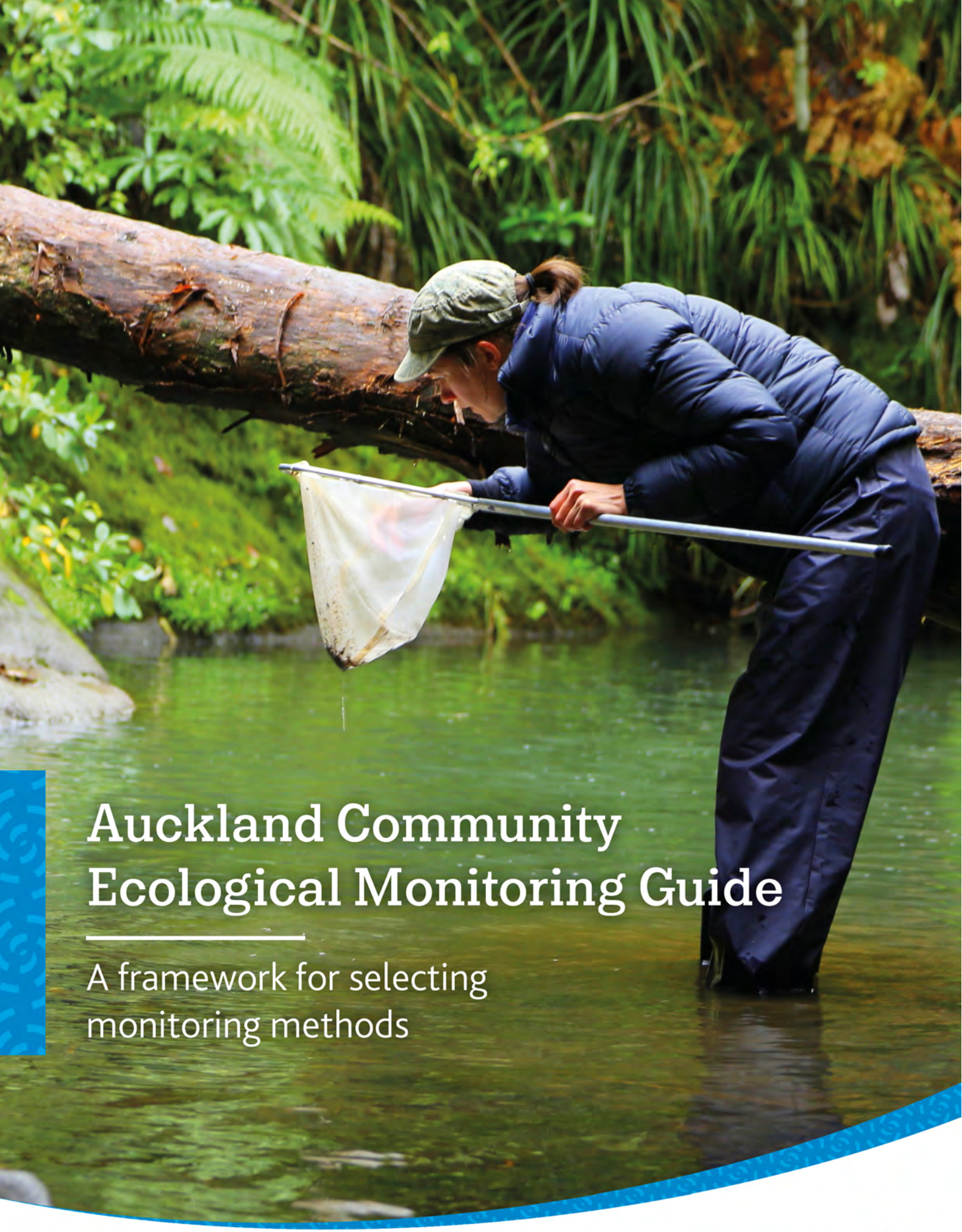

Auckland Community Ecological Monitoring Guide

A framework for selecting monitoring methods

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1 Introduction

Use this guide to choose the best methods to monitor the health of ecosystems or ecosystem components that your community group is managing, restoring or studying. The guide will help you to measure changes in the state of animal pests, weeds, water quality, habitat health, vegetation, planting progress and native wildlife in Tāmaki Makaurau / Auckland's diverse ecosystems. How you use this guide will depend on the stage of restoration your group and project has reached. If you are checking and reviewing your current approach to monitoring, you can dip into the section you need, or if you are just beginning to set up your monitoring, we recommend you work through the whole guide.

Community-led ecological restoration projects are making a significant contribution to conserving Tāmaki Makaurau / Auckland's environment and its unique biodiversity. Well over 100 community groups are now engaged in restoration projects and collectively helping to turn the tide on biodiversity loss and ecosystem decline. Many more unlisted groups and individuals also contribute. Dedicated volunteers work in a range of ecosystems including forest, scrub, lakes, streams, wetlands, estuaries, dunes and rocky shores. Their activities commonly include:

- managing pests (e.g. possums, rats, stoats, pigs, hedgehogs, goats)
- fencing out livestock
- controlling weeds (e.g. willow, woolly nightshade, ginger)
- planting new areas to increase habitat
- planting streambanks (riparian areas) to improve water quality and stream health
- clearing litter
- returning missing threatened species to where they were once found.

Restoring an ecosystem to a healthy state is a major task for any group of volunteers. Monitoring the inputs (i.e. activity monitoring), as well as what has been achieved (outcome monitoring), is essential to ensure the project is on the right track towards achieving its objectives. To obtain robust data that supports and informs the project; monitoring needs to be well planned, resourced and timely, along with the appropriate expertise, to help design the study and collect, analyse and interpret the data.

1.1 The scope of the guide

This guide helps you select the monitoring methods most suitable for your group, project and restoration objectives. It doesn't contain a complete list of all monitoring methods and doesn't detail how to do each method. Instead the guide provides a link to each monitoring protocol along with information about where to get further support.

Each method has been selected for its scientific rigour, relevance to Tāmaki Makaurau / Auckland ecosystems, broad relevance to community group projects, and suitability for people with varying levels of skill and experience. Methods needing special skills or qualifications (e.g. SCUBA diving), expensive equipment, or which pose a significant risk to users or the environment, are not included. Groups planning to use these types of methods should seek expert advice. Although many projects have a strong education and advocacy component, social research is a specialist area and beyond the scope of this guide. Detailed procedures for managing health and safety aspects of monitoring operations are also not included.

1.2 How the guide works

The guide is structured into the following five sections:

1. **Understanding your project**

   Take a step back, talk with your group (if you have one) or others doing similar work, and briefly set out key parts of your project. This will really help in the long term by making sure you have monitoring that suits your project.
2. **Practical monitoring outline**

   A range of practical considerations when deciding what monitoring to undertake – like a monitoring design checklist.
3. **Data Storage**

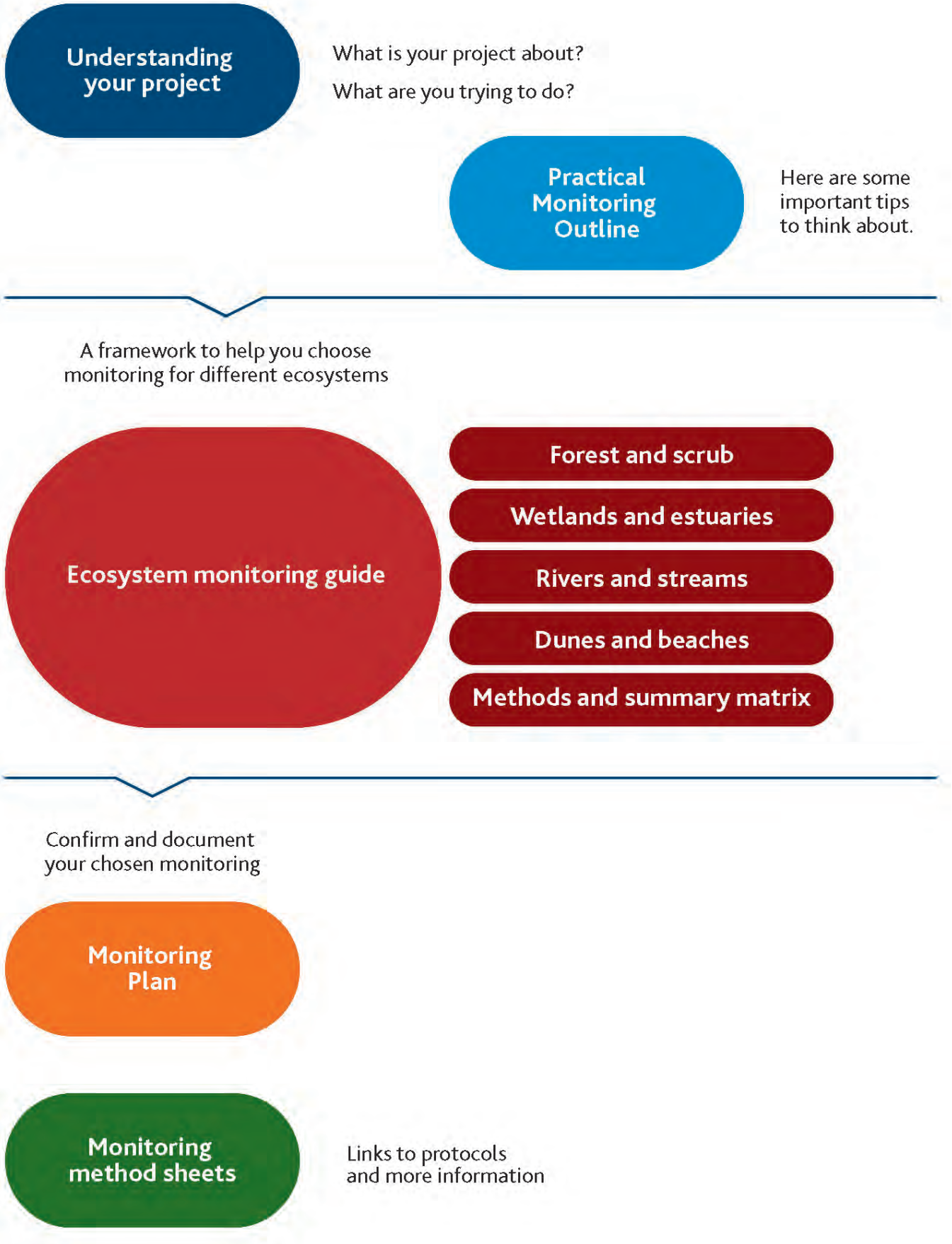
   Considerations for storage of data, analysis and interpretation.
4. **Ecosystem monitoring guide**

   This section guides selection of monitoring methods suitable for monitoring common activities and outcomes in Tāmaki Makaurau / Auckland ecosystems (forest and scrub, wetlands and estuaries, rivers and streams, dunes and beaches).
5. **Monitoring plan**

   A simple template to record your monitoring plan, setting out what monitoring methods you will use and how. The template helps to ensure your monitoring plan is applied, by allowing everyone, now and in the future to see the plan – and the monitoring decisions you have made.
6. **Monitoring method sheets**

   A series of individual sheets for each method. Sheets set out basic information about the method and where to find its protocol or instruction

Figure 1. The layout of Auckland Community Ecological Monitoring Guide sections



1.3 Which monitoring methods are included

A bewildering array of monitoring methods exist in New Zealand to measure ecosystem change. For this guide, to select the most suitable methods for community ecological restoration projects, a wide range of methods was reviewed using eleven criteria developed from discussions with community group representatives and council staff. Each method was then assessed against the criteria and then rated overall as being of high suitability (a score of 3), medium suitability (a score of 2), or low suitability (a score of 1). Individual monitoring method summary sheets include the criteria for assessment and provide additional information for each method, see section 7.

Table 1. List of criteria used for each monitoring method and definitions for highly suitable, medium and low suitability

Criteria	High suitability (3)	Medium suitability (2)	Low suitability (1)
Scientific robustness	Well accepted and used across a range of organisations. Used in scientific papers; long history of use. There is an existing clear and agreed standard protocol for its use.	Several effective studies have used this method. More recent but appears reliable. Standard protocol but may be some variability in use.	Relatively new or little-used technique. Uncertainty over its robustness. No standard protocol.
Broad applicability	Measurement provides useful data for a wide range of indicators (e.g. tracking tunnels can provide rodent, invertebrate and lizard information).	Can be used to collect data on a narrow range of indicators.	Only suitable for specific measurement of one indicator (e.g. lizard terrestrial artificial cover).
Skill level required	**Easy** – Can be easily picked up on the job and immediately undertaken (e.g. photopoint). Simple to measure. Easy to understand the results.	**Medium** – Requires some training but can be accomplished by most individuals with training and support (e.g. five-minute bird count).	**High** – Suitable only for specialist with tertiary education and experience in the subject (e.g. mist netting, invertebrate survey).

Criteria	High suitability (3)	Medium suitability (2)	Low suitability (1)
Precision / sensitivity	Can provide high precision with relatively small sample sizes. Able to pick up changes over fairly short time frame (one-two years).	Can pick up some indicators with good level of precision.	Difficult to identify clear changes with confidence unless they are very large. May require several years (or longer) for changes to show up.
Data management	Existing well-used data storage and analysis are available.	Data management partially developed. For example, may be standard data structures and analysis approaches, but no national storage.	No existing data management system.
Data analysis	Data management is easy to use and generate summary results. No specialist skills required.	Will require some skill to analyse the data, but easily learned.	Complicated to analyse, requires specialist post sample collection analysis (e.g. lab testing).
Cost and equipment	**$** – Only requires common household equipment or free set of instructions. Likely < $200.	**$$** – Will require purchase of some specialist equipment but generally easily obtained and inexpensive. Likely < $1000.	**$$$** – Expensive specialist equipment or lab analysis required. Likely > $1000.
Time	**Quick** – Very quick to undertake both measurement and analysis, and does not need to be frequently repeated.	**Moderate** – Moderately quick to take the measurement (less than one hour per sampling station) and does not need to be done frequently or require lengthy analysis.	**Long** – Would take several days to capture the required data (e.g. many repeat visits over a year) or requires very extensive analysis.

Criteria	High suitability (3)	Medium suitability (2)	Low suitability (1)
People	**Quick** – Can be safely and effectively achieved by one-two people.	**Moderate** – Would need a small group of people (three-five) working simultaneously.	**Long** – Requires a large group of people (more than five) working simultaneously to capture required data.
Safety	Safe activity with no significant hazards or risk management required other than general working in the environment/ with other people etc. Low probability of serious injury.	Some risk involved with moderate to high probability of an incident that could lead to serious injury. Controls needed.	Hazardous activity requiring certification (e.g. tree climbing and use of ropes). Significant controls needed to minimise risk of serious injury or death.
Permit requirements (e.g. lizard handling)	No permit required.	Requires permit/consent from one agency.	Requires permit from more than one agency (e.g. DOC, ethics board, council).

2 Understanding your project

Each community ecological restoration project differs from the next. The ecosystem you are working in, the location, your project vision and objectives all define what sort of monitoring is best and the types of methods used.

2.1 Which ecosystem(s) are you working in?

A feature of the Tāmaki Makaurau / Auckland area is its diversity of ecosystems and community groups' project sites reflect this. Identifying the broad ecosystem type(s) of your project site will guide your restoration and the monitoring to choose. Tāmaki Makaurau / Auckland ecosystems in this guide are categorised as:

- Forest and scrub
- Wetlands and estuaries
- Lakes and streams
- Dunes and beaches.

The ecosystem section in this guide explains each ecosystem type more fully[1].

In Tāmaki Makaurau / Auckland as in many cities, original ecosystems are often highly modified. What remains can be severely degraded or cleared/drained altogether in favour of urban and rural development. However, restoration is still important in these areas and can happen at a backyard level. This could involve weed control and planting on your own property or being part of neighbourhood pest animal control or Weedbusters group.

You can still do ecological monitoring in a modified environment, i.e. urban backyard, and to help you identify these ecosystems in their modified condition we have provided modified ecosystem descriptions in section 5 ecosystem monitoring guide.

