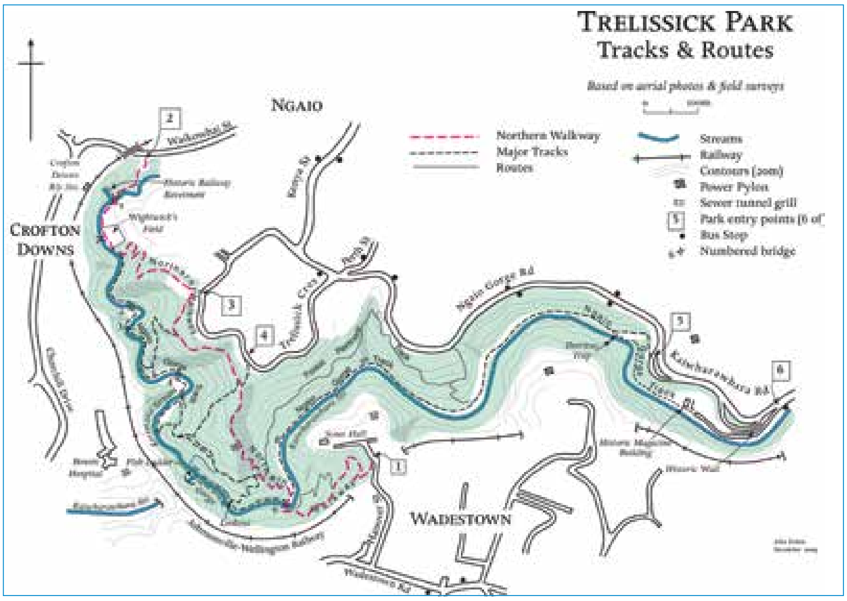
Who will use the monitoring results, and for what purpose?

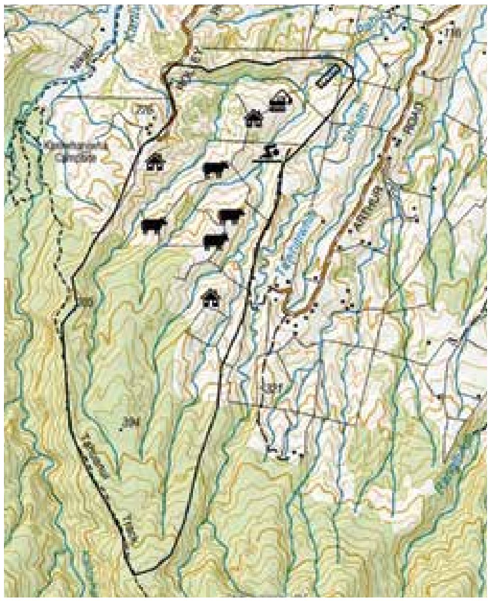
You might intend your data for yourself only, your students, your streamcare group, your local community (neighbours, catchment group, iwi/hapū), your regional council, an industry organisation (e.g. Beef + Lamb NZ, DairyNZ) or the New Zealand public.

You might intend the data to be used for:

- Education only
- A quick assessment to highlight places needing more detailed investigation
- Monitoring the effects of your own (or your community's) land management
- Adding data to council State of Environment monitoring
- Influencing decision-makers (e.g. local industries, water managers, government).

Your answers to these questions will determine how much training is needed before you monitor, which method you use (for indicators that have a quick and an advanced/detailed option), and what level of data quality and data assurance you need.





GATHER BACKGROUND INFORMATION

Before you develop your monitoring project, you should take time to review the environmental information available for your stream, its catchment (the area of land where its water comes from), and (if relevant) the issue you are concerned about. It is important to gather information about the whole catchment, especially upstream of your site(s). Remember that historical as well as present-day issues may be having an effect on your stream. If you want to monitor impacts of future developments, you need information on the developments too.

Begin by writing down what you and your group already know, making notes on a map where relevant. Then ask what else you need to know.

Sources of information

You can find a lot of information about your stream and catchment from your regional council. Council staff may be able to provide you with maps showing land use, possible pollution sources, and other features that may affect water quality and stream ecological health. Regional councils and NIWA also have up-to-date monitoring data on water quality, aquatic life, streamflow and rainfall from hundreds of sites throughout New Zealand. Data from nearby stream flow (hydrometric) and rainfall monitoring sites can be particularly helpful for interpreting your monitoring results.

Make a catchment map

Mark the boundaries and basic features of your catchment using a topographic map or any other available maps or aerial photos. A topographic map shows the shape and elevation of land forms with contour lines, normally at a scale of 1:50,000. You can find maps and aerial photos on-line or by calling your local or regional council. The aerial photos on www.nzwatercitizens.co.nz, which have REC (River Environment Classification) rivers marked, can also be used.

On the map, mark

- the stream network (including tributaries)
- relevant natural features (e.g. soil types, waterfalls, wetlands)
- land uses and human activities that may affect your stream
- ecologically, recreationally or culturally important places
- existing monitoring sites.

If you are mainly interested in what is happening on a particular parcel of land, it could be useful to make a more detailed map of that area.