Threats to ecosystems, restoration activities carried out, and what we want to find out by monitoring them, varies widely across ecosystem types. Managing and monitoring forest seedlings, for example, is important in a forest, but less so on dunes and beaches. Some management and monitoring, such as pest animal control, will be similar across several ecosystem types, e.g. across forest, wetland and dune ecosystems.

[1] The Guide does not include marine ecosystems, rock stack/cliff ecosystems, or subterranean systems.

If you are working across several different ecosystems, you will need to consider how that affects the management and monitoring of your project area. You may find that there are methods that work in two or more of the ecosystems you are working in. If your site has forest and wetland, for example, chew cards may be a better pest monitoring tool than tracking tunnels, which could end up flooded in the wet areas.

2.2 What is your vision?

Be as clear as you can on what the long-term, big picture vision for your project is – this is the legacy your project will leave. Some projects start because of a simple desire for action, e.g. to control pests, with a bigger, more encompassing vision evolving over time. Other projects start with a clear vision that identifies a problem that needs solving, e.g. “Bring the dawn chorus back to our suburb”, or “Develop a corridor of protected habitat from the mountains to the sea”. Have a discussion with your group as well as project partners (or think about your own project). Develop a brief statement that is inspiring and easily understood by the wider community, and broad enough to engage your target audience.

Definition: vision

In your vision statement include key changes that will take place in the long-term or problems that will be solved because of your project. What will you see/experience in the future when you visit this place?

2.3 What are your short, medium and long-term objectives?

Many community-led ecological restoration projects are long-term efforts with a vision that can only be realised over decades (or longer). Restoration activities and the outcomes resulting from them form the pathway towards achieving the vision. Objectives give structure to the project. Using the SMART (**S**pecific, **M**easurable, **A**chievable, **R**elevant, **T**ime-bound) framework keeps objectives grounded and easier to report on, for example “Tracking tunnel rates for rats are less than 10% across the reserve by 2020” or “Infestations greater than 1m^2 of the weed *Tradescantia fluminensis* have been controlled and removed from 2km of stream bank by 2019.”

Definition: objectives

Specific areas of work or outcomes you will achieve as you move toward your vision. Objectives should be "SMART" – **S**pecific, **M**easurable, **A**chievable, **R**elevant, **T**ime-bound. What restoration management activities are you doing?

Identify the management activities your project is undertaking. These are the specific things you are doing to protect and restore the whole ecosystem, or particular species within an ecosystem. Activities commonly carried out in Tāmaki Makaurau / Auckland restoration projects include:

- controlling pest animals such as possums, rats, stoats, hedgehogs and feral cats that threaten native species
- controlling weeds such as woolly nightshade, ginger, privet and willow
- planting native species on stream and riversides (riparian zones) and other areas where weeds have been cleared to create habitat and restore ecosystem function
- removing rubbish from beaches and streams.

Definition: activity

Operational management works such as controlling pest plants and animals and planting and restoring native species.

2.4 What outcomes are you looking for?

Outcomes are the changes that result from project restoration activities. If we control possums, rats and stoats, for example, the desired outcome could be an increase in native birdlife. If goats are controlled, an outcome could be improved vegetation condition such as more native seedlings in the forest understorey. Common outcomes for community ecological restoration include:

- **Native wildlife:** increased bird numbers in general or increases in particular species such as bittern, dotterel, kererū, tui; or increased numbers of lizards or amphibians, or increased numbers of wēta and other large invertebrates, or increased fish abundance.
- **Vegetation:** improved canopy health and forest understorey.
- **Water:** improved conditions for stream life and reduced sediment levels.

Monitoring the outcomes of your restoration activities either confirms that your management activities are effective, or indicates where you need to make changes to achieve your objectives.

It is easy to focus on the ecological restoration outcomes because that is what our projects are primarily about. Social outcomes are also important and include enhanced scientific and ecological literacy in the community; improved social contact and community building; the creation of local employment; as well as health and fitness benefits. Although measuring social outcomes can be challenging, ultimately, they will provide a more holistic view of your restoration project. If you are interested in these aspects, seek specialist advice.

Definition: outcome

The specific ways in which the ecosystem has changed in relation to your management, resulting for example in more native bird life, improved water quality, more native vegetation cover, etc.

2.5 So where does monitoring fit in?

Monitoring provides critical feedback for managing your project, understanding whether your activities are making a positive change to your site, and if project objectives are being achieved. Without some level of monitoring in place we do not have a measurable restoration project. Monitoring can be large-scale, time intensive programmes, but there is also a wide range of monitoring you can choose from that won't significantly increase volunteer time and effort. Monitoring can be as simple as consistently recording trap catches, or visually documenting change by annually photographing the same project site(s).

Monitoring is important to:

- track progress toward your project objectives
- quantify your project achievements to funders, as well as support applications for new funding
- boost your volunteers' morale by demonstrating the differences they have helped to make
- flag new concerns, e.g. pest increases may mean changing trap and bait set up
- save time by focussing on things that work best and leaving those that don't
- inspiring other community members to volunteer on a project that has a proven track record for making a difference
- provide data for local, regional and/or national level State of the Environment reporting.

Definition: monitoring

Repeated collection of observations or measurements to detect change in condition or progress toward a management objective.

Definition: monitoring question

The key question you want your monitoring to answer will often be framed around the objectives of your project, e.g. How has bird abundance changed over time? What area of new forest has been planted?

Definition: activity monitoring

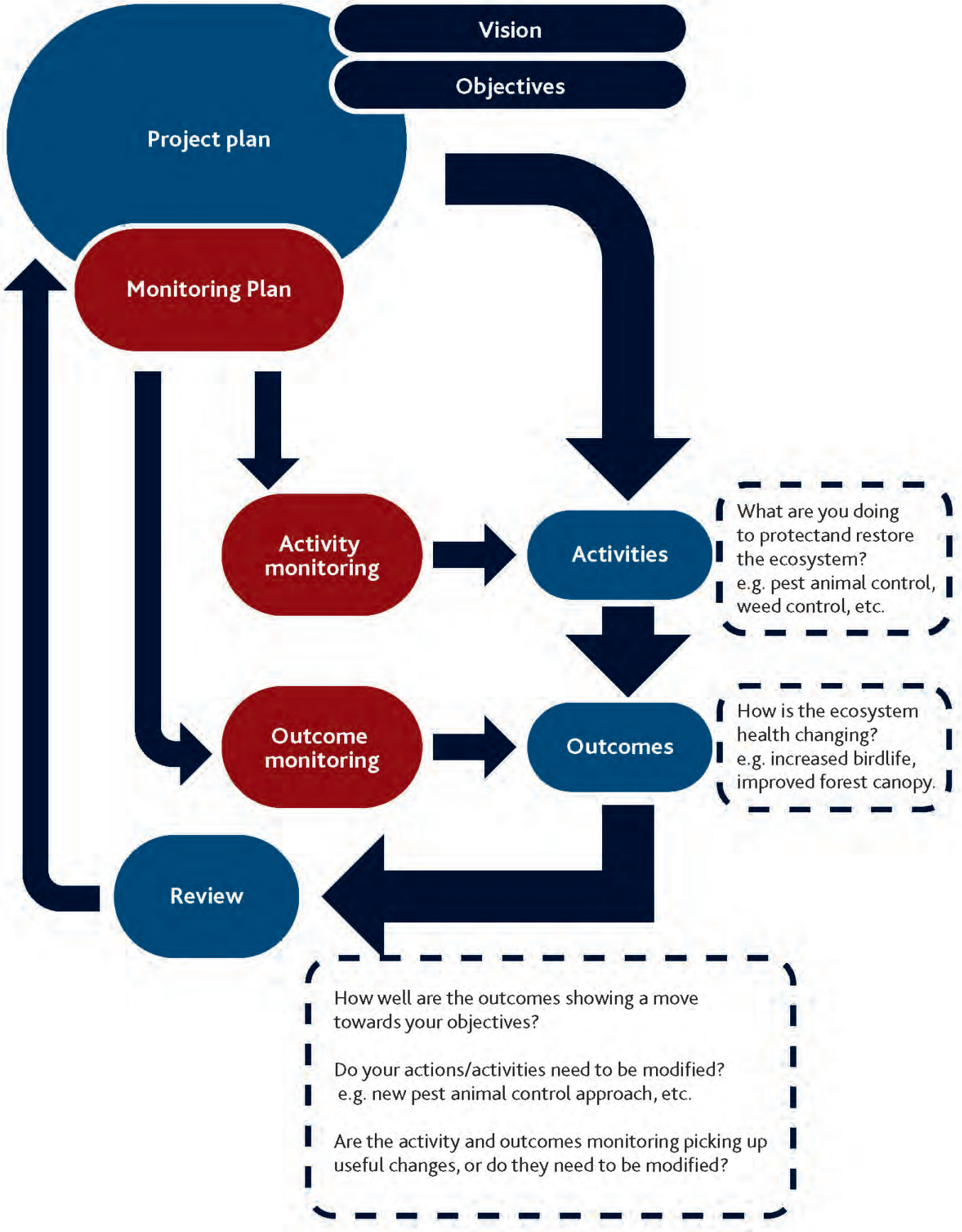
Monitoring the management activities carried out on your project such as pest animal control, weed control or planting. Activity monitoring examples include using tracking tunnels to give an index of animal pests, recording predator trapping results, recording area and number of plants planted.

Definition: outcome monitoring

Monitoring the results of your management activity, i.e. the changes that have occurred in your ecosystem/project area. Outcome monitoring examples include changes in native bird abundance, changes in water quality and changes in the number of native seedlings in the understorey.

As outlined in the diagram below, effective restoration project monitoring should be part of a cycle of planning, activities, outcomes and review. Both activity monitoring and outcome monitoring show how the project is progressing and where management can be improved.

Figure 2. The monitoring cycle



3 Practical monitoring outline

This section is like a monitoring design checklist. It provides a range of practical insights to monitoring to help you decide what monitoring you will undertake. Each subheading below is incorporated into the monitoring plan section of this guide. We recommend you work through this section of the guide as you fill in your monitoring plan.

3.1 Your site

3.1.1 Quick Health Check

A health check is useful if the project is new, or you are doing a review of your project and monitoring programme. The check provides a quick visual assessment that covers many aspects of your project area/ecosystem. It's useful for helping to pinpoint where the biggest management issues are and where your management and monitoring should be focusing. It is advisable to get an expert to interpret the results of your health check.

Examples of Quick Health Checks include:

- FORMAK site assessment: http://formak.co.nz/pdfs/03-site-assessment/site-assessment-field-instruction.pdf
- WETMAK the wetland WOF check: http://www.landcare.org.nz/files/file/1219/Module%203%20Wetland%20WOF%20Check.pdf
- Waicare SoSmart assessment: https://waicare.org.nz/Files/3%20-%20Field%20Manual.pdf

3.1.2 Scale

The scale of community-led ecological restoration projects around Tāmaki Makaurau / Auckland varies widely – from urban backyards and small urban reserves to projects along large tracts of coastline and forest in the Waitākere and Hunua Ranges. Each of these projects contribute to restoring and protecting Tāmaki Makaurau / Auckland's biodiversity, however the way monitoring is selected and applied to these diverse projects is influenced by their scale and location.

The protocols for some monitoring methods require measurements that may be difficult to achieve in some locations.

A good example of this is choosing the right scale of monitoring to account for the size of animal home ranges.

The influence of home range on pest animal monitoring in small project areas

Whenever you monitor pest animals make sure you know the approximate home range sizes of the pest species you are targetting. If the home range of a pest is much bigger than your project area, it will be difficult to relate your pest monitoring results to your pest control, because the results will be influenced by what is happening over a larger area outside your project boundaries.

The shape of your control area will also determine how well you can defend the core area from reinvasion. Narrow vegetation corridors with lots of edge will be harder to defend and monitor than square or circular areas. If you have a smaller project, don't be discouraged. Rather, see this as an opportunity to collaborate with neighbours and carry out restoration work over a wider area. It is still worth monitoring small projects, but keep in mind the constraints and the effects of outside influences. This is where simple presence and absence data may be the most useful monitoring outcome.

Table 2. Examples of home ranges for some common pest animal species. For further information, see 'Pest Animal Control Guidelines for the Auckland Region' (available on Auckland Council website 2018).

Species	Home range in metres
Possum	120 (female), 140 (male)
Rat	160 (ship rat), 600-700 (Norway rat)
Mouse	30
Stoat	1300

Major projects in large areas

In large areas (e.g. > 300 hectares), a wider range of different monitoring methods and protocols can be used, given sufficient project funding. For large-scale projects, it is important to have well-designed monitoring to ensure adequate coverage of the area. This will allow you to gain an overview of the whole area, rather than just the place where the monitoring is actually undertaken. Most monitoring protocols should provide an outline of suggested sampling regimes, but it is also advisable to seek specialist advice if you plan to monitor a large area. This will help to ensure your results are statistically robust.

Projects in small reserve areas

With projects in small reserves (e.g. one-two hectares or less), it is not physically possible to have many sampling points. This means a smaller amount of data will be collected and it will not be representative of the wider area. Although small-scale sites may allow weeds to be accurately mapped, pest animal monitoring data and

bird counts for example, are unlikely to be representative of the wider area. Data from small areas can be aggregated with that from other sites across the surrounding landscape to provide more representative monitoring for a much larger area.

It is also important to note that managing a small area may not produce wider benefits. For example effective animal pest control may be difficult to achieve because of constant reinvasion. This is where collaboration with neighbours or neighbouring groups is important, because overall the joint effort will produce much wider benefits. These monitoring results are still useful – but you need to understand how scale may affect the results.

Understanding your site vs contributing to understanding at a larger scale

An important aspect of monitoring and scale is the scale at which the data will be viewed. Will the data be amalgamated across multiple sites to get an understanding of what is happening in the larger landscape scale? A line of tracking tunnels in a small reserve in an urban area, for example, may not tell you much about fluctuations in pest numbers in that reserve. This is because rats may constantly move into the area and your local management is unlikely to change this. However, if there are tracking tunnels in lots of small urban reserves within a larger suburb, they can potentially form part of monitoring rat levels in that suburb. They could be used to show changes following introduction of a suburb-wide predator control programme.

In a similar way, outcome monitoring needs to consider whether you want to understand changes in your site, or changes in the wider landscape. For example, a single five-minute bird count in your neighbourhood reserve won't help you much with understanding the details of bird life in your reserve. But if you add it to a much larger data set of bird counts from across many sites over the whole suburb or city it can show broad changes that are occurring.

3.1.3 Location

Areas within an urban or highly visited area

Urban or well-visited sites can be challenging to monitor. Methods that involve for example installing and marking plots or camera traps may be vandalised or stolen, so it may be necessary to use alternative methods such as photopoints that can be established from a key feature or landmark.

Noisy roads and urban areas can make bird counts or acoustic monitoring difficult. However, they don't rule out these approaches – in fact the level of noise may be of interest. Just think about how an urban or highly populated area might affect your use of the method. Bird counts for example could be carried out on Sunday mornings, when the traffic is quieter.

Steep, difficult country with poor access

A practical approach is needed for project sites on very steep and difficult terrain – community volunteers may not necessarily have enough fieldwork skills. Identify difficult or hazardous areas within your wider project area and where possible set up monitoring outside these areas. It is important to identify that you have done this in your monitoring plan so that any impact on the final monitoring results can be considered.

3.1.4 Health and safety

The monitoring methods in this guide are safe for community groups to use. However, the locations where monitoring is carried out and the way it is undertaken may create hazards. All projects must have effective processes in place to manage the safety of their workers, the public and contractors. This needs to be addressed separately by projects and encompass monitoring work.

It's important to understand your health and safety obligations and responsibilities under the Health and Safety at Work Act 2015. This Act does apply to the activities of community volunteers. See: https://worksafe.govt.nz/managing-health-and-safety/workers/

Health and safety considerations for your project monitoring plan include:

- Avoid creating a monitoring programme that will put people in hazardous situations e.g. putting monitoring lines through particularly steep and difficult country. If necessary these areas should be monitored by fit, experienced and trained people each with a cellphone (and a personal locator beacon if the area is very large or remote) and first aid kit.
- Be aware of, and then manage the range of hazards that can occur when doing monitoring work in and around urban areas, e.g. aggressive dogs, possible entrapment by dangerous people.
- Aim to select and design monitoring that will answer your monitoring questions – yet still allow you to monitor the site safely.

3.2 Your capability

3.2.1 Is your monitoring sustainable?

Monitoring is about consistently re-measuring the same things over time and examining changes that occur. If you have a complex, difficult and expensive suite of monitoring to carry out, then the chances are it won't get regularly and consistently

measured. It is often better to have a simple approach that is regularly remeasured than an approach that is only occasionally or partially measured.

Look at your monitoring programme tasks and make sure you:

- have a sensible programme of monitoring that is fun to do – so it will be done
- generally underestimate what you can get done – so it's not too taxing
- spread the load and do monitoring in groups – so it is social and safe
- regularly feed information back to your volunteers – this demonstrates the value and relevance of the data they collect, and helps keep them motivated to continue
- provide opportunities for your volunteers to learn new skills – swap tasks around to keep them fresh
- consider your funding streams – is it easier to get a lump sum for an automated monitoring system (with low running costs), e.g. a game camera network, or is it easier to get regular small amounts of money for low, but ongoing costs like tracking cards?

Use the Methods Summary Matrix (Section 5) to scan quickly the skills, cost and time required for the different methods you are thinking of using. If you are considering a new method, then a trial is a good idea to check if the monitoring method is sustainable for your group.

3.2.2 How capable is your group?

Many factors affect the capability of groups involved with restoration as well as their monitoring choices.

Skills

What skills do you have within your project group? Are there people skilled in technology who are happy to manage high volumes of data, e.g. from acoustic monitoring? Are there people with strong botanical or ornithological knowledge? If there is someone with specific skills for whom you might consider more complex monitoring linked to those skills. However, your group's skill-set could also change over time as people learn (on the job or via extra training), or others retire from the project.

People

Projects and their supporters differ widely between groups. Factors such as the project participants' physical ability and daily and long-term availability can influence the monitoring methods you choose.

Financial

Is there a cost associated with your chosen monitoring method? Some methods require purchase of equipment and tools. Is your project likely to have ongoing access to funds for equipment and possibly more expensive monitoring methods?

Having consistent financial support can affect the choice of monitoring you do. Some projects have a major financial backer, which allows more costly and possibly time-saving options, such as hiring contractors to carry out more technical monitoring tasks, allowing community volunteers to focus on less demanding monitoring. In some cases the council and other agencies will be able to provide or lend monitoring equipment, or funding may be available to support community monitoring projects.

Partners and collaborators

You may have project partners or collaborators who can assist with monitoring, or who have a need for specific types of monitoring information. For example, are you able to collect monitoring data to compare with other restoration projects in the neighbourhood, the wider community or region? Examples of local initiatives are pest-free neighbourhoods and Weedbusters programmes, while large-scale initiatives include the North-West Wildlink and Pest Free Auckland 2050.

3.3 Your monitoring

3.3.1 Sampling design

For most monitoring – especially large projects where answers to critical monitoring questions are needed, an effective sampling design is vital. The number of sample points you have, and where you undertake measurements will determine how precise your monitoring results will be, and whether you can detect real changes over time. For small areas where basic methods are used, e.g. setting up and repeating photopoints, or mapping weed distribution across the whole site, sampling design is less important. Information about sampling design is provided in the monitoring methods sheets (see Section 7 in the back of this guide). However, for larger and more complex projects it is recommended that you seek advice on design and sampling. This could be the difference between gathering valuable long-term data and gathering data that is not very useful.

3.3.2 Locating and marking your monitoring sites

The layout and location of monitoring sites for any type of monitoring is important, whether bird counts, vegetation plots or photopoints. These are a key part of your sampling design, so follow the instructions detailed in the standard protocols listed in each of the monitoring methods sheets. Depending on your project site and data needs, you may need to balance sampling design with the safety and practicality of getting to monitoring sites.

Since monitoring will often require you to remeasure the same site, you need to have a reliable way to relocate points in the field. Deciding how you will permanently mark monitoring locations will depend on the location, ecosystem type and level of public use. Common marking methods include tags on trees or posts or stakes in the

ground. Individual monitoring protocols will usually give guidance on the most appropriate marking method.

3.3.3 Timing

Start at the start

Always try to get a monitoring measurement (or several, depending upon the type of monitoring and objectives of the project) undertaken before you start your management activities. This is your baseline state against which to measure the effects and changes your restoration project will have. A common mistake is to think “It’s not worth monitoring yet because we haven’t done anything”. The largest changes, and where your monitoring will often provide its greatest value is in the very early stages of your management. The earlier and longer you can have your monitoring in place the better. If you have already started your project, it is a good idea to check if there is any existing baseline information you can use for your area, e.g. old photographs of your site or existing bird count data for the neighbourhood.

Timing through the year

Consider what time of year your monitoring needs to be undertaken to match for example with your management activities and seasons. Some monitoring, such as trap records, are just collected when you do the job – so that’s easy. Other monitoring, such as bird counts can be suited to particular times of the year. If you are only doing bird counts once a year, doing them in spring to early summer means birds are at their noisiest and easiest to detect. When monitoring rats, it is useful as a minimum to monitor seasonal highs (usually late summer-autumn) and lows (usually late winter-spring). Make sure all subsequent monitoring is done at the same time of year to ensure you are comparing like with like.

Check your monitoring method protocol carefully to see what, if any, seasonal requirements it might have. Also consider accessibility – wetlands are generally easier and safer to access for monitoring in late summer when they are drier.

How frequently to measure

How often you remeasure will depend on the type of monitoring you are doing. Check the protocol for each monitoring method. Some methods involve remeasuring more than once a year to pick up seasonal cycles, while others, e.g. vegetation plots, may only need measuring every five years, because they change slowly.

How will monitoring fit with the rest of your workload?

Think carefully about setting up a monitoring programme that gives you a spread of tasks, so that all of your planned monitoring is easly achievable, rather than all at the same time of the year. Make a monitoring calendar so that you can anticipate tasks that are coming up and to ensure important monitoring is not forgotten.

3.3.4 Indicator species

An approach sometimes used in monitoring is to follow changes in indicator species as a way of examining wider ecosystem health. However, care is required here because the abundance of an indicator species may mean different things at different sites. Kererū numbers for example may fluctuate as birds respond to seasonally available fruit supplies such as taraire and pūriri. An indicator plant species may not occur at a site for reasons that are not related to management, e.g. soil type and climate. Changes over time can also result in new species becoming important that were not previously considered as potential indicators. Focusing specifically on indicator species in your monitoring design may overlook changes in other species.

A carefully planned monitoring programme should capture information on a range of potential indicator species. All of these species then form part of the analysis. This allows you later to select particular species of interest from your total set of monitored data, rather than risking the monitoring being designed to target particular species.

Table 3. General guidance on indicator species in Tāmaki Makaurau / Auckland. Sourced from Monks et al. 2013. DOC R&D Series 338, with additional information from Auckland Council staff.

Ecosystem	Group	Species	An increase of the indicator species abundance may suggest:
Forest and Scrub	Birds	Tui	• Reduced predation • Improved habitat/food source
		Kererū	
		Tomtit	
	Plants	Asplenium ferns	• Reduced herbivore impacts
		Large leaved coprosmas	
		Griselinia species	
	Lizards	Forest and Pacific gecko	• Reduced predation • Reduced habitat modification
		Auckland green gecko	
	Invertebrates	Wēta	• Reduced predation • Reduced herbivore impacts

Ecosystem	Group	Species	An increase of the indicator species abundance may suggest:
Wetland and Estuary	Birds	Spotless crake	• Reduced predation • Improved habitat
		Banded rail (estuaries)	
		Bittern	
	Plants	Seagrass – *Zostera muelleri*	• Reduced sedimentation – better water clarity in estuaries
		Raupō	• High fertility – nutrient leaching from surrounding landscape into the wetland
Rivers and streams	Freshwater Fish	Longfin eel	• Reduced habitat modification • Reduced human impact • Reduced predation
		Giant kōkopu	
		Inanga	
	Invertebrates	Sensitive species – see Waicare guide	• Improved water quality
Dune and Beach	Birds	NZ dotterel	• Reduced habitat modification • Reduced predation • Reduced human disturbance
		Variable oystercatcher	
		NZ pipit	
	Lizards	Shore skink	• Reduced habitat modification • Reduced predation
		Moko skink	
		Common gecko	

As discussed above, the indicator species you choose will vary between projects and there are many factors to consider when deciding which indicator species to use. If you decide to use indicator species, it is suggested you discuss your selected indicator list with an appropriate expert.

3.3.5 Ensuring monitoring provides a practical management feedback loop

Monitoring should provide a feedback loop for ongoing site management. This allows you to adapt your management to meet project objectives as well as helping to achieve the best result for the least effort. For example:

“We used to pulse the rat bait every six weeks, which required a lot of volunteer effort, however our monitoring showed that the rats were taking a long time to recover, so we now find that we can achieve much the same result with just three bait pulses per year.”

“We stopped controlling goats and if you look at the photopoints before and after this change you can see the understorey has now gone.”

Changing the management of your project site (e.g. increasing or decreasing the level of pest control, weed control and/or planting) should change the results you get from your monitoring.

4 Data storage

Monitoring is about examining changes over time or enabling comparisons between different areas. It is critical that your data is collated and stored correctly and is easily accessible.

4.1 Data

The protocols for different monitoring methods will often identify their data storage formats e.g. standard spreadsheets or online databases. However, for many methods data storage formats are not well developed – which leaves groups to find their own ways of managing data storage.

Consider the following:

- Follow the standard data formats and information about data storage in the monitoring protocol for the method you are using.
- Enter your data into available standard digital formats (e.g. spreadsheet) or online database as soon as you can after collection – since you will have recently collected the data you will be familiar with it and you may pick up errors, which you can fix during data entry.
- Record important 'meta data' with your data. This is the information about how the data was collected including what monitoring protocol you used, and where the measurements were undertaken. This information ensures the data is correctly analysed. It is also helpful for continuity of your project, because it enables a smooth handover when group members retire from the project.
- Store any field forms and notes for a generous length of time, even if you have transferred the data to some digital form. This allows you to check if you discover some anomalies later and still have access to any additional notes on field forms.
- Make sure any digital data are securely backed up. If these data are on a public online system back-up will already be in place. However, it's always a good idea to have your own copies as well. If the data are held at multiple locations it is less likely to be lost.

Recording your data in standard formats provides wider value, because it allows easy comparison with other monitoring from your neighbourhood, the region or country.

Shared online data recording is becoming available for some monitoring methods. This is most advanced for trapping and bait station records with systems such as Trap.NZ and CatchIT (trapping only).

Work is also being undertaken to encourage shared access to data through a 'data commons'. This protects the privacy and rights of those creating the data, but allows data to be used for research and understanding which benefits everyone. To find out more, see the Aotearoa New Zealand Data Commons Project (datacommons.org.nz).

4.2 Data analysis and reporting

Your data analysis and reporting should relate to your monitoring questions; i.e. it should provide answers or demonstrate progress towards your project objectives (see 2.2 – 2.6 above). It's a good idea to do some simple analyses and reporting as soon as you can after your fieldwork. This provides an immediate update to all involved in the monitoring, provides feedback to project managers and can help to improve your future monitoring. More complex data analyses will take time and may require expert advice from a biostatistician.

4.2.1 Reporting

Reporting should provide simple and intuitive summaries of monitoring and trends. Again, this should link directly back to your monitoring questions and the objectives of your project.

Shared online data systems will produce simple standard reports. With further development, these are likely to become more sophisticated over time.

A standard 'report card' or 'dashboard' report can sometimes be developed that is easily understood across different projects and areas. The Auckland Council State of the Environment Report Cards are a good example, see https://www.aucklandcouncil.govt.nz/environment/state-of-auckland-research-report-cards/Documents/air-quality-report-card-auckland-area-2016.pdf

4.3 Review your monitoring

It's important that you review your monitoring programme from time to time (e.g. every two-three years), to ensure it is still the best fit for the job. This might reveal the need for improvements, or identify new management issues. However, at the same time it is also very important to maintain continuity so that you can track key changes during the life of your project. As highlighted under 'Quick Health Check' (see next section for examples), doing a quick visual check of your project site can be a useful part of reviewing your monitoring. However, be careful not to keep adding new components to your monitoring for the sake of it, because you need to make sure your monitoring remains achievable.

The science of monitoring is dynamic, reflecting changes both to the environment and the way data are collected and analysed. New technologies have become available, which can collect the same data in better ways, or collect new data altogether. Old technologies can sometimes be used in new ways due to the way data are managed. New advanced trapping databases for example, can quickly detect changes in trap catch levels, while in future it might also be possible to scan sound files automatically for different bird calls. This is an extremely time-consuming job to do manually. In addition, new pests and diseases arrive, and they may change the dynamics and ecology of whole parts of the landscape.

5 Ecosystem monitoring guide[2]

From tiny soil microbes to towering kauri trees, Tāmaki Makaurau / Auckland has amazing biodiversity.

At least 37 distinct types of land and freshwater ecosystems are identified in the 2015 State of the Environment report for the Tāmaki Makaurau / Auckland region. These ecosystems occur in coastal dunelands, wetlands and salt marshes, lava fields and volcanic cones, on the rugged hills of the Waitākere and Hunua Ranges and Aotea / Great Barrier and Hauturu / Little Barrier islands and on the many other islands in the Hauraki Gulf.

Collectively, these ecosystems provide habitat for over 20,000 species of native plants, animals and micro-organisms, most of which are unique to Aotearoa / New Zealand. These include one of the rarest birds in Aotearoa / New Zealand (tara-iti, New Zealand fairy tern), a relict population of kōkako in the Hunua Ranges, and on Hauturu / Little Barrier Island, the world's heaviest insect (wēta punga/giant wēta) along with a reintroduced population of the world's heaviest and only lek-breeding parrot (kākāpō). Many species are also unique to the Tāmaki Makaurau / Auckland region, including the chevron skink (niho taniwha), black petrel (tāiko), New Zealand storm petrel and Great Barrier Island kānuka. For these species, Tāmaki Makaurau / Auckland is the only place we can protect and sustain them. The region also supports a variety of reptiles, a native frog, and both species of Aotearoa / New Zealand's only native land mammals (the long-tailed and short-tailed bats, pekapeka). Although the Tāmaki Makaurau / Auckland region covers only 2% of the country's total land mass, it is home to a high number of threatened species. This includes 49 (20%) of Aotearoa / New Zealand's threatened terrestrial vertebrate fauna species and 169 (19%) of Aotearoa / New Zealand's threatened plant species.

Archaeology, written descriptions and historic photos show how greatly the region's landcover has changed from pre-human times through to the recent period. The pace of this change slowed dramatically in the late 20th century. Existing areas of native habitat are now being preserved, or have increased in size with further restoration planting around their margins. Within the last 15 years, over 400 hectares have been added to native ecosystems in the Tāmaki Makaurau / Auckland urban area, mostly through plantings around the margins of larger native remnants, along with replanting native forest species following the removal of exotic plants. Community-based ecosystem restoration projects play an important role in this work.

Most Aucklanders agree that the quality of the natural environment is an integral part of their quality of life, and it is the natural environment and landforms which make the region special. Our land, soil and terrestrial biodiversity have a strong intrinsic,

[2] *Extracted from the Auckland Region State of the Environment Report 2015.*

cultural and historic value, and we rely on the ecosystem services they provide for our day-to-day existence. Biodiversity is everyone's business. As Tāmaki Makaurau / Auckland grows, the pressure on our biodiversity and soil resources will increase. Safeguarding these resources is vital – they are in our backyards and neighbourhoods and are affected by nearly all of our activities.