For example, for a farm map, mark:

- all streams, including drainage ditches where water flows for at least part of each year
- all buildings (name them, e.g. house, hay shed, milking shed)
- roads and tracks
- water wells
- paddocks (e.g. sheep grazing, cattle grazing, crops, rotated)
- forest blocks (permanent or for harvest)
- areas that flood and areas that are permanently wet.

On the streams, mark:

- regular stock crossings
- vehicle fords
- reaches where stock have access to the water
- any locations where water is taken from the stream
- points on each stream receiving direct inputs (e.g., stormwater discharges, effluent discharges)
- vegetation along the stream bank
- unstable/eroded banks.

Catchment description form

A catchment description allows you to understand the current uses, values and threats to the streams in your catchment.

The form on the NZ Water Citizens website can help you to think broadly about the health of your catchment and will be useful for selecting monitoring locations and interpreting your results. You may want to expand on some sections or leave some sections blank and fill them in later when you have more information. As you fill out the catchment description form, add relevant information to your catchment map. We recommend asking your regional council for help with completing this catchment description and creating maps.

Keep your catchment description along with any other information about your catchment (e.g., maps, council reports, articles or news stories) together in a safe place. As you learn more about your catchment, revisit your catchment description and add to it.

WHERE TO MONITOR

The number and location of sites you choose to monitor depends on your monitoring goals. This section helps you decide how many monitoring sites you need and where to locate them.

The location of your main monitoring site may be already decided if:

- you are interested in a particular site on a particular stream (e.g., a popular swimming site, the stream that runs past your house/farm property/school/park/marae); or
- you want to learn how to monitor and need the nearest accessible stream.

Even so, you may want to add other sites for comparison (e.g. a "reference" or "control" site – see below).

You will need to plan carefully where to locate your monitoring site(s) if:

- you are interested in a whole stream (or a long section) rather than a particular place on it
- you want to investigate the effects of a particular activity or land use
- you want to determine where in a catchment the greatest impact on a stream is occurring
- you want to involve all the landowners in your catchment in learning about/improving stream health; or
- you want to add useful data to council monitoring.

Check your stream is suitable for monitoring

SHMAK has been designed for use in streams that are safely wadeable under all but high flow (flood) conditions. This normally means a maximum of 0.5 m deep, though up to 1 m deep may be fine if the current is very slow. During flood flows wading might not be safe even in quite small streams (though in some places sampling can be done safely from a bank or bridge).

Deciding on the number of monitoring sites

The number of monitoring sites depends on your monitoring goals.

- If you are monitoring for **education and awareness-raising**, to **describe the current state** of a stream compared to a guideline (e.g., to determine if it is safe to swim in), or to **contribute to regional monitoring,** you may only need to monitor a single site.
- To **assess an impact** (determine whether a particular activity, land use or discharge is having an impact) or **evaluate a restoration project**, you need to monitor at least two sites – a "*control*" site upstream and an "*impact*" site downstream of the area where the impact is suspected (see definitions below). If there are no suitable control sites upstream of the suspected impact, a site on a nearby stream of similar size and character, but lacking the impact, may be suitable for a control. A nearby "*reference*" site (see below) could also be useful to see how much your impact site differs from natural condition.
- To assess the effects of your own farm on a stream that flows through it, you will need an "*inflow*" and an "*outflow*" site.
- If you are **investigating an issue of concern**, you might need several sites around the catchment, upstream and downstream of the possible sources of the issue.
- If you are monitoring to **detect trends over time**, we recommend monitoring a "*reference*" site as well as your main site of interest. A reference site provides a benchmark to compare stream health and changes in stream health indicators over time at your main site.

Types of monitoring sites

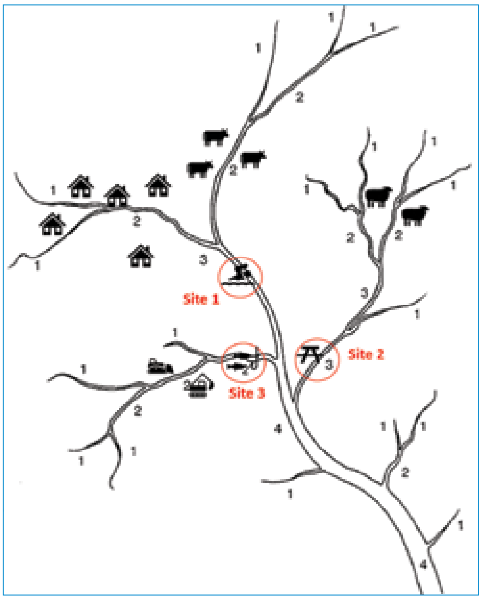
Impact sites (also called test sites) are sites affected (or suspected to be affected) by a disturbance such as a particular land use or pollution source. The 'disturbance' could also be a positive activity such as riparian restoration.

Control sites are sites that are identical in all respects to the impact site except for the disturbance or activity of interest. They are typically upstream of the impact site or on a very similar stream nearby.

Inflow and outflow sites are located where a stream enters and leaves the area being assessed. They can be used to measure the effects of a single land use (e.g., a farm) on a stream. The inflow site is equivalent to a control site, and the outflow site equivalent to an impact site.