The loss of Aotearoa / New Zealand's indigenous biodiversity is our most pervasive environmental issue. To protect and enhance our terrestrial biodiversity, we need accurate records of the extent and quality of biodiversity across the region. The Auckland Council has an extensive biodiversity monitoring programme, while an increasing number of community groups, schools and individuals also carry out monitoring to assess the state of their local environment and track the success of their restoration efforts.

Forest and scrub

5.1 Forest and scrub

About 30% of the Tāmaki Makaurau / Auckland region (c. 5000 km² mainland and islands) is clad in native forest or scrublands. These areas include magnificent stands of mature kauri, lush coastal broadleaf forest, lava flow rock forests, tawa and taraire forest with towering emergent podocarps, montane cloud forests, regenerating scrublands and rare pockets of lowland kahikatea forest. Twelve forest and six terrestrial scrub/shrubland ecosystem types (including cliff shrub communities) have been identified and described in the region[3]. These forest and scrub ecosystems support a wide range of native plants and animals, including rare native birds like kōkako, tiny native frogs in bushy streams, long-tailed bats, skinks and geckos, and a host of threatened plant species.

What does this ecosystem look like when it has been modified and altered over time?

Remember

Historically, forest and scrub occurred across much of the Tāmaki Makaurau / Auckland region, but vegetation clearance for farming, urban development and roads have dramatically altered the landscape. The remaining small forest remnants reveal glimpses of the past.

Can I still do ecosystem monitoring when my project area is more modified than natural?

Most definitely! You can still do ecological monitoring in modified forest and scrub ecosystems. Groups of native trees in your backyard, the local park or bush and scrubland patches in rural pasture land may be all that's left of the original forest and scrub ecosystems. Monitoring will help you understand if the restoration activities you are doing are helping to protect (removing pests) and improving the biodiversity within your modified forest and scrubland ecosystems. Many backyard and neighbourhood projects have started in this way.

If you consider your project area to contain modified forest and scrub ecosystems it may also have modified wetlands and streams within the project area; refer to Wetlands and Estuaries and Streams and Rivers sections of the ecosystem guide for monitoring guidance in these modified ecosystems.

[3] Singers, N.; Osborne, B.; Lovegrove, T.; Jamieson, A.; Boow, J.; Sawyer, J.; Hill, K.; Andrews, J.; Hill, S.; Webb, C. 2017. Indigenous terrestrial and wetland ecosystems of Auckland. Auckland Council.

5.1.1 Threats

The only remaining extensive tracts of mature forest in the Tāmaki Makaurau / Auckland region are in the Waitākere and Hunua Ranges and on Aotea / Great Barrier and Hauturu / Little Barrier islands. Historic land clearance means that most forest and scrub ecosystems in the Tāmaki Makaurau / Auckland region are now fragmented and threatened to varying degrees. Today, less than one per cent of natural dune-forest ecosystems remain, while floodplain kahikatea forests, pūriri forest and kauri forest are also of greatly reduced extent. Some forest ecosystems are naturally range-restricted, such as the cloud forest on rare, seabird-burrowed soils on the summit ridges of Hauturu / Little Barrier.

Threats to the long-term viability of forest and scrub ecosystems in the Tāmaki Makaurau / Auckland region include:

- habitat destruction through vegetation clearance
- fragmentation, isolation, and edge effects
- physical isolation from other similar ecosystems
- invasion by pest plants
- pest animals (browsing, seed predation, native fauna predation)
- livestock (browsing, trampling)
- loss of pollinators and seed dispersers (birds, lizards, insects)
- soil erosion
- pathogens/disease (e.g. *Phytophthora agathidicida*, PTA, which causes kauri dieback).

Despite their challenges, many of the region's larger tracts of forest and scrub still have high levels of diversity and species richness. Contributing factors include the wide range of landforms, soil types and climatic regimes, pest-free habitats on islands, as well as ongoing management by agencies and the community. The effects of weeds and fragmentation are most severe in rural and urban landscapes where forest and scrub patches are small and isolated.

5.1.2 Restoration activities and outcomes

There has already been significant restoration work across a range of forest and scrub ecosystems in the Tāmaki Makaurau / Auckland region by organisations, groups and individuals. Community groups in Tāmaki Makaurau / Auckland, often supported by the council, have been planting to recreate and reconnect native forest and scrub, controlling pests and weeds, and in some larger areas re-introducing threatened species such as whitehead, robin and kōkako. As a result of their activities important conservation outcomes are being achieved such as increases in native birds and lizards, improved forest canopy health and greater regeneration in the understorey.

5.1.3 Quick Health Check, activity and outcome monitoring for forest and scrub

Forest and scrubland areas in Tāmaki Makaurau / Auckland range from tiny backyard pockets of rock forest to large tracts of forest on the ranges covering over 15,000 hectares.

Start your project by defining your monitoring area. It needs to be one or more of the following:

- generally managed as one unit, e.g. requiring the same type and level of pest control
- a similar forest type that would be logically grouped together
- one geographic unit e.g. valley, flood plain, hill ridges
- a small area/remnant that is treated as one unit because of its size.

Commonly monitored elements in native forest or scrub:

- vegetation (native and exotic)
- native animals (birds, lizards, frogs, bats, invertebrates)
- animal pests.

Birds are useful indicators of ecosystem quality and condition as they are high up the food chain. Generally, if birds are doing well, then it is likely that the invertebrates, plants and other life forms they depend on further down the food chain are also doing well[4].

Table 4 provides a Quick Health Check, which can be used to assess a wide range of ecosystem measures and establish your pre-restoration starting point (baseline state). The table also includes common restoration management activities and types of outcomes often sought by community groups. Linked to each activity and outcome are typical monitoring questions and associated monitoring methods. Where several methods are given, decide which is the most appropriate for your project. Each monitoring method is rated against skills, cost and time (see Table 1 for rating definitions) to help you choose the one(s) most suited to your project.

The method name links to a more detailed monitoring method sheet in a later section of this guide, we recommend you read these sheets to help you refine your monitoring choices.

[4] Auckland Council SOE report 2015

Table 4. Carrying out a Quick Health Check, activity and outcome monitoring for forest and scrub ecosystems

Quick Health Check				
Monitoring Question	**Monitoring Method**	**Monitoring Method Assessment**		
		Skills	**Cost**	**Time**
What is the general health of the forest/scrubland?	Site Assessment – FORMAK	Moderate	$	Quick
What areas need the most attention?	Site Assessment –FORMAK	Moderate	$	Quick

Activity - *Pest animal control*				
Monitoring Question	**Monitoring Method**	**Skills**	**Cost**	**Time**
How many pests have we killed?	Trapping records	Easy	$	Quick
How much bait has been consumed? Where is bait take high and low across my site?	Bait take records	Easy	$	Quick
What pest animal species are present?	Tracking tunnels	Easy	$$	Moderate
	Chew cards	Easy	$$	Moderate
	Camera traps	Easy	$$$	Longer
How is pest animal abundance changing?	Tracking tunnels	Easy	$$	Moderate
	Chew cards	Easy	$$	Moderate
	Camera traps	Easy	$$$	Longer
How is rabbit abundance changing?	Spotlight counts	Easy	$	Moderate

Activity - *Weed control*				
Monitoring Question	**Monitoring Method**	**Skills**	**Cost**	**Time**
What weed species are present and where?	Weed survey	Moderate	$	Moderate
What area of weeds has been treated? What species of weeds have been treated?	Weed control records	Easy	$	Quick
How has weed density changed over time?	Vegetation Plot – FORMAK	Experienced	$$	Moderate
	Photopoints	Easy	$	Quick
How has weed distribution changed?	Weed survey	Moderate	$	Moderate

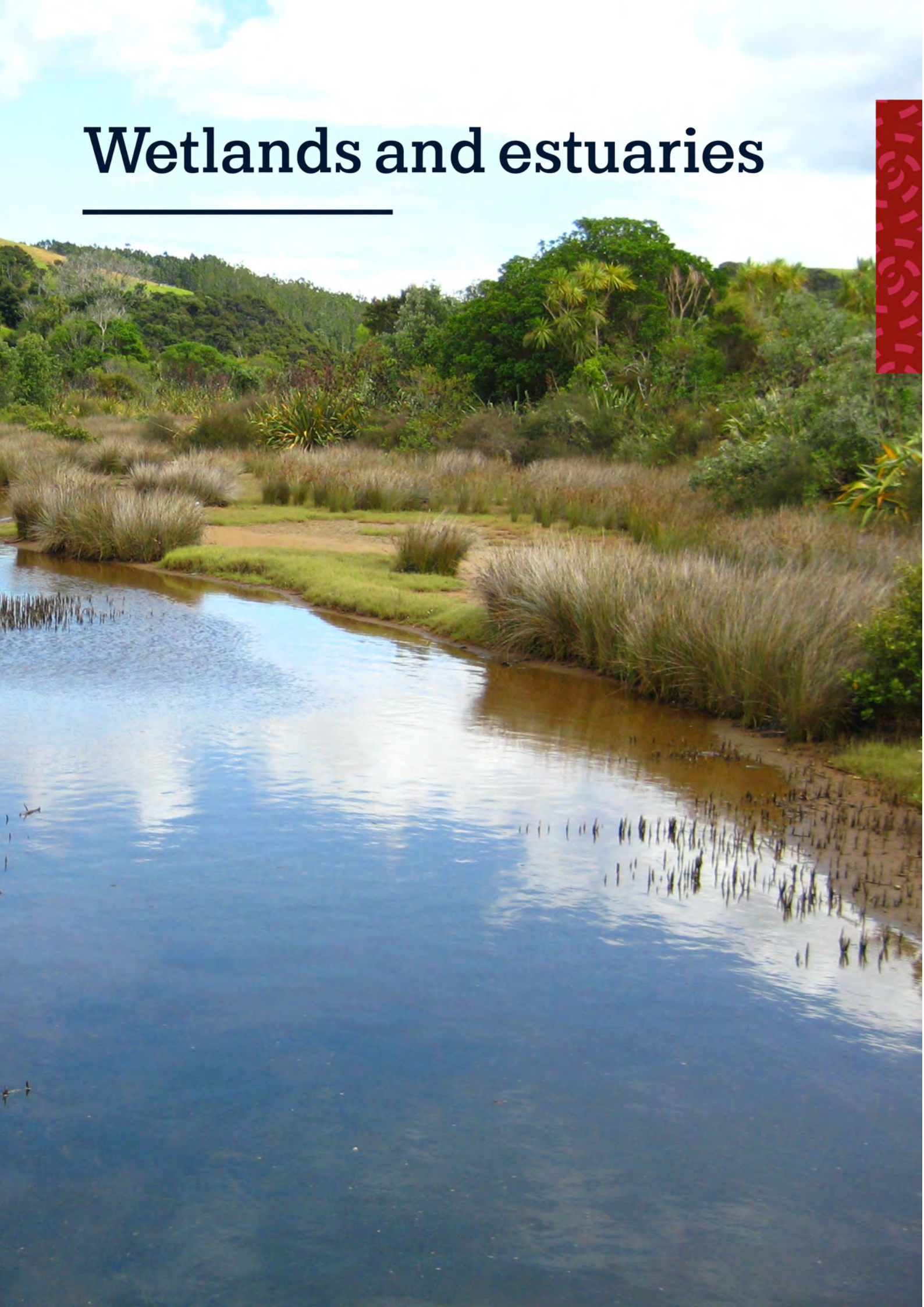
Table 4. Carrying out a Quick Health Check, activity and outcome monitoring for forest and scrub ecosystems

Activity - *Restoration planting*				
Monitoring Question	**Monitoring Method**	**Skills**	**Cost**	**Time**
What area/length has been planted? How many plants have been planted?	Planting records	Easy	$	Quick
How many plants have survived?	Survival counts	Easy	$	Quick
What area/length is successfully established?	Photopoints	Easy	$	Quick
	Vegetation Plot – FORMAK	Experienced	$$	Moderate
	Planting records	Easy	$	Quick

Outcomes - *Improved native wildlife*				
Monitoring Question	**Monitoring Method**	**Skills**	**Cost**	**Time**
What bird species are present?	Bird acoustic monitoring	Moderate	$$$	Longer
	Five-minute bird count	Moderate	$	Moderate
	Visual bird counts – *suitable for modified forest ecosystems i.e. backyard garden bird surveys.*	Easy	$$	Moderate
How has bird abundance changed?	Five-minute bird count	Moderate	$	Moderate
	Visual bird counts – *suitable for modified forest ecosystems i.e. backyard garden bird surveys.*	Easy	$$	Moderate
Are bats present – what species?	Bat acoustic monitoring	Moderate	$$$	Moderate
Are geckos or skinks present?	Tracking tunnels	Easy	$$	Moderate
How has lizard abundance changed over time?	Use above method for general indication. **Results can be very difficult to interpret as lizard numbers are often very low**	Easy	$$	Longer
What wēta species are present?	Wēta motels	Easy	$$	Moderate
	Tracking tunnels	Easy	$$	Moderate
How has wēta abundance changed?	Wēta motels	Easy	$$	Moderate

Outcomes - *Improved vegetation*				
Monitoring Question	**Monitoring Method**	**Skills**	**Cost**	**Time**
How is canopy condition changing?	Photopoints	Easy	$	Quick
How is understorey changing?	Photopoints	Easy	$	Quick
	Vegetation Plot –FORMAK	Experienced	$$	Moderate

Wetlands and estuaries



5.2 Wetlands and Estuaries

Freshwater and saline wetland ecosystems are diverse, ecologically sensitive places where water is the dominant driving force. The plants and animals living there have adapted to surviving in wet and often changeable conditions.

Many different wetland types occur in the Tāmaki Makaurau / Auckland region, and in pre-human times, the region's freshwater wetlands were far more extensive than they are today. Where lava flows blocked streams, and in volcanic craters and depressions, cabbage tree and harakeke (flax) swamps formed. In the Kaipara, Franklin and Rodney lowlands, swamp forests with kahikatea, pukatea, swamp maire, raupō, cabbage trees and harakeke covered large expanses of poorly drained land. Along the coast swamps graded into saltmarshes with oioi and sea rush and salt meadows of glasswort, remuremu, bachelor's button and sea primrose. Extensive mangrove swamps formed in the region's more sheltered harbour reaches. Low nutrient bogs and fens occurred near the coast in Rodney and on Aotea / Great Barrier island. The extensive Waitematā, Kaipara and Manukau harbours, which are drowned river valleys, supported thousands of shorebirds including both Aotearoa / New Zealand and trans-equatorial migrants.

As with the rest of Aotearoa / New Zealand, wetlands in the Tāmaki Makaurau / Auckland region have been seriously depleted and degraded, with most freshwater wetlands now less than 10 hectares in size. About 3700 hectares of freshwater wetlands (reduced from an estimated 58,000 hectares), and about 14,000 hectares of estuarine wetlands remain. These still support a range of native fauna including black mudfish (rediscovered in the region in 2004), banded rail, bittern, spotless crake and, in pest-free areas, pāteke (brown teal). The Kaipara and Manukau Harbours and the Firth of Thames still support thousands of shorebirds. The Firth of Thames is recognised under the Ramsar Convention as a wetland of international importance.

Overall, nine distinct freshwater ecosystems[2] have been described for the Tāmaki Makaurau / Auckland region: Bamboo rush, greater wire rush, restiad rushland (WL3); Oioi, restiad rushland/reedland (WL10); *Machaerina* sedgeland (WL11); Mānuka, tangle fern scrub/fernland (mānuka fen) (WL12); Herbfield (lakeshore turf) (WL15); Flaxland (WL18), and Raupō reedland (WL19). In addition, four types of saline wetlands have been identified, including seven variants of mangrove forest and scrub.

5.2.1 Threats

Lowland wetlands are now among the most threatened ecosystems in Aotearoa / New Zealand, having suffered extensive loss through drainage and land clearance. While the rate of loss for larger wetlands appears to have slowed since the 1980s,

smaller wetlands less than one hectare continue to disappear, and many of these losses are unrecorded.

Ongoing threats to wetlands in the Tāmaki Makaurau / Auckland region include drainage, damage from livestock, pollution (e.g. nutrients and sediments), and invasive pest animals and weeds. The region has over 1100 naturalised exotic plant species, and only about 400 native plant species. Many exotics cause problems in wetlands because they displace native plants and alter soil and water properties. Estuaries are more resilient to weed invasion than freshwater wetlands, but are still vulnerable to salt-tolerant species (e.g. sickle grass, cordgrass, saltwater paspalum and sea couch). Invasive marine invertebrates such as the Pacific oyster also threaten estuarine systems in the Tāmaki Makaurau / Auckland region.

Climate change poses new risks from sea level rise, increased rates of extreme flooding and droughts. Most of the region's saltmarshes are backed by farmland or residential areas, offering limited space for species to retreat inland in response to rising sea levels. Increased sedimentation has resulted in a decline of sea grass and caused an expansion of mangrove communities.

5.2.2 Restoration activities and outcomes

Well-informed management and appropriate restoration can help to protect and enhance our remaining wetlands as well as prevent further losses. In the Tāmaki Makaurau / Auckland region, the council, community groups, organisations and individuals have been restoring and enhancing wetlands, controlling pests and replanting areas with native plants. Increases in native bird numbers and improved wetland vegetation are important conservation outcomes of these projects.

Several major wetland and saltmarsh areas across the region have been restored. These include over 500ha at the former Mangere Wastewater Treatment Plant oxidation ponds (decommissioned and returned to harbour), Waiataura urban wetland (reconstructed), Tāwharanui wetland (protected by a pest-proof fence and extensive riparian plantings), and the wetlands in Awhitū Regional Park (greatly expanded in area by fencing and planting).

5.2.3 Quick Health Check, activity and outcome monitoring for wetlands and estuaries

Wetland and estuary monitoring starts with a quick overview to sort out the main features and key issues and define the wetland type (fresh or saline; enriched or peaty; swamp, fen or bog), and where in the landscape it lies (basin, valley, depression, slope). Identify the site's main needs (water or pollution management, fencing, pest or weed control), and then plan your monitoring to assess your success in resolving those problems.

For tall forested wetlands, such as those with kahikatea, we recommend you use the methods described above for Forest and Scrub ecosystems. Willow and mānuka wetlands with a lower canopy can be monitored using the methods described in this section.

In estuaries, the number and type of animals found in intertidal mud and sandflats can indicate ecosystem health. Unlike birds or water, these organisms don't move around much so they represent local conditions well.

Table 5 provides a Quick Health Check, which can be used to assess a wide range of ecosystem measures and establish your pre-restoration starting point (baseline state). The table also includes common restoration management activities and types of outcomes often sought by community groups. Linked to each activity and outcome are typical monitoring questions and associated monitoring methods. Where several methods are given, decide which is the most appropriate for your project. Each monitoring method is rated against skills, cost and time (see Table 1 for rating definitions) to help you choose the one(s) most suited to your project.

The method name links to a more detailed monitoring method sheet in a later section of this guide, we recommend you read these sheets to help you refine your monitoring choices.

Table 5. Carrying out a Quick Health Check, activity and outcome monitoring for wetlands and estuaries

Quick Health Check				
Monitoring Question	**Monitoring Method**	**Monitoring Method Assessment**		
		Skills	**Cost**	**Time**
What is the general health of the wetland?	Wetland WOF check – WETMAK	Easy	$	Quick
	Estuary WOF check – Turning the Tide	Easy	$	Quick
What areas need the most attention?	Wetland WOF check – WETMAK	Easy	$	Quick
	Estuary WOF Check – Turning the Tide	Easy	$	Quick

Activities - *Pest animal control*				
Monitoring Question	**Monitoring Method**	**Skills**	**Cost**	**Time**
How many pests have we killed?	Trapping records	Easy	$	Quick
How much bait has been consumed? Where is bait take high and low across my site?	Bait take records	Easy	$	Quick
What pest animal species are present?	Tracking tunnels	Easy	$$	Moderate
How is pest animal abundance changing?	Chew cards	Easy	$$	Moderate
	Camera traps	Easy	$$$	Longer

Activities - *Weed control*				
Monitoring Question	**Monitoring Method**	**Skills**	**Cost**	**Time**
What weed species are present and where?	Weed survey – WETMAK	Moderate	$	Moderate
What area of weeds has been treated? Which species of weeds have been treated?	Weed control records	Easy	$	Quick
How has weed density changed over time?	Weed survey – WETMAK	Moderate	$	Moderate
	Vegetation plot – WETMAK	Moderate	$$	Quick
	Photopoint	Easy	$	Quick
How has weed distribution changed?	Weed survey – WETMAK	Moderate	$	Moderate

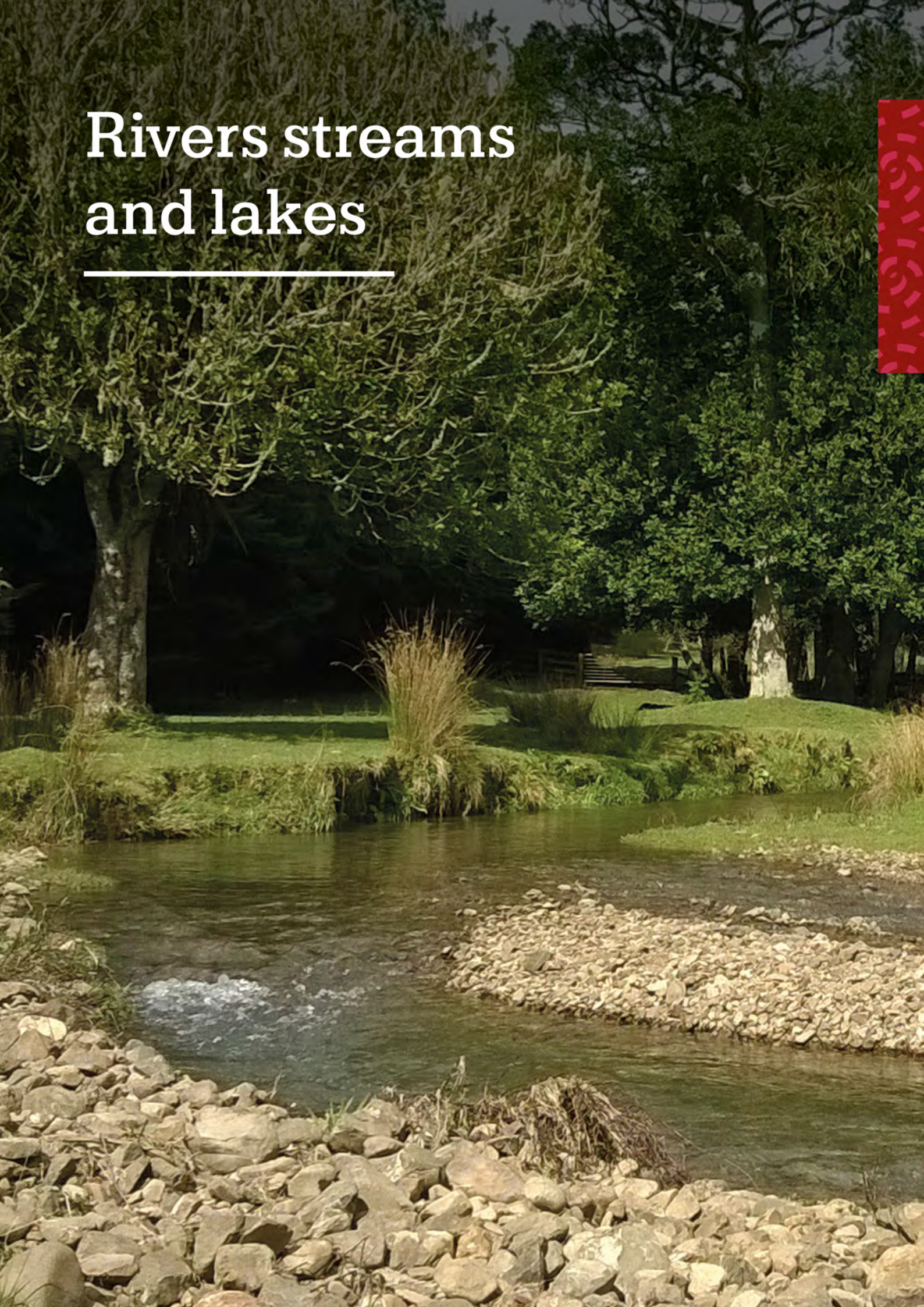
Table 5. Carrying out a Quick Health Check, activity and outcome monitoring for wetlands and estuaries

Activities - *Restoration planting*				
Monitoring Question	**Monitoring Method**	**Skills**	**Cost**	**Time**
What area/length has been planted? How many plants have been planted?	Planting records	Easy	$	Quick
How many plants have survived?	Survival counts	Easy	$	Quick
What area/length is successfully established?	Photopoints	Easy	$	Quick
	Vegetation plot –WETMAK	Moderate	$$	Quick
	Planting records	Easy	$	Quick

Outcomes - *Improved native wildlife*				
Monitoring Question	**Monitoring Method**	**Skills**	**Cost**	**Time**
What bird species are present?	Bird acoustic monitoring	Easy	$$$	Longer
What cryptic (secretive) bird species are present?	Call playback	Moderate	$$	Moderate
How has bird abundance changed?	Five-minute bird count	Moderate	$	Moderate
	Visual bird counts	Moderate	$$	Moderate
Are bats present – what species?	Bat acoustic monitoring	Moderate	$$$	Moderate
What lizard species are present?	Tracking tunnels	Moderate	$$	Moderate
How has lizard abundance changed over time?	Use above method for general indication. **Results can be very difficult to obtain as lizard numbers are usually very low.**	Easy	$$	Longer

Outcomes - *Improved vegetation*				
Monitoring Question	**Monitoring Method**	**Skills**	**Cost**	**Time**
How is wetland vegetation changing?	Photopoints	Easy	$	Quick
	Vegetation plot –WETMAK	Moderate	$$	Quick
	Mapping wetland vegetation – WETMAK	Moderate	$	Quick
What plant species are present? Are native plants more abundant than exotic plants?	Vegetation plot –WETMAK	Moderate	$$	Quick

Rivers streams and lakes



5.3 Rivers, streams and lakes

The Tāmaki Makaurau / Auckland region boasts around 16,500km of permanently flowing rivers and streams. Many of these are short and swift, draining high catchments to the nearby coast. The region also has a number of olcanic crater lakes e.g. Lake Pupuke and Crater Hill, and also lakes and springs associated with the Tāmaki Makaurau / Auckland volcanic field such as Western Springs, and various springs around Onehunga. Large artificial lakes have been created behind water supply dams in the Waitākere and Hunua Ranges.

Our freshwater environments sustain a number of native fish species, kōura (freshwater crayfish), and numerous other invertebrates and aquatic plants. Forested streams also provide habitat for the threatened Hochstetter's frog, one of only four native frog species in Aotearoa / New Zealand.

5.3.1 Threats

These ecosystems are vulnerable to water pollution, elevated temperatures, water diversion, habitat destruction, invasion by exotic aquatic weeds and pest fish, over-harvesting and litter pollution. Many land uses generate direct and indirect contaminant discharges, which include sediments, metals, nutrients and biological wastes (organic and faecal material). Many urban streams were piped decades ago, and pipes and culverts have disrupted migration pathways between inland waterways and the sea that many native fish species, especially galaxiids need to complete their life cycle.

The healthiest streams are those with forest buffers, which shade and keep the water cool, filter run-off and stabilise the stream banks. Today, due to land clearance and urban development, only a fifth of streams in the Tāmaki Makaurau / Auckland region pass through native forest[5].

Most of the region's lakes have only moderate water quality, and they also rate as ecologically moderate because of the negative effects of invasive aquatic flora and fauna. Significant threats to lake water quality include nutrient enrichment from agriculture in surrounding catchments and pest fish.

Climate change predictions for Tāmaki Makaurau / Auckland indicate that extreme flood and drought events could increase in the future[3]. Urban Stream Syndrome (i.e. flashier water movements, high levels of nutrients and other pollutants, altered channel morphology, less species richness along with fewer specialised species), along with invasive exotic lakeweeds and nitrate in groundwater, are all major issues identified in the Auckland Council freshwater monitoring programme.

[5] Auckland Council SOE report 2015

5.3.2 Restoration activities and outcomes

Over 2000 volunteers from over 100 community groups are dedicated to stream restoration in the Tāmaki Makaurau / Auckland region[6]. Community groups and agencies in Tāmaki Makaurau / Auckland have been planting riparian vegetation, clearing rubbish out of waterways, daylighting streams, installing fish ladders and monitoring water quality.

5.3.3 Quick Health Check, activity and outcome monitoring for rivers and streams

A healthy aquatic ecosystem is a complex association of animals, plants and physical and chemical factors. Unhealthy streams and lakes are often dominated by populations of pollution-tolerant invertebrates and fish. To assess the overall quality of a water body, a range of physical (e.g. temperature), chemical (e.g. nutrients or contaminants) and biological measurements (e.g. macrofauna) are commonly monitored.

The Auckland Council has been monitoring rivers and streams for more than 25 years and currently monitors 36 sites across the region. The council also regularly monitors five of the most important lakes, using the LakeSPI (Submerged Plant Indicators) assessment criteria, and a suite of water quality variables including physical water properties as well as phytoplankton and rotifer samples. Data collected by community groups and individuals can complement council monitoring – and the potential contribution that community groups and individuals can make is exemplified in NIWA freshwater ecologist Dr Richard Storey's statement, "*Streams are a bit like blood vessels – councils monitor the arteries and big veins but the capillaries need monitoring as well*."

Responses in water quality to restoration efforts can take a long time. In most cases, degradation is the result of many years of land use and contaminant inputs, and restoration can take just as long, or even longer. A commitment to long-term monitoring is needed.

Some fauna monitoring methods, such as native frog searches and fish trapping require specialist skills or pose a welfare risk to threatened species, and methods are not presented here for those situations. The methods for monitoring swampy margins of lakes are provided in the Wetlands and Estuaries section.

[6] Auckland Council SOE report 2015

Table 6 provides a Quick Health Check which can be used to assess a wide range of ecosystem measures and establish your pre-restoration starting point (baseline state). The table also includes common restoration management activities and types of outcomes often sought by community groups. Linked to each activity and outcome are typical monitoring questions and associated monitoring methods. Where several methods are given, decide which is the most appropriate for your project. Each monitoring method is rated against skills, cost and time (see Table 1 for rating definitions) to help you choose the one(s) most suited to your project.

The method name links to a more detailed monitoring method sheet in a later section of this guide, we recommend you read these sheets to help you refine your monitoring choices.