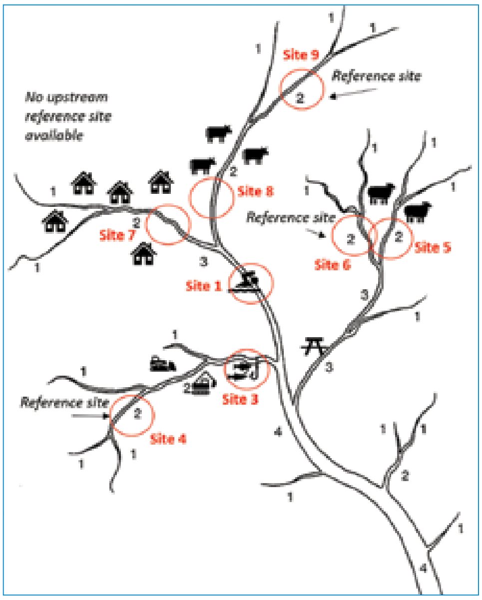
Reference sites are on a similar type of stream to your impact (test) sites but are as natural as possible. Monitoring reference sites allows you to assess how different your impact site is from natural condition, and (over time) to separate natural variation from changes due to human influences.

Case Study: Monitoring to describe the current state of specific stream sites versus monitoring for impact assessment



Example 1. Monitoring to describe the current state.

You are interested in knowing the water quality at popular recreational sites in your catchment (Sites 1-3). Monitoring these sites can provide information on its suitability for different types of recreation (e.g. swimming and boating). You can compare data you collect to relevant water quality guidelines but without control sites or reference sites it will likely be difficult to find the source of any pollution you detect.



Example 2. Monitoring for impact assessment

You want to determine if different disturbances in the catchment are having an impact on your favourite recreational sites. For each impact site, you also have a control site upstream of the impact. Some sites won't have an upstream control and so you will use a similar site on a neighbouring stream. You may also want to target specific impacts, for example urban impacts (Site 7) versus farming impacts (Site 8).

Selecting sites: step by step

Step 1: Review your map

The first step in selecting a site or sites is to review the map(s) of your stream and catchment that you made earlier. Highlight the streams you are most concerned about. The annotated map will help you to decide where to carry out the monitoring. It will also provide a record of your monitoring site locations once they are chosen. At a later stage, after you have carried out your monitoring, the information on the map may help you interpret your results.

Step 2: Mark possible monitoring sites on the map

Mark a rough location on the map for each control, impact, inflow/outflow and/or reference site that you need. Do this for each stream that you are concerned about. Think about how easily you can access the streams at the locations you have marked, and whether they are "wadeable."

Consider monitoring alongside professionals at any professionally-monitored sites nearby. If your data agree closely with theirs at this site, then you can be confident that your monitoring data at all your sites are reliable.

Estimate the time required to visit all your sites. Does the overall time commitment seem feasible if long-term monitoring is an aim? It's better to start with a few sites that you can monitor regularly, rather than over-commit yourself with too many. You can add more after you have gained confidence.

Step 3: Verify your monitoring sites

Next, visit your stream(s) to visually assess their condition, check they are accessible (wadeable, safe to enter, you have landowner permission) and ensure they are suitable for the indicators you would like to monitor. Bring your catchment map so if your first choice of sites aren't suitable you can find others.

Assign a name to each site you have selected, e.g. *"Shady Stream site 1"*. This site name (or a suitable code such as "SS1") will be used for all future monitoring.

WHAT TO MONITOR

Match indicators and methods with your goals

To avoid unnecessary effort, choose indicators that are most relevant to your monitoring goals, the issues or concerns you have about your stream, or the activities that could be causing an impact. Tables 2-1 to 2-3 outline the indicators you might choose to achieve different goals.

Some indicators in SHMAK have two methods – a quick one and an advanced (more detailed and accurate) one. Choose the method that matches your goals and the level of data quality you need to achieve them.

Consider practical factors

Your selection of indicators and methods also depends on practical factors including the equipment you have access to, number of people available, the time you can spend monitoring, your experience and confidence, and the money you have available to purchase equipment and consumables.

Table 2-1. Linking your monitoring goals with possible indicators.

MONITORING GOAL	POSSIBLE INDICATORS
EDUCATION AND AWARENESS	
Some indicators are easier to measure than others, and some have an easier and a more detailed method. Choose indicators and methods that match the skill level of your group. Some indicators take longer to measure than others. Choose ones that fit your timeframe. Aim for indicators that capture people's imaginations or that illustrate a particular teaching point.	Visual clarity, temperature, and conductivity are easy and quick Benthic macroinvertebrates and fish always grab people's interest Nitrate, phosphate, *E. coli* bacteria and rubbish are highly topical Visual clarity, nitrate and *E. coli* tests are very engaging
DESCRIBE THE CURRENT STATE	
Choose indicators that have standards or guidelines to protect ecological, recreational or other values for comparing your data to.	Visual clarity, temperature, dissolved oxygen, *E. coli*, periphyton (attached algae), benthic macroinvertebrates
ASSESS AN IMPACT, INVESTIGATE AN ISSUE, EVALUATE A RESTORATION PROJECT OR DETECT TRENDS	
Choose indicators that match your concerns and the likely effects of different activities or land uses	See Tables 2-2 and 2-3 below
CONTRIBUTE TO REGIONAL MONITORING OR SCIENTIFIC RESEARCH	
SHMAK indicators have been chosen to match those monitored by councils.	Monitor as many indicators as possible. Be aware that nitrate and phosphate may not be accurate at low levels and won't be directly comparable with council lab data.

DRAFT
Summer 2019–2020

Impact assessment

If your monitoring goals involve assessing the impact of a particular land use, land management or activity on stream health, then choose indicators that are likely to measure the impacts related to that activity. Table 2-2 shows the types of impact caused by different land uses or activities.

Table 2-2. Examples of different activities and the impact they may have on stream health. Impacts with an asterisk cannot be measured directly using SHMAK, though they will affect stream life indicators.

ACTIVITY	IMPACT ON STREAMS
Agriculture – cropping	Fine sediment, increased nutrients, loss of riparian vegetation, increased water temperature
Agriculture – livestock	Fine sediment, increased nutrients, loss of riparian vegetation, increased water temperature, faecal contamination, bank erosion
Construction	Fine sediment, rubbish, stream habitat alteration, barriers to fish migration
Forestry	Fine sediment, increased nutrients, loss of riparian vegetation, habitat alteration, increased water temperature
Industrial discharges	Toxic contaminants*, increased nutrients, organic compounds**
Urban development	Loss of riparian vegetation, faecal (and other) contamination from stormwater and wastewater inputs, altered stream habitat, barriers to fish migration, rubbish, increased water temperature

*Toxic contaminants include a wide variety of substances that could kill stream plants and animals.
**Organic compounds are substances that use up oxygen as they are eaten by bacteria.

Evaluating restoration

If you are undertaking stream restoration, the goals of your restoration will inform your choice of monitoring indicators. In Table 2-3 we outline different restoration goals, and the indicators relevant to each goal. We recommend reading more about these in ***The Restoration Indicator Toolkit*** (Parkyn et al. 2010), and also seeking professional advice. It may be wise to measure many indicators at the start (e.g. the full SHMAK range), then reduce the number to those you can keep monitoring regularly. In case you find later that some of those first indicators are important, you have some data to act as a "baseline" for comparing to later years.

Table 2-3. Suggested monitoring indicators relevant to different restoration goals. The goals refer to the main value you are hoping to restore.

NATURAL HABITAT	BIODIVERSITY	WATER QUALITY	RECREATION	DOWNSTREAM IMPACTS
Visual clarity	Visual clarity	Visual clarity	Visual clarity	Visual clarity
Temperature	Temperature	Temperature	Temperature	Temperature
Periphyton	Dissolved oxygen	Dissolved oxygen	*E. coli*	Nutrients
Macrophytes	Periphyton	Nutrients	Periphyton	*E. coli*
Streambed composition	Macrophytes	*E. coli*	Rubbish	
Stream habitat	Benthic macroinvertebrates	Periphyton		
Rubbish	Fish	Benthic macroinvertebrates		

WHEN TO MONITOR

How often you visit your site will be determined by your goals and the monitoring indicators you choose. If your goal is to look at a stream's suitabilty for swimming, then weekly monitoring during the bathing season is usually needed (as some indicators used to measure "swimmability", e.g. *E. coli*, can change quickly). If your goal is education, the timing of monitoring visits may be determined mainly by students' timetables (though to compare results from year to year it is best to monitor at the same time each year).

For most other goals, the guidelines below can be used.

ANNUAL	MONTHLY	CONTINUOUS
Benthic macroinvertebrates	Water quality indicators	Streamflow
Macrophytes	Periphyton	Water temperature
Fish	Rubbish	Dissolved oxygen
Stream habitat indicators		Conductivity

Annual indicators – These are indicators that are relatively stable over a year or are most relevant in a particular season. Monitor in the same month every year to ensure you can compare between years. Fish abundances are quite seasonal due to migrations. Macrophytes grow more in summer, and benthic macroinvertebrates are slightly more abundant in summer. Summer is the typical season for monitoring all of these.

Monthly indicators – These are indicators that show much greater variation during a year. Monthly monitoring is needed to smooth out the variations and find average levels. Monitoring at the same time each day is important for indicators that change noticeably over a day (e.g. temperature, conductivity, dissolved oxygen and pH). For periphyton and *E. coli*, you may choose to monitor monthly during the summer period only.

Continuous indicators – These are indicators that can change a lot over a single day. Continuous monitoring requires a "logger" that takes measurements automatically every few minutes (or other interval). Continuous streamflow data from your stream or one nearby may be available from your regional council.

Practical matters

The schedule described above is the one used by regional councils and is recognised as "standard practice" by professionals. So, it is the ideal if you can manage it. But monitoring water quality monthly is time-consuming. If your (or your group's) time is limited, you are free to choose your own schedule. It is better to set a slightly less demanding schedule that you can stick with for the long term rather than burning yourselves out after a few months. One good compromise may be to reduce water quality monitoring from monthly to quarterly. Be aware, though, that it will then take longer to build up enough data to understand variability, to determine average values and to see trends.