Table 6. Carrying out a Quick Health Check, activity and outcome monitoring for rivers and streams

Quick Health Check				
Monitoring Question	**Monitoring Method**	**Monitoring Method Assessment**		
		Skills	**Cost**	**Time**
What is the overall state of the stream like? What features need attention?	SO SMART – quick visual check of streams – Waicare	Easy	$	Quick

Activities - *Pest animal control*				
Monitoring Question	**Monitoring Method**	**Skills**	**Cost**	**Time**
How many pests have we killed?	Trapping records	Easy	$	Quick
How much bait has been consumed? Where is bait take high and low across my site?	Bait take records	Easy	$	Quick
What pest animal species are present? How is pest animal abundance changing?	Tracking tunnels	Easy	$$	Moderate
	Chew cards	Easy	$$	Moderate
	Camera traps	Easy	$$$	Longer

Activities - *Weed control*				
Monitoring Question	**Monitoring Method**	**Skills**	**Cost**	**Time**
What weed species are present in riparian areas and where?	Weed survey – WETMAK	Moderate	$	Moderate
What area of weeds has been treated? What species of weeds have been treated?	Weed control records	Easy	$	Quick
How has weed density changed over time?	Weed survey – WETMAK	Moderate	$	Moderate
	Vegetation plot – WETMAK	Moderate	$$	Quick
	Photopoint	Easy	$	Quick
How has weed distribution changed?	Weed survey – WETMAK	Moderate	$	Moderate

Activities - *Restoration planting*				
Monitoring Question	**Monitoring Method**	**Skills**	**Cost**	**Time**
What area/length has been planted? How many plants have been planted?	Planting records	Easy	$	Quick
How many plants have survived?	Survival counts	Easy	$	Quick
What area/length is successfully established?	Photopoints	Easy	$	Quick
	Vegetation plot – WETMAK	Moderate	$$	Quick
	Planting records	Easy	$	Quick

Activities - *Stream clean ups*				
Monitoring Question	**Monitoring Method**	**Skills**	**Cost**	**Time**
How much litter was removed? What length of stream margin was cleared of litter? What types of litter were collected?	Litter count records	Easy	$	Quick

Table 6. Carrying out a Quick Health Check, activity and outcome monitoring for rivers and streams

Outcomes - *Improved native wildlife*				
Monitoring Question	**Monitoring Method**	**Skills**	**Cost**	**Time**
What bird species are present?	Bird acoustic monitoring	Easy	$$$	Longer
How has bird abundance changed?	Call playback	Moderate	$$	Moderate
How has bird abundance changed?	Five-minute bird count	Moderate	$	Moderate
	Visual bird counts	Easy	$$	Moderate
What fish species are present?	Fish spotlight survey	Moderate	$	Moderate
How has fish abundance changed over time?	*Can potentially use spotlight count – but very difficult to get consistent and useful results over time.*			
How good is the stream habitat?	Stream habitat assessment – Waicare	Moderate	$	Moderate
What groups of aquatic macroinvertebrate species are present?	Macroinvertebrate sampling – Waicare	Moderate	$	Moderate
How has aquatic macroinvertebrate composition changed?	Macroinvertebrate sampling – Waicare	Moderate	$	Moderate

Outcomes - *Improved vegetation*				
Monitoring Question	**Monitoring Method**	**Skills**	**Cost**	**Time**
How is riparian vegetation changing?	Photopoints	Easy	$	Quick
What plant species are present?	Vegetation plot –WETMAK	Moderate	$$	Quick
Are native plants more abundant than exotic plants?	Vegetation plot –WETMAK	Moderate	$$	Quick

Outcomes - *Improved water characteristics*				
Monitoring Question	**Monitoring Method**	**Skills**	**Cost**	**Time**
How are microbiological contamination levels changing?	Total coliform and E. coli – Waicare	Moderate	$$	Moderate
How are levels of key nutrients and other aspects of chemistry changing?	Water chemistry tests (N, P, DO, BOD, pH) – Waicare	Moderate	$$$	Moderate
How are physical water properties changing?	Water physical properties (temperature, conductivity)	Easy	$$	Moderate
What are sediment levels like? How are they changing?	Shuffle sediment test	Easy	$	Quick
	Water clarity test – Waicare	Easy	$$	Moderate
Does the aquatic macroinvertebrate community include groups requiring high water quality?	Macroinvertebrate sampling – Waicare	Moderate	$	Moderate
How does the stream shape and flow compare with other streams, and how is it changing?	Stream shape cross section – Waicare	Easy	$	Moderate
	Stream flow float and head rod – Waicare	Easy	$	Quick

Outcomes - *Matāuranga Māori*				
Monitoring Question	**Monitoring Method**	**Skills**	**Cost**	**Time**
What is the overall cultural health of the waterway?	Cultural Health Index			

Dunes and beaches

5.4 Dunes and beaches

Beaches and dunelands are an important feature of the coastline on the mainland and Hauraki Gulf islands. Black ironsand beaches line the west coast, while white sand beaches are a feature of the east coast and gulf islands. Cobbled beaches also occur on some offshore islands. Sand-binding vegetation (e.g. spinifex and pīngao) plays an important role in the formation and stabilisation of coastal sand dunes.

The plants and animals in dune environments have adapted to cope with their constantly changing and often severe environmental conditions. They are salt tolerant, able to cope with tides and constant sand movement, changing ground-water levels, sun and wind exposure. Some of Tāmaki Makaurau / Auckland's dune plants are rare or threatened, including sand coprosma, creeping fuchsia, sand spike sedge and sand tussock.

Dunes and beaches are important habitat for some shorebirds, including New Zealand dotterel, New Zealand fairy tern, Caspian tern and variable oystercatcher. Dunelands also support smaller creatures such as the copper butterfly, while beaches harbour various terrestrial invertebrates, and also shellfish. The threatened katipō spider, synonymous with New Zealand dunes, may now be extinct in Tāmaki Makaurau / Auckland and Northland. Pebbly beaches and boulder banks on offshore islands with few or no introduced predators are home to shore skinks and our only egg-laying skink species.

Ecosystems identified in the Tāmaki Makaurau / Auckland Region[7] on dunes and beaches include three beach systems: shore-bindweed, knobby clubrush gravelfield/stonefield; herbfield (coastal turf); iceplant, glasswort herbfield/loamfield, and two dune ecosystems: spinifex, pīngao grassland/sedgeland and oioi, knobby clubrush sedgeland.

5.4.1 Threats

Residential development, recreational activities, farming, pine plantations and sand mining have contributed to the modification of coastal dunes. Damaged or destroyed dune vegetation can lead to dune instability and wind erosion. Animal pests that threaten dune plants and wildlife include rabbits, hedgehogs, rodents, mustelids and cats. An array of exotic plants also modify the natural character and functioning of Tāmaki Makaurau / Auckland's dunes, including marram and kikuyu grass, pampas, tree lupin, evergreen buckthorn, boneseed, wilding conifers, herbs such as purple groundsel, and succulents like agave, often growing from discarded garden waste. Past efforts to stabilise dunes, using the introduced sand grass marram, have displaced native species and result in over-steepened dunes. It is now recognised that native dune plants provide the best protection.

[7] Singers et al. 2017.

Litter, particularly plastics, is an ongoing and widespread problem for Tāmaki Makaurau / Auckland's coastal environment. It degrades habitats and fouls beaches, and through accidental injestion, is causing high mortality of marine and bird life. Most of the litter found near Tāmaki Makaurau / Auckland comes from activities on land, but fishing-related materials are a major source farther away from the city. Plastics are the most abundant litter item, as they remain in the environment for a long time and can be transported over long distances.

The effects of climate change, including more frequent and severe storms and sea-level rise, also pose a threat to coastal ecosystems and their inhabitants.

5.4.2 Restoration activities and outcomes

Many management activities are carried out across dunes and beaches by organisations, groups and individuals. Community volunteers engage in beach clean-ups, dune planting, weed control, predator control, and shorebird protection, which includes education and temporary fencing of nesting areas. Planting native spinifex, pīngao and pōhuehue helps combat sand erosion and creates shelter for shorebirds and other duneland fauna such as the copper butterfly.

These activities contribute to important conservation outcomes such as increases in native bird numbers and improved duneland vegetation.

5.4.3 Quick Health Check, activity and outcome monitoring for dunes and beaches

Common monitoring methods for dunes and beaches include vegetation plots, shorebird counts and pest monitoring. Some fauna monitoring methods, such as skink trapping require specialist skills, permits, or pose a welfare risk to threatened species, and methods for those situations are not presented here.

Dunes and beaches are generally very public spaces and access is usually easy and safe. They provide opportunities to engage local residents in monitoring activities, but also require special precautions to secure any monitoring devices from tampering and ensure public safety.

Table 7 provides a Quick Health Check which can be used to assess a wide range of ecosystem measures and establish your pre-restoration starting point (baseline state). The table also includes common restoration management activities and types of outcomes often sought by community groups. Linked to each activity and outcome are typical monitoring questions and associated monitoring methods. Where several methods are given, decide which is the most appropriate for your project. Each monitoring method is rated against skills, cost and time (see Table 1 for rating definitions) to help you choose the one(s) most suited to your project.

The method name links to a more detailed monitoring method sheet in a later section of this guide, we recommend you read these sheets to help you refine your monitoring choices.

Table 7. Carrying out a Quick Health Check, activity and outcome monitoring for dunes and beaches

Quick Health Check				
Monitoring Question	**Monitoring Method**	**Monitoring Method Assessment**		
		Skills	**Cost**	**Time**
How is the general dune condition changing over time?	Dune health check – *In development by Auckland Council*	*	*	*
What areas need the most attention?	Dune health check – *In development by Auckland Council*	*	*	*

Note: * – not assessed as still in development.

Activities - *Pest animal control*				
Monitoring Question	**Monitoring Method**	**Skills**	**Cost**	**Time**
How many pests have we killed?	Trapping records	Easy	$	Quick
How much bait has been consumed? Where is bait take high and low across my site?	Bait take records	Easy	$	Quick
What pest animal species are present? How is pest animal abundance changing?	Tracking tunnels	Easy	$$	Moderate
	Chew cards	Easy	$$	Moderate
	Camera traps	Easy	$$$	Longer
How is rabbit abundance changing?	Spotlight counts	Easy	$	Moderate
	Camera traps	Easy	$$$	Longer

Activities - *Weed control*				
Monitoring Question	**Monitoring Method**	**Skills**	**Cost**	**Time**
What weed species are present in riparian areas and where?	Weed survey	Moderate	$	Moderate
What area of weeds has been treated? What species of weeds have been treated?	Weed control records	Easy	$	Quick
How has weed density changed over time?	Weed survey	Moderate	$	Moderate
	Vegetation plot – *(use WETMAK protocol)*	Moderate	$$	Quick
	Photopoint	Easy	$	Quick
How has weed distribution changed?	Weed survey	Moderate	$	Moderate

Table 7. Carrying out a Quick Health Check, activity and outcome monitoring for dunes and beaches

Activities - *Beach clean ups*				
Monitoring Question	**Monitoring Method**	**Skills**	**Cost**	**Time**
How much litter was removed? What length of beach or area of dune was cleared of litter? What types of litter were collected?	Litter count records	Easy	$	Quick

Outcomes - *Improved native wildlife*				
Monitoring Question	**Monitoring Method**	**Skills**	**Cost**	**Time**
What bird species are present?	Visual bird counts	Moderate	$$	Moderate
How has bird abundance changed?	Visual bird counts	Moderate	$$	Moderate
What lizard species are present?	Tracking tunnels	Easy	$$	Moderate
How has lizard abundance changed over time?	Use above method for general indication. **Results can be very difficult to obtain as lizard numbers are usually very low.**	n/a	n/a	n/a
How has intertidal shorelife changed?	Marine metre square (MM2)	Moderate	$	Moderate

Outcomes - *Improved native wildlife*				
Monitoring Question	**Monitoring Method**	**Skills**	**Cost**	**Time**
How is dune vegetation changing?	Photopoints	Easy	$	Quick
	Vegetation Plot *(use WETMAK protocol)*	Moderate	$$	Quick
	Mapping vegetation	Moderate	$	Quick
What plant species are present?	Vegetation plot *(use WETMAK protocol)*	Moderate	$$	Quick
Are native plants more abundant than exotic plants?	Vegetation plot *(use WETMAK protocol)*	Moderate	$$	Quick

5.5 Methods Summary Matrix

Summary information for the different ecosystems is shown in Table 8 for all monitoring methods listed in this guide. The table can be used as a quick reference for the different methods you are thinking of selecting. You can check how useful they are for monitoring a range of ecosystems, activities and outcomes, as well as the level of skill, cost and time involved, see Table 1 for definitions of these ratings.

Once you have identified methods that best match your group's capacity and project, review individual method sheets for each to confirm their suitability, or if there are other important considerations. The protocol listed in each method sheet will give you an overview of how it will work for you.

Table 8. Overview of all monitoring methods in the guide

Monitoring Method	Ecosystems				Activities	Outcomes	Skills	Cost	Time
	Forest and Scrub	Wetland and Estuary	River and Stream	Dune and Beach					
Bait take	✓	✓	✓	✓	Pest animal control		Easy	$	Quick
Bat acoustic monitoring	✓	✓	✓			Presence of bats	Moderate	$$$	Moderate
Bird acoustic monitoring	✓	✓	✓			Increased native bird life	Easy	$$$	Moderate
Call playback		✓	✓			Increased native cryptic (secretive) birds	Moderate	$$	Moderate
Camera traps	✓	✓	✓	✓	Pest animal control		Easy	$$$	Longer
Chew cards	✓	✓	✓	✓	Pest animal control		Easy	$$	Moderate
Cultural Health Index – stream health			✓			Stream health	Moderate	$	Moderate
Dune health check				✓		General dune health	Easy	$	Quick
Estuary WOF check		✓				General estuary condition	Easy	$	Quick
Fish spotlighting			✓			Fish species present	Moderate	$	Moderate
Five-minute bird count	✓	✓	✓			Bird species present, increased native bird life	Moderate	$	Moderate
Habitat assessment (streams) – Waicare			✓			Improved stream habitat	Moderate	$	Moderate
Inanga – assessing spawning habitat – Whitebait Connection			✓			Quality of inanga (whitebait spawning habitat)	Easy	$	Moderate
Litter count records	✓	✓	✓	✓	Litter clean ups		Easy	$	Quick
Macroinver-tebrate sampling – Waicare			✓			Stream biology, water quality	Moderate	$$	Moderate
Mapping wetland vegetation – WETMAK		✓			Weed control	Improved wetland vegetation	Moderate	$	Quick
Marine Metre Squared		✓		✓		Species present	Moderate	$$	Moderate
Photopoint	✓	✓	✓	✓	Weed control, restoration planting	Improved native vegetation	Easy	$	Quick
Plant survival counts	✓	✓	✓	✓	Restoration planting		Easy	$	Quick
Planting records	✓	✓	✓	✓	Restoration planting		Easy	$	Quick
Shuffle sediment test			✓			Water quality	Easy	$	Quick

Table 8. Overview of all monitoring methods in the guide

Monitoring Method	Ecosystems				Activities	Outcomes	Skills	Cost	Time
	Forest and Scrub	Wetland and Estuary	River and Stream	Dune and Beach					
Site assessment – FORMAK	✓				Pest animal control, weed control	General forest condition	Moderate	$	Quick
SO SMART quick visual check – Streams – Waicare			✓			General stream health	Easy	$	Quick
Spotlight counts – rabbits	✓			✓	Rabbit abundance		Easy	$	Quick
Stream flow rate (float and head rod) – Waicare			✓			Changes in channel and flow	Easy	$	Quick
Stream flow rate (float and head rod) – Waicare			✓			Changes in channel and flow	Easy	$	Quick
Stream shape (cross section) – Waicare			✓			Changes in channel and flow	Easy	$	Moderate
Total coliform and E coli – Waicare			✓			Water quality	Moderate	$$	Moderate
Tracking tunnels	✓	✓	✓	✓	Pest animal control	Increased lizard fauna, increased large invertebrates	Easy	$$	Moderate
Trapping records	✓	✓	✓	✓	Pest animal control		Easy	$	Quick
Vegetation plot – FORMAK	✓				Weed control	Improved forest understorey condition	Experienced	$$	Quick
Vegetation Plot – WETMAK		✓	✓	✓		Improved wetland vegetation	Moderate	$$	Quick
Visual bird counts*	✓	✓	✓	✓		Bird species present Increased native bird life	Easy/ Moderate	$$	Moderate
Water chemistry (pH, N, P, DO, BOD) – Waicare			✓			Water quality	Moderate	$$$	Moderate
Water clarity (turbidity) test – Waicare			✓			Water quality	Easy	$$	Moderate
Water physical properties (temperature, conductivity)			✓			Water quality	Easy	$$	Moderate
Weed control records	✓	✓	✓	✓	Weed control		Easy	$	Quick
Weed survey – WETMAK	✓	✓	✓	✓	Weed control		Moderate	$	Moderate
Wēta motels	✓	✓				Increased wēta fauna	Easy	$$	Moderate
Wetland WOF check – WETMAK		✓				Wetland health	Moderate	$	Quick

* Visual bird counts more suited to modified forest ecosystems i.e. backyard garden bird surveys and shorebird counts (beach and dune).