On the other hand, monitoring macroinvertebrates once a year may be not frequent enough, as it's easy to forget the different macroinvertebrate types over a year. Quarterly monitoring may help to keep you familiar with the identifications.

High flows and floods

Data collected during floods are particularly useful because floods carry high amounts of fine sediment and other contaminants. However, do not attempt to enter a stream in flood. Instead, take water samples from a bridge (if there is one, using a bucket and rope). If there is no bridge but there is safe access to the stream bank, use a pole sampler. A pole sampler can be made using a telescoping handle, such as a window-washer's pole brush, with the sample bottle taped or wired to it. Indicators usually measured by placing equipment in the stream (e.g. temperature, conductivity, black disc for visual clarity), should be measured on water samples collected in a bucket (provided this is safe). For visual clarity this would require the clarity tube method.

How long to keep monitoring

The longer you can keep monitoring, the more useful your data will be. This is for two reasons. First, all indicators change naturally over time, so you need to monitor several times to work out average values. We recommend at least three years of monitoring to have confidence in your results for **characterising current state** of your stream. Second, it often takes many years (10+) to see changes in stream condition. Some indicators change faster than others, but all will need at least five years to **detect trends** over time.

If your goal is to **evaluate the success of stream restoration**, we recommend at least two years of pre-restoration monitoring to get a good set of baseline data. For more information, consult **The Restoration Indicator Toolkit** (Parkyn et al. 2010) and your local regional council.

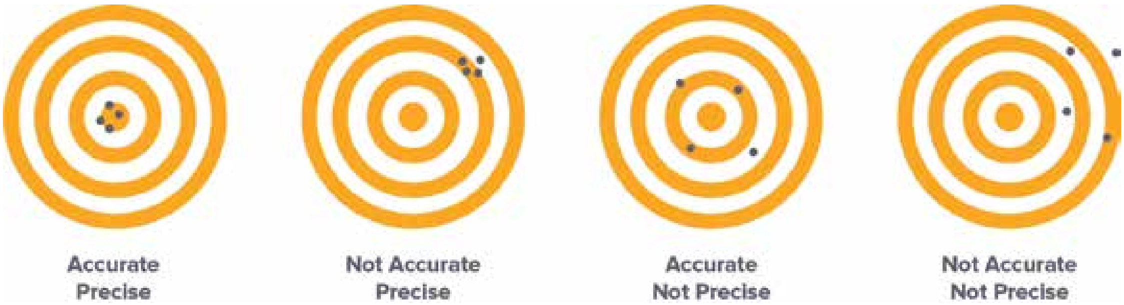
DATA QUALITY

Ultimately you need to ensure that the data you collect is of high enough quality to answer the questions you are asking about your stream. Therefore, the quality you aim for depends on your monitoring goals and who will be seeing or using your data. Generally, if you hope your data will influence (or be used by) others, it will need to be higher quality than if you are using it only for your own information. Table 2-4 is a guide to the minimum data quality needed for different goals and uses. Of course, for any goal, the higher the data quality, the more useful it will be. The highest-quality volunteer data can be defined as being closely comparable to data produced by professionals.

Table 2-4. Minimum data quality needed to achieve different monitoring goals. Use these levels in conjunction with Table 2-5.

GOAL	MAIN INTENDED USE OF DATA	MINIMUM DATA QUALITY LEVEL
Education: introduce stream ecology and monitoring methods, raise awareness	None. Emphasis is on doing rather than on the data itself	Demo
Education: a project involving data analysis	Yourself/your group	Fit for own use
Quick assessment to identify places for further investigation	Depends	Fit for own use
Evaluate a restoration project	Yourself/your group	Fit for own use
Assess your own land management	Yourself/your group	Fit for own use
Describe current state, assess an impact, investigate an issue of concern	Shared with community	Fit for shared use
Contribute to regional monitoring or scientific research	Shared with researchers/ council/public	Fit for shared use
Influence freshwater decision-making	Shared with decision-makers	Fit for shared use

DRAFT
Summer 2019–2020



Data quality concepts

Data quality is made up of a number of concepts and the "jargon" can get quite confusing. Here we outline the main concepts relating to data quality. Other terms, less-often used, are in the glossary.

Accuracy: How close the measurement is to the "true" value. The smaller the difference between the measurement and its "true" value, the more accurate the measurement. Accuracy can be determined by measuring a sample that has a known value, such as a standard reference sample from a lab, and comparing the measured value to the known (true) value. However, in the natural environment, the true value is not known, so accuracy cannot be assessed.

Reproducibility: Where accuracy cannot be assessed, the best that can be done is to assess reproducibility. This is where two different people or agencies working independently, get similar results. Reproducibility implies (but does not quite prove) accuracy.

Precision: How similar repeated measurements are when collected by the same person or someone else in your group. Repeated samples or measurements are often called replicates. Like reproducibility, precision does not tell you how accurate a measurement is.

Bias: Where your measurement is consistently higher or lower than the true value.

Quality assurance (QA): The overall plan, including the study design, monitoring protocols, training, quality control, and data management, that promotes data quality. QA begins before you even step in the stream.