6 Monitoring plan

The monitoring plan allows you to record your approach to monitoring. This means that it can be picked up by anyone in your project in the future to provide an overview of the monitoring being undertaken. Use this section once you are clear on the monitoring questions you are answering and have identified the monitoring methods you will apply.

The ecosystem monitoring guide and summary matrix allows you to check that the monitoring methods chosen are appropriate. Use the individual method sheets to check how a particular method is rated for aspects such as scientific robustness, and also to direct you to the full protocol/ instructions for the method.

We suggest you seek technical help if required, from Auckland Council staff, when you are working through preparing your monitoring plan.

6.1 Completing the monitoring plan

6.1.1 Our project

Start by completing the first part of the monitoring plan that sets out what your project is about. Refer to the guidance in Section 2 to record the ecosystem(s) you are working on, as well as your vision and objectives. Decide the management activities you will be implementing, and what outcomes you are expecting from doing this. Also, decide what key monitoring questions you should be asking – you will see many of these set out in the tables in Section 6. The points you record in this section will be the basis of selecting the most useful monitoring for your project.

6.1.2 Things to consider

Work through the points under this section of the plan. You will find comments and guidance around these points in Section 3 – Practical monitoring outline. The notes you make here will help you to choose the most suitable monitoring methods.

Make some notes on why you chose the monitoring method in your plan. These notes will be helpful when it's time to review your monitoring plan. Were skills, time or cost a crucial factor in your original decisions? Sometimes we forget the details of why a decision was made, or the people who made earlier decisions are no longer involved. It's good to have a record of why you chose a particular method, so that when you review your monitoring plan you know the history.

6.1.3 Our monitoring

In this part of the plan, record how each monitoring method you have selected will be used. Each 'monitoring method' box in the plan is for a different method. If you are using four different methods, you will need to complete the monitoring method box

four times. The information in this section documents how you will lay out and measure monitoring sites over time, so that your monitoring is consistent and valid. These are the ‘meta data’ about how the monitoring data were collected. This means anyone in the future can repeat the monitoring and understand how to compare it with other data sets.

6.2 Worked examples

6.2.1 Example one: suburban predator control and bird restoration (‘Backyard Birds’)

This project works across several suburbs containing residential properties and occasional small reserves and parkland. A group has been established to control predators across the suburb, so that more native birdlife can move across and live in the area. They are particularly interested in getting people involved, both in backyard predator control and controlling predators throughout reserve areas. The group may look at planting to improve bird habitat in the future.

A small core of skilled people started the group, but they expect there are few people living in the project area with experience in conservation and predator control. Many are very busy (so unlikely to have much time) and there are few retirees, but there may be access to funding.

The group has worked with Auckland Council to start planning the project. They also have a good relationship with the Department of Conservation, and a local outdoor clothing shop, which is interested in promoting the project.

The project area links into surrounding, but distant, forest. Most of the residential areas covered by the project would originally have been covered in forest.

Monitoring plan

Our project

Project name	*Backyard Birds*
Ecosystem(s)	What ecosystem(s) does your project cover? Forest and Scrub / Wetland and Estuary / Lake and Stream / Dune and Beach
Vision	What is the long-term vision you want the project to achieve? *Native birds provide a lively dawn chorus across the suburb and move safely through backyards and a network of predator free habitat.*
Objectives	Break the vision down into a list of key objectives that will move toward the vision • *Predator control is in place across all public reserves in the project area by the end of year two.* • *Rat abundance is reduced and maintained at below 5% tracking rates across the area by the end of year five.* • *Native songbird species are present in all reserve areas within five years.* • *Increased native songbirds in all reserve areas within 10 years.* • *Half of all new tree planting on public land is with bird attracting native species within five years.*
Activities	What management activities are you undertaking to meet your objectives? Pest animal control / weed control / restoration planting / beach clean-ups / stream clean-ups Other (notes):
Outcomes	What outcomes are you seeking? • **Improved native wildlife** (Increased native birds / increased lizard species / increased bats / increased invertebrates / increased fish / improved whitebait spawning) • **Improved native vegetation** (improved native vegetation condition / improved native understorey vegetation / more native forest habitat). • **Improved water quality** / natural water flow. Other (notes):

Based on the above points, look at each ecosystem and list your possible monitoring methods. Answer the questions below, to help confirm which ones will work for you.

Things to consider

That may affect our choice of monitoring

SITE	**Quick Health Check**	Has a Quick Health Check been done (optional)? *Site assessments undertaken across five largest reserves* What key issues were raised? *Very few birds, degraded weedy habitat, significant possum sign.*
	Scale	Is the project area and areas you will be working on small (e.g. a few hectares or less) or large, e.g. across a whole catchment? *Project area is across three moderate-sized catchment areas. Area is mainly residential but has occasional small reserve areas and parkland. Monitoring will be done throughout the three catchments as a neighbourhood programme.*
	Location	Is the project in a remote rural area, in the middle of an urban area, or on an island? *Urban area*
	Multiple ecosystems?	Do I need to choose a monitoring method that will work across different ecosystems on my site? *Modified forest ecosystem focus*
	Health and safety	Are there any particular health and safety hazards of your project site that will need to be considered in the design of monitoring? *Two of the small reserve areas have steep cliff areas with difficult access.*
CAPABILITIY	**Skills**	Does your group have particular technical or other skills? How do you think these might change over time? *There are currently good skills in the group in predator control however we also have a big range of skill levels in other areas (e.g. data management/collection, bird counts).*

Things to consider

That may affect our choice of monitoring

CAPABILITIY	**People**	Do you have lots of volunteers, or are you a small group? Will it be easy to involve people in monitoring or not? *We have a small core group and expect to have lots of backyard volunteers who will have little time for detailed monitoring.*
	Financial	Do you have access to ongoing financial funding support, or will it always be difficult to find money? *A number of people across the residential area have offered to pay an annual subscription in support. There is also at least one business interested in providing support and promotion. These amounts alone will not be large though.*
	Partners	Who are your key partners and stakeholders that you need to work with? *The local community boards will be a key partner for engagement with the local communities. Auckland Council and DOC will be an important source of technical support. The outdoor clothing shop will be a useful partner for promoting the project and displaying monitoring results.*
Monitoring methods selected for our project		Which monitoring method(s) have you selected? List below and then complete a separate monitoring method sheet for each different method you will use in your project.
		1. Chew cards *2. Five-minute bird count* *3. Visual bird count (garden bird survey)*

Our monitoring

Separate entry for each monitoring method.

Monitoring method name

Chew cards

What <u>activity and/or outcome</u> will this method be monitoring?

Activity – Pest animal control

What is/are the monitoring question(s) you are trying to answer?

How is pest animal abundance changing?

Where will monitoring points be located?

Chew cards will be located in two ways:

1. *On transects with 10 cards per transect and cards 20m apart in reserve areas (as shown on map).*
2. *Two cards on each participating residential property.*

How will you mark plots/sites in the field that need to be remeasured?

Mark the transect lines through reserve areas with a tag on tree every 100m and flagging tape between if necessary.

Timing: When will you start and finish monitoring?

Once per year

How often will you monitor?

N/A

What time of year?

Late winter

How will you store your data?

Paper and electronic?

Paper records in the field then to online data.

Which online data system?

Use monitoring section of Trap.NZ

How will you analyse and report?

Indicator species?

Main focus will be on tracking rat chew rates

Management feedback?

Where chew rates are high in reserves and surrounding residential areas, work to intensify predator control.

Review?

Re-examine monitoring approach after three years..

Monitoring method name

Five-minute bird count

What <u>activity and/or outcome</u> will this method be monitoring?

Increased levels of native wildlife..

What is/are the monitoring question(s) you are trying to answer?

What bird species are present?
How have bird numbers changed?

Where will monitoring points be located?

Count stations (points) located in reserve areas so they are 200m apart, and where possible at least 100m into the reserve. Small reserves may only have one count. Across all the reserves will be a total of approximately 50 counts.

How will you mark plots/sites in the field that need to be remeasured?

Count stations marked with a tag on tree. Locations have GPS coordinates and are marked on map.

Timing: When will you start and finish monitoring?

How often will you monitor?

Once per year

What time of year?

Late October – Early November

How will you store your data?

Paper and electronic?

Paper field records. Entered into standard DOC spreadsheet format..

Which online data system?

None at present. Will transfer to a secure and widely used system if one develops.

How will you analyse and report?

Will chart changes in individual species over time.

Monitoring method name

Visual bird count (garden bird survey)

What <u>activity and/or outcome</u> will this method be monitoring?

Improved native wildlife

What is/are the monitoring question(s) you are trying to answer?

What bird species are present and how many?

Where will monitoring points be located?

All interested residents will undertake a count in their backyard.

How will you mark plots/sites in the field that need to be remeasured?

Counts will be from a known comfortable vantage point on people's properties. The location will be noted but not marked.

Timing: When will you start and finish monitoring?

Late June – early July.

How often will you monitor?

Once per year.

What time of year?

Late June – early July as defined by national Garden Bird survey programme..

How will you store your data?

Paper and electronic?

Paper record during count.

Which online data system?

Landcare Research Garden Bird survey system

How will you analyse and report?

Distribution and relative frequency of different species across the area will be presented.

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6.2.2 Example two: small rural reserve

A group of rural landowners is interested in improving the health of a local bush reserve. The reserve is mainly lowland native forest, but also has a small area of wetland on one edge. The total reserve size is approximately five hectares.

The group is concerned about weeds that are spreading into the reserve and suppressing native plant regeneration. The forest canopy and understorey are in poor condition. The group want to focus initially on looking after the native vegetation/habitat that is present. They mostly live and work around the area and can put some of their time into tasks such as weed control. They don't have much experience of monitoring and want to put most of their energy into getting rid of weeds, but they see the need for monitoring to see what they have achieved, and to justify progress to funders providing money for contractors, chemicals and equipment.

Monitoring plan

Our project

Project name	*Middle Bush Reserve*
Ecosystem(s)	What ecosystem(s) does your project cover? Forest and Scrub / Wetland and Estuary / Lake and Stream / Dune and Beach
Vision	What is the long-term vision you want the project to achieve? *Middle Bush Reserve is a healthy example of forests that once grew throughout the area and a starting point for an expanding framework of native vegetation..*
Objectives	Break the vision down into a list of key objectives that will move toward the vision • *Weeds with high ecological impact are removed from the reserve within five years.* • *Within 10 years the forest understorey is regenerating with a range of native species to maintain the forest.* • *A healthy forest canopy covers all mature forest trees within five years.*
Activities	What management activities are you undertaking to meet your objectives? Pest animal control / weed control / restoration planting / beach clean-ups / stream clean-ups Other (notes):
Outcomes	What outcomes are you seeking? • **Improved native wildlife** (Increased native birds / increased lizard species / increased bats / increased invertebrates / increased fish / improved whitebait spawning) • **Improved native vegetation** (improved native vegetation condition / improved native understorey vegetation / more native forest habitat). • **Improved water quality** / natural water flow. Other (notes) *Wider outcomes are likely to occur in the future – but are not the short-term focus of the project.*

Based on the above points, look at each ecosystem and list your possible monitoring methods. Answer the questions below, to help confirm which ones will work for you.

Things to consider

That may affect our choice of monitoring

SITE	**Quick Health Check**	Has a Quick Health Check been done (optional)? What key issues were raised? *Weeds abundant in many areas of the reserve, particularly edges and more open areas of small wetland.*
	Scale	Is the project area and areas you will be working on small (e.g. a few hectares or less) or large, e.g. across a whole catchment? *Small scale, approximately five hectares*
	Location	Is the project in a remote rural area, in the middle of an urban area, or on an island? *Rural area*
	Multiple ecosystems?	Do I need to choose a monitoring method that will work across different ecosystems on my site? *Have both forest and a small area of wetland.*
	Health and safety	Are there any particular health and safety hazards of your project site that will need to be considered in the design of monitoring? *Terrain relatively easy and does not create unusual hazards. Wetland could be a hazard to small children.*
CAPABILITIY	**Skills**	Does your group have particular technical or other skills? How do you think these might change over time? *Most members are farmers and have practical skills in weed control, but are less interested in technical monitoring approaches.*

Things to consider

That may affect our choice of monitoring

CAPABILITIY	**People**	Do you have lots of volunteers, or are you a small group? Will it be easy to involve people in monitoring or not? *This is a small but committed group. Most live locally and are likely to remain involved in the project.*
	Financial	Do you have access to ongoing financial funding support, or will it always be difficult to find money? *There is likely to be more access to labour and in-kind support than funding.*
	Partners	Who are your key partners and stakeholders that you need to work with? *Auckland Council has provided useful support. A vegetable processing company is also providing some funding.*
Monitoring methods selected for our project		Which monitoring method(s) have you selected? List below and then complete a separate monitoring method sheet for each different method you will use in your project.
		1. *Weed survey – WETMAK* 2. *Photopoints* 3. *Weed control records* 4. *Vegetation plot – FORMAK*

Our monitoring

Separate entry for each monitoring method.

Monitoring method name

Weed survey - WETMAK

What <u>activity and/or outcome</u> will this method be monitoring?

Weed control

What is/are the monitoring question(s) you are trying to answer?

What weed species are present and where.

Where will monitoring points be located?

Follow monitoring protocol to undertake a weed survey and mapping throughout the reserve.

How will you mark plots/sites in the field that need to be remeasured?

Show path of survey on map and also record GPS coordinates of weed sites.

Timing: When will you start and finish monitoring?

Survey every three years to check on progress with control, and any new weeds..

What time of year?

Likely to be easiest in summer, particularly when some weed species are flowering. Avoid survey when species with easily spread seeds are in seed..

How will you store your data?

Paper and electronic?

Store paper survey record sheets.

Electronic storage in spreadsheet of individual weed records.

Which online data system?

May load some key species to NatureWatch. Interested in possibly using weedmanager system currently being developed.

How will you analyse and report?

Indicator species?

Map the location and relative abundance of key weed species across the area.

Management feedback?

Identify priorities for weed control and possible patterns of weed introduction or spread (e.g. weed dumping at end of road).

Review?

Review approach at least every five years.

Monitoring method name

Photopoints

What <u>activity and/or outcome</u> will this method be monitoring?

Weed control, improved vegetation.

What is/are the monitoring question(s) you are trying to answer?

How has weed density changed over time?
How is vegetation cover of stream banks changing?
How is understorey changing?
How is wetland vegetation changing?

Where will monitoring points be located?

Photopoints will be placed in key locations including:
- *A site with a view of a major patch of key weed species*
- *3-4 different overview sites from outside the reserve that show a view of the forest canopy*
- *an overview of the small wetland*
- *2-3 views within the forest of the understorey.*

How will you mark plots/sites in the field that need to be remeasured?

Photopoints will be marked with a tag on a nearby tree or fence post. The precise location of the photopoint will be marked with a 50mm x 50mm post driven deeply into the ground..

Timing: When will you start and finish monitoring?

How often will you monitor?

Once a year

What time of year?

November

How will you store your data?

Paper and electronic?

Images filed electronically by photopoint on group Google drive

Which online data system?

Use group Google drive until suitable online system available

How will you analyse and report?

Image sequences reported every year, and also provided as timelapse sequences.

Monitoring method name

Weed control records

What <u>activity and/or outcome</u> will this method be monitoring?

Weed control

What is/are the monitoring question(s) you are trying to answer?

What area of weeds has been treated?
What species of weeds have been treated?

Where will monitoring points be located?

Maps and/or GPS coordinates of weed control locations are recorded..

How will you mark plots/sites in the field that need to be remeasured?

Sites mapped and/or GPS coordinates.

Timing: When will you start and finish monitoring?

How often will you monitor?

Records for all weed control operations

What time of year?

Whenever weed control occurs

How will you store your data?

Paper and electronic?

Paper and electronic maps of location of control. Weed control data sheets filed. Filed on group Google drive.

Which online data system?

Will keep availability of suitable online systems under review

How will you analyse and report?

Annual summary of weed control. Track how this has changed in relation to different areas/species and amount of weed control

Monitoring method name

Vegetation plot – FORMAK

What <u>activity and/or outcome</u> will this method be monitoring?