Quality control (QC): The activities that are in place to control error while you are conducting your monitoring (e.g., collecting replicates, checking field instruments). These measures ensure the monitoring results are representative of the overall condition of the sample area. QC procedures can be internal (done by project volunteers) or external (done by outside professionals).

Training

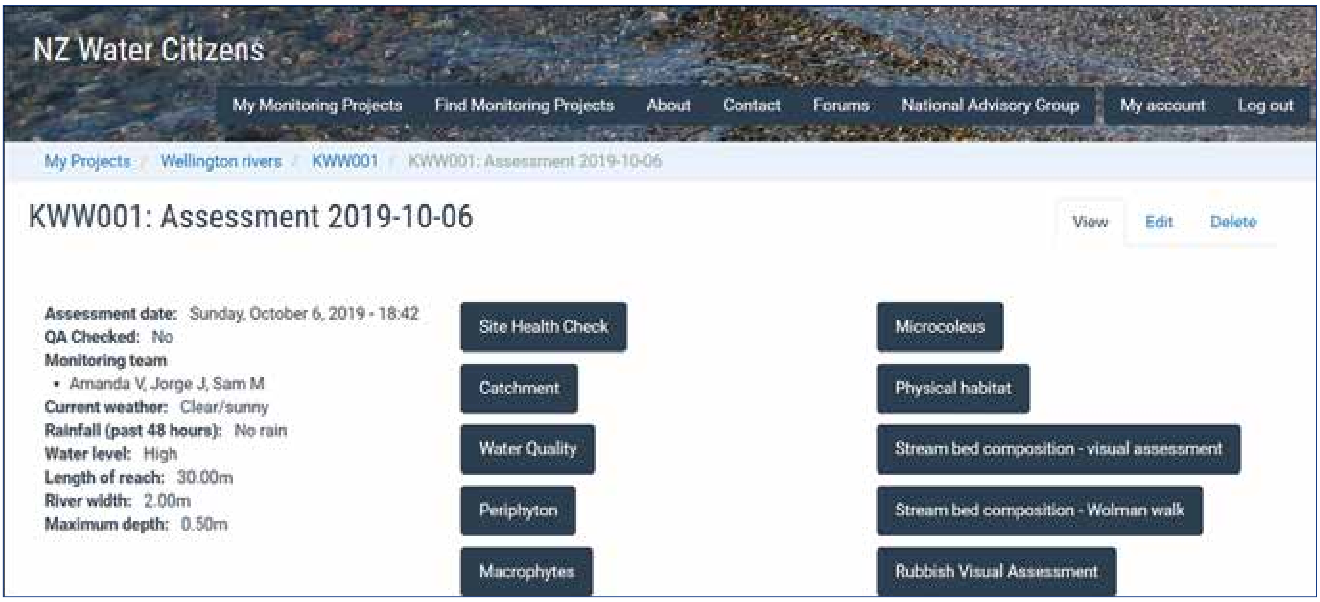
Hands-on training with a qualified instructor is key to collecting high quality data. A SHMAK training course will provide you with the necessary skills to perform all the monitoring methods outlined in this manual in a scientifically robust way. Some aspects, for example, *E. coli* methods or identification of benthic macroinvertebrates, require extended training due to their complexity. **Check the NZ Water Citizens website** to learn about training opportunities in your area. For those who can't access face-to-face training, the website also has training videos and links to other training resources. For ongoing learning, there are facts sheets, articles, web links and forums for discussions with experts and other volunteers.

Nominate a training coordinator in your group who will:

- keep up to date with training opportunities
- ensure that at least one trained person is on every sampling trip, and
- keep documentation of everyone's training.

Quality Assurance and Quality Control

Once you have decided on the level of data quality you need (relative to your monitoring goals and the uses of your data, Table 2-4 above), decide which QA/QC steps you need to reach that data quality. These steps are outlined in Table 2-5.



Internal Quality Control Procedures

Field replicates: Field replicates are two or more measurements or samples collected and tested from the same site by the same person or by two people in your group. By collecting field replicates, you can assess your performance and the precision (repeatability) of your results. For some field measurements, such as visual clarity, the method always involves two measurements. If the measurements from replicates are more than about 10% different, it could indicate differences in the way each individual is measuring. For *E. coli* and other laboratory measurements, it may be too costly to collect replicate samples every time. If so, when developing a monitoring plan, decide how often you will collect replicate samples (e.g., every 5th or 10th sampling event).

Voucher specimens: Vouchers can be physical specimens or photographs. For benthic macroinvertebrate monitoring, you can preserve a set of at least one good specimen (preferably 3 – 5) of each taxon found at a site. Your identifications can then be confirmed by an expert. Photographs, provided they are of high quality (in focus, high resolution and showing the relevant body parts), are useful if you want to release the animals back into the stream.

Blanks: A blank is a sample (usually of pure water) that you would expect to give a "zero" measurement. It is a way of checking for contamination during sample handling and analysis, and that your equipment is correctly "zeroed". A field blank is put into a sample bottle in the field, and is a check on your field and lab methods. A lab blank is put into a sample bottle in the lab and checks only your lab methods. In SHMAK, lab blanks are recommended when testing for *E. coli*. A sample bottle is filled with tap, bottled or distilled water and then analysed for *E. coli* using the same method as for a stream water sample.

Standards: A standard is a dissolved chemical solution made up in a lab to a known concentration. You can check the accuracy of a meter (such as your conductivity meter) by measuring a standard with the meter. If the meter reads too high or low, you can adjust it (calibrate it) to read the value of the standard. A chemical test such as for nitrate or phosphate can be checked in the same way. If these are not giving accurate readings, check the expiry date of the chemical test packets.

Data management: Data management represents the systems you have in place to ensure proper sampling information (date/time, site name, flow conditions, etc.) is recorded, data entry and transcription errors are minimised, missing data are noted, and data and documents are stored safely.

Choose someone in your group to check in the field that data sheets are complete and data look correct, and someone to upload data to a computer and check that no errors have been made in uploading. The NZ Water Citizens website www.nzwatercitizens.co.nz can store information about your site, details about each monitoring trip and the data collected on each trip. Other information, such as your monitoring plan, background information and maps, should be stored in a safe place (e.g., in a filing cabinet or on a shared computer drive). Make sure more than one person knows where the information is kept.

External Quality Control Procedures

External quality assurance and quality control (QA/QC) will pick up any issues with how you take measurements that could lead to errors in your data.

Field replicates: Field replicates are collected by sampling side-by-side with a professional such as regional council monitoring staff. If your results agree, this shows you can collect "reproducible" data, giving you confidence in your methods.

Data review: Asking an outside partner or agency to review your data is another effective quality control measure. This is especially important if you would like the agency to use your data. An external review can help identify gaps in your quality control efforts. It also ensures that your data collection and reporting activities make sense to others.

Auditing: A formal audit by a professional agency is probably the most thorough external QA/QC procedure. It would typically include field replicates and data review (described above) as well as checking that all field and lab methods are being followed correctly.

Table 2-5. Recommended QA/QC procedures for three levels of data quality.

QA/QC PROCEDURE	DATA QUALITY LEVEL		
	DEMO	FIT FOR OWN USE	FIT FOR SHARED USE
MONITORING PLAN			
Monitoring plan developed and recorded		Template filled in	Reviewed by professional
TRAINING AND AUDITING			
Training	Follow instructor's directions	Read manual, watch videos	Training course completed
Audit by trainer or professional			Once every 2 years
DATA COLLECTION			
Standard equipment used	For every monitoring event	For every monitoring event	For every monitoring event
Equipment is working, chemicals not expired[1]	For every monitoring event	Before every monitoring event	Before every monitoring event
Equipment calibrated or validated		Conductivity meter calibrated	Also nutrient tests validated (10%)
Containers and equipment cleaned/ sterilised[2]		For every monitoring event	For every monitoring event
Method level	SHMAK level 1	SHMAK level 1	SHMAK level 2
Record date, location, weather and flow conditions	For every monitoring event	For every monitoring event	For every monitoring event
Visual assessments done in pairs[3]		Whenever possible	For every monitoring event
Tests/observations repeated[4]		Clarity	Also 10% of water quality samples
Tests/observations repeated by a professional[5]		If possible	All indicators. Once per 2 years.
Samples stored and transported correctly	For every monitoring event	For every monitoring event	For every monitoring event
Lab blanks used for *E. coli*		On 10% of samples	On 10% of samples
DATA MANAGEMENT			
Data checked in field – correct and complete	For every monitoring event	For every monitoring event	For every monitoring event
Data stored securely		For every monitoring event	For every monitoring event
Data transfer to spreadsheet/ website checked		For every monitoring event	For every monitoring event
Data verified by expert			Checked regularly

[1] relevant equipment: clarity tube and black disc viewer (check for scratches on viewing window), temperature/conductivity meter (check correctly working), nitrate kit, phosphate checker, *E. coli* plates (check correct storage and expiry of chemicals), kick net (check for holes).

[2] sample containers for conductivity, nitrate and phosphate require cleaning. Containers and equipment for *E. coli* require cleaning and sterilising.

[3] two people discuss their estimates and agree on the value to be recorded. Relevant to visual assessments of cover (periphyton, macrophytes, stream bed composition), identification of bugs and fish, rubbish visual reach assessment.

[4] tests for "repeatability" or "precision".

[5] you and a professional monitor side by side. Either you go to a professional monitoring site, or the professional comes to your site. Tests for "reproducibility".

GIVING EVERYONE A ROLE

Running a successful stream monitoring project involves many roles and responsibilities. It is important that everyone in your monitoring group knows what tasks they are responsible for and the effort is shared among members. Think about the different tasks that need to be accomplished and agree which members of your group will take on which roles, according to their interests and skills. Examples of possible monitoring roles include:

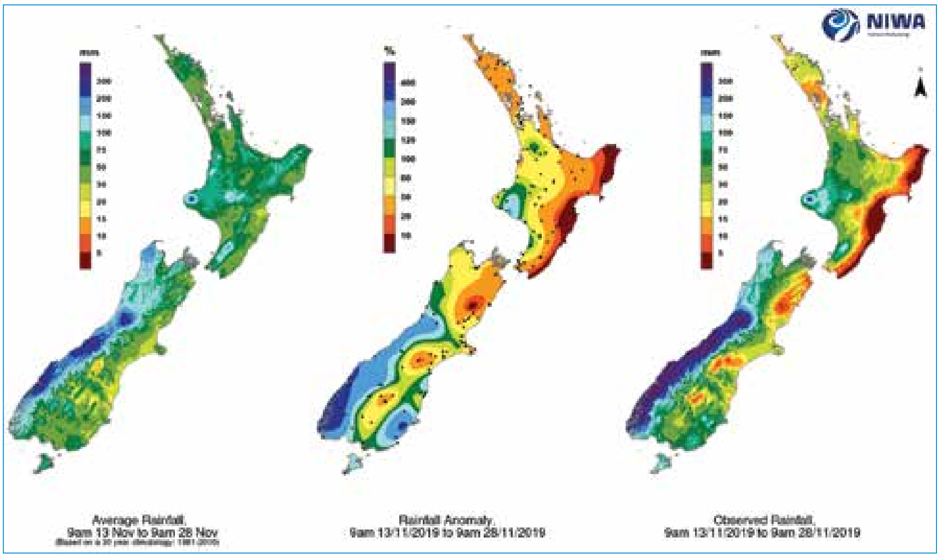
- **Project Coordinator:** The overall leader. Keeps track of the monitoring plan, reminds volunteers of monitoring dates on the schedule, convenes group meetings and training events.
- **Health and Safety Coordinator:** Oversees the development, putting in place and periodic review of a Health and Safety Plan that ensures all group members know how to stay safe when monitoring.
- **Training Coordinator:** Understands the monitoring methods and regularly upskills and attends refresher courses. Although we recommend that everyone attend a training course, your group may not have the resources to send everyone. The training coordinator could become a trainer by taking a "train-the-trainer" course when available and periodically re-watching the SHMAK training videos.
- **Equipment Coordinator:** Stores monitoring equipment, checks expiry of reagents, ensure field equipment is working, orders new consumables and replaces damaged or broken items.
- **Data Management Coordinator:** Collects and stores data sheets, enters data into database, checks for missing data, conducts data analysis and reports back to the wider group. Flags any issues to be raised with the regional council or other support agency.
- **Data Entry Assistant:** Assists with data entry, particularly checking that the all the data from datasheets have been entered into the database correctly.

Multiple roles might be performed by the same person.

DEVELOPING YOUR MONITORING PLAN

A monitoring plan gives an overview of your project, including all the decisions you made in designing your project. The monitoring plan will ensure that everyone involved in the monitoring project understands why the data are being collected and how it will be used. You should nominate a project coordinator who will lead the development of the plan and review the plan, say annually, to ensure it continues to meet the needs of the project. The value of your data is directly related to how much effort you apply in developing your monitoring plan.

A monitoring plan template can be found on the NZ Water Citizens website.



SOURCES OF INFORMATION

Land, Air, Water Aotearoa (LAWA)

LAWA presents information on freshwater and beach water quality, freshwater quantity, air quality and land cover. You can search for river monitoring sites in your region. Not all sites monitored by regional or unitary councils can be found on LAWA but it is a good starting place. LAWA also provides information on land cover (vegetation) from the New Zealand Land Cover Database (LCDB)

Ministry for the Environment (MfE)

You can browse and download information on a wide variety of information sources about your region. This includes a list of vulnerable catchments, climate data (sunshine hours, average rainfall, etc.), location of aquifers, and land use maps. MfE also publishes a report every three years on the state of New Zealand's fresh waters as part of their Environmental Reporting Series.

NZ Landcare Trust

NZ Landcare Trust works with landowners from across the country and support catchment groups in restoring and monitoring streams. NZ Landcare Trust may have been involved in a project on your stream or in your catchment. Their regional webpages provide more detailed information on projects and the contact details of the NZ Landcare Trust coordinator in your region.

NIWA

New Zealand Freshwater Fish Database (NZFFD)

The New Zealand Freshwater Fish Database contains over 34,000 freshwater fish observations. Data stored include the location of sample sites, the fish species present, as well as information on their abundance, size, sampling methods and a physical description of each site. You can search for fish species found in your catchment.

National Climate Database

The climate database receives data from over 600 climate stations across the country. It includes data on rainfall, temperature, sunshine, frost, wind and rain. Search the database to determine your closest climate station.

National River Information

NIWA monitors river flows and water quality at a number of sites across New Zealand. Use NIWA's Hydro Web Portal to explore all data locations using a map. Select the sites in your catchment to view and export available data.

NIWA has also produced NZRiverMaps, an interactive web-based tool for exploring national scale estimates of various river-related properties, including water quality, hydrology, bed sediment size, invertebrates, fish presence, bed sediment cover and water allocation.

Our Environment – Manaaki Whenua Landcare Research

Our Environment provides access to Manaaki Whenua Landcare Research's environmental data. You can use online, interactive maps to learn about geology, soils, vegetation, land use etc. in your area, and create custom maps to help you select monitoring sites.

NZ Water Citizens

The NZ Water Citizens website stores data that have been entered by other volunteer monitoring groups. You can view, graph and download data from other groups in your area.