Improved vegetation
Weed control

What is/are the monitoring question(s) you are trying to answer?

How is the understory changing?
How has weed density changed over time?

Where will monitoring points be located?

Four plots will be set up in the reserve as on the map. These are spread across the reserve and represent the forest types present.

How will you mark plots/sites in the field that need to be remeasured?

Plots marked with tag on tree and pegs, in accordance with protocol.

Timing: When will you start and finish monitoring?

How often will you monitor?

Every five years

What time of year?

Summer

How will you store your data?

Paper and electronic?

Paper plot sheets filed.
Data recorded in spreadsheet

Which online data system?

Will move to online data system once FORMAK online system is redeveloped

How will you analyse and report?

Provide summaries of weed species and native seedlings in different size classes. Track changes in this over time.

6.2.3 Example three: small rural stream on private land

A dairy farmer has decided to fence and plant the stream banks on his property and wants to know if these actions will make a difference (improvement) to the water quality and health of their stream. The stream headwaters and a 1km length of the stream are on the property. The stream runs through grazed farmland, the stream bank is pasture grass and largely devoid of native vegetation, some erosion has occurred previously along the stream banks. The landowner has attended a Waicare training course and been a parent helper with the local school's Waicare monitoring. The local school are interested in lending Waicare monitoring equipment to keen landowners and having students help with the water quality monitoring.

Monitoring plan

Our project

Project name	*Waiwai stream*
Ecosystem(s)	What ecosystem(s) does your project cover? Forest and Scrub / Wetland and Estuary / Lake and Stream / Dune and Beach
Vision	What is the long-term vision you want the project to achieve? *The headwaters of Waiwai stream will be healthy and flourishing with good water quality and an abundance of native freshwater fish and invertebrate will be present in the stream. The stream banks of Waiwai stream will be covered in native shrubland and stock will no longer have access to the stream banks and stream.*
Objectives	Break the vision down into a list of key objectives that will move toward the vision • *Stock grazing of the stream banks will stop at the start of year one.* • *Headwaters and 1km of stream will be stockproof-fenced at the end of year two.* • *1km of planting (both sides of stream) will be completed by the end of year five.* • *Within 10 years the stream habitat will have been improved.* • *The stream banks will have a healthy native forest canopy cover within 15 years.*
Activities	What management activities are you undertaking to meet your objectives? Pest animal control / weed control / restoration planting / beach clean-ups / stream clean-ups Other (notes): *fencing, stock removal*
Outcomes	What outcomes are you seeking? • **Improved native wildlife** (Increased native birds / increased lizard species / increased bats / increased invertebrates / increased fish / improved whitebait spawning) • **Improved native vegetation** (improved native vegetation condition / improved native understorey vegetation / more native forest habitat) • **Improved water quality** / natural water flow. Other (notes) *Improved in-stream habitat for native freshwater fauna.*

Based on the above points, look at each ecosystem and list your possible monitoring methods. Answer the questions below, to help confirm which ones will work for you.

Things to consider

That may affect our choice of monitoring

SITE	**Quick Health Check**	Has a Quick Health Check been done (optional)? *Yes, quick visual check – streams –Waicare* What key issues were raised? *Stream banks have poor vegetation cover, erosion evident. Stock have access to stream and are contributing to the pollution of the stream.*
	Scale	Is the project area and areas you will be working on small (e.g. a few hectares or less) or large, e.g. across a whole catchment? *Small scale, approximately 1km of stream.*
	Location	Is the project in a remote rural area, in the middle of an urban area, or on an island? *Rural area (not remote), short walk from the farm house.*
	Multiple ecosystems?	Do I need to choose a monitoring method that will work across different ecosystems on my site? *Only stream ecosystem.*
	Health and safety	Are there any particular health and safety hazards of your project site that will need to be considered in the design of monitoring? *Water hazard, especially if we involve the school children in the monitoring.*
CAPABILITIY	**Skills**	Does your group have particular technical or other skills? How do you think these might change over time? *I'm a farmer, I can use my farm equipment for fencing and planting. I have helped with school Waicare monitoring and the local school teacher can also provide advice on the monitoring.*

Things to consider
That may affect our choice of monitoring

<table>
<tr><td rowspan="3">CAPABILITIY</td><td>People</td><td>Do you have lots of volunteers, or are you a small group? Will it be easy to involve people in monitoring or not?

Just me and my partner, don't have much time for monitoring, more interested in the doing.
My son is keen on photography maybe he could do photopoints and some assistance will be available from the local school children (room 3) for Waicare monitoring. School has indicated they can't do all the Waicare monitoring modules so have decided to focus on habitat assessment – due to it being easy and low cost.</td></tr>
<tr><td>Financial</td><td>Do you have access to ongoing financial funding support, or will it always be difficult to find money?

Healthy Waters adviser has indicated I should apply to council's stream protection fund for half fencing costs.
Will grow some of the plants in our farm nursery.
School will lend Waicare monitoring equipment and students may help with some planting.
Need some funds for half fence costs and plants we need to buy – will stage planting to spread the cost.</td></tr>
<tr><td>Partners</td><td>Who are your key partners and stakeholders that you need to work with?

Local school
Council funding team and Healthy Waters adviser</td></tr>
<tr><td colspan="2" rowspan="2">Monitoring methods selected for our project</td><td>Which monitoring method(s) have you selected? List below and then complete a separate monitoring method sheet for each different method you will use in your project.</td></tr>
<tr><td>1. Quick visual check – streams
2. Photopoints
3. Habitat assessment (streams)</td></tr>
</table>

Our monitoring

Separate entry for each monitoring method.

Monitoring method name

Quick visual check – streams

What <u>activity and/or outcome</u> will this method be monitoring?

Health check – general stream health.

What is/are the monitoring question(s) you are trying to answer?

What is the health of my stream?

Where will monitoring points be located?

Follow monitoring protocol, assessment covers the length of the stream on our property.

How will you mark plots/sites in the field that need to be remeasured?

Use aerial photos of our stream and mark up.

Timing: When will you start and finish monitoring?

Will do health check in year one, five, 10 and 15.

How often will you monitor?

Every five years.

What time of year?

Will do at the start of each season (winter, spring, summer, autumn).

How will you store your data?

Paper and electronic?

Use Waicare datasheet, store electronically.

Which online data system?

Waicare

How will you analyse and report?

Indicator species?

N/A

Management feedback?

Identify changes and discuss with farm manager.

Review?

Review approach at least every five years.

Monitoring method name

Photopoints

What <u>activity and/or outcome</u> will this method be monitoring?

Weed control, improved vegetation.

What is/are the monitoring question(s) you are trying to answer?

How has weed density changed over time?
How is vegetation cover of stream banks changing?

Where will monitoring points be located?

Two photopoints – one for each side of the stream.

How will you mark plots/sites in the field that need to be remeasured?

Photopoints will be marked with a tag on a nearby tree or fence post.

Timing: When will you start and finish monitoring?

How often will you monitor?

Once a year

What time of year?

February (when students back at school to help).

How will you store your data?

Paper and electronic?

Images filed electronically by photopoint on farm computer.

Which online data system?

N/A

How will you analyse and report?

See if students want to make a sequence to show changes through images. Ask students to write an article in the school newsletter.

Monitoring method name

Habitat assessment (streams)

What <u>activity and/or outcome</u> will this method be monitoring?

Planting
Fencing
Improved stream habitat for native freshwater species.

What is/are the monitoring question(s) you are trying to answer?

Is planting and fencing of our stream improving stream habitat quality?

Where will monitoring points be located?

Follow Waicare monitoring protocol, assessment covers the length of the stream on our property.

How will you mark plots/sites in the field that need to be remeasured?

Use aerial photos of our stream and mark up.

Timing: When will you start and finish monitoring?

Start year one and finish at year 15

How often will you monitor?

Yearly

What time of year?

February (when students back at school to help).

How will you store your data?

Paper and electronic?

Use Waicare datasheet, store electronically.

Which online data system?

Waicare

How will you analyse and report?

Indicator species?

N/A

Management feedback?

Identify changes and discuss with farm manager. Discuss changes with school students.

Review?

Review approach at three years.

Blank monitoring plan template

Our project

Project name	
Ecosystem(s)	What ecosystem(s) does your project cover? Forest and Scrub / Wetland and Estuary / Lake and Stream / Dune and Beach
Vision	What is the long-term vision you want the project to achieve?
Objectives	Break the vision down into a list of key objectives that will move toward the vision.
Activities	What management activities are you undertaking to meet your objectives? Pest animal control / weed control / restoration planting / beach clean-ups / stream clean-ups Other:
Outcomes	What outcomes are you seeking? **Improved native wildlife** (increased native birds / increased lizard species / increased bats / increased invertebrates / increased fish / improved whitebait spawning). **Improved native vegetation** (improved native vegetation condition / improved native understorey vegetation / more native forest habitat). **Improved water quality** / natural water flow. Other:

Based on the above points, look at each ecosystem and list your possible monitoring methods. Answer the questions below, to help confirm which ones will work for you.

Things to consider

That may affect our choice of monitoring?

SITE	**Quick Health Check**	Has a Quick Health Check been done (optional)? What key issues were raised?
	Scale	Is the project area(s) you will be working on small (e.g. a few hectares or less) or large (e.g. across a whole catchment)? Does your monitoring area differ from your project area – e.g. are you setting up monitoring across your whole project area or only part of it?
	Location	Is the project in a remote rural area, in the middle of an urban area, or on islands?
	Multiple ecosystems?	Do I need to choose a monitoring method that will work across different ecosystems on my site?
	Health and safety	Are there any particular health and safety hazards of your project site that will need to be considered in the design of monitoring?
CAPABILITIY	**Skills**	Does your group have particular technical or other skills? How do you think these might change over time?
	People	Do you have lots of volunteers, or are you a small group? Will it be easy to involve people in monitoring or not?

Things to consider

That may affect our choice of monitoring?

CAPABILITIY	**Financial**	Do you have access to ongoing financial funding support, or will it always be difficult to find money?
	Partners	Who are your key partners and stakeholders that you need to work with?
Monitoring methods selected for our project		Which monitoring method(s) have you selected? List below and then complete a separate monitoring method sheet for each different method you will use in your project.
		1. 2. 3. 4. 5. 6.

Our monitoring

Separate entry for each monitoring method.

Monitoring method name:

What <u>activity and/or outcome</u> will this method be monitoring?

What is/are the monitoring question(s) you are trying to answer?

(Record one of the questions on the ecosystem sheets.)

Where will monitoring points be located?

(Attach a map if useful.)

How will you store your data?

Paper and electronic?

Which online data system?

How will you mark plots/sites in the field that need to be remeasured?

Timing: When will you start and finish monitoring?

How often will you monitor?

What time of year?

How will you analyse and report?

Indicator species?

Management feedback?

Review?

Monitoring method name:

What activity and/or outcome will this method be monitoring?

What is/are the monitoring question(s) you are trying to answer?

(Record one of the questions on the ecosystem sheets.)

Where will monitoring points be located?

(Attach a map if useful.)

How will you mark plots/sites in the field that need to be remeasured?

Timing: When will you start and finish monitoring?

How often will you monitor?

What time of year?

How will you store your data?

Paper and electronic?

Which online data system?

How will you analyse and report?

Indicator species?

Management feedback?

Review?

Attach additional copies of this sheet for extra methods.

7 Monitoring method sheets

Bait take

Summary:	Simple recording of bait take from different pest animal control bait stations. Good simple method of identifying broad levels of pest animal activity and where these are located in the project area. Valuable also in monitoring total toxin applied over time.
Ecosystems:	Forest and Scrub, Wetlands and Estuaries, Dunes and Beaches.
Activity monitoring:	Pest animal control.
Outcome monitoring:	0
Questions:	How much bait has been consumed by pests? Where is bait take high and low across my site?
Protocol:	No specific protocol. Standard recording system provided in Trap.NZ. Also record tables provided by Auckland Council and WWF NZ Monitoring Toolkit.

Criteria	Score	Comment
Scientific robustness	2	Has been used in a range of projects to monitor bait take at an operational level. Not aware of use in scientific studies.
Broad applicability	2	Applicable to operations with pest animal control using bait stations. Suitable for different pests and ecosystems. Not always possible to separate bait take by different pests – e.g. possum and rodent take from bait stations. However, well managed operations will often be focussed on particular pest control from bait stations.
Skill level	3	Just need to be able to follow standard recording protocol to record bait taken.
Precision/sensitivity	2	Able to pick up differences in broad bait take over time giving an approximation of pest presence. Also good for identifying spatial hotspots in bait take.
Data management	2	Some systems available – e.g. Trap.NZ. Use increasing but not widespread at this stage.
Data analysis	2	Some use in summarising and presenting hotspots. Trap.NZ beginning to add standard reports and maps.
Cost/equipment	3	No special equipment.
Time	3	Undertaken in conjunction with control operations so minimal additional time.
People	3	Can be done with one person during bait filling (two for safety).
Safety	3	No additional safety issues beyond those already present for refilling bait stations.
Permit	3	No permit required.

Scores: 3 = high suitability, 2 = moderate suitability, 1 = lower suitability

Scale issues:	Appropriate for use at different scales – can show level of bait take at a project/area level and also report at regional level.
Limitations:	Is influenced by the nature of the baiting operation – e.g. density of bait stations, frequency of refilling, etc. Cannot always identify the species taking the bait.
Notes:	Good simple method that does not require much additional effort. Just discipline of keeping records. This is being made significantly easier by online and app based data systems such as Trap.nz.
Related methods:	Trapping records
Weblink:	www.trap.nz/ http://assets.wwf.org.nz/downloads/hpf_monitoring_toolkit.pdf
Protocol use notes:	0

Bat acoustic monitoring

Summary:	An automated recording system deployed in the field for a set period that detects and records sounds emitted by bats. Can be coupled with a bird acoustic recording device to collect data on birdlife over the same period.
Ecosystems:	Forest and Scrub, Wetlands and Estuaries, Rivers and Streams.
Activity monitoring:	0
Outcome monitoring:	Improved native wildlife.
Questions:	Are bats present? What species of bat are present?
Protocol:	DOC Monitoring Toolkit – Counting away from roosts – automatic bat detectors, Sedgeley 2012.

Criteria	Score	Comment
Scientific robustness	2	Broad protocols are present but not particularly specific. Useful and reliable method for assessing bat presence but not really suitable for abundance.
Broad applicability	1	Only for bats but combo bat/bird recorders are being developed.
Skill level	2	Relatively simple data collection with a small amount of training. More skill needed than for hand-held detectors – but not too difficult to identify bat passes.
Precision/sensitivity	1	Good for presence absence – getting an idea of distribution and for broad levels of activity (high, medium, low) but not for changes in abundance.
Data management	2	A DOC database exists – but unclear if still operating or maintained.
Data analysis	2	Simple summary of results – no specific analysis/summary routines are present.
Cost/equipment	1	Detector units around $400-$500. Need a number of these if assessing wider areas. Potential to share units among groups.
Time	2	Putting out automated recorders fairly quick and easy. Some time involved in checking recording/spectrograms.
People	3	Can be done with one person (two for safety).
Safety	3	No specific safety issues. Does not require night visits, so safer than use of hand-held detectors.
Permit	3	No permit required.

Scores: 3 = high suitability, 2 = moderate suitability, 1 = lower suitability

Scale issues:	Can look at presence in individual areas and also use this information to look at bat distribution across the region.
Limitations:	Requires some skill to interpret results. Bats can be present in very low numbers – so difficult to detect. Hand-held bat detectors using triangulation may be better for estimating abundance and more engaging for the community.
Notes:	A simple and interesting method that involves people in gathering data. Not particularly useful for looking at changes in abundance.
Related methods:	**Bat hand-held detectors** (not included in this guide), is being developed by Auckland Council, contact biodiversity@aucklandcouncil.govt.nz if you would like more information on a hand-held detector protocol. Acoustic monitors have the advantage of being able to capture data 24/7 for the period deployed.
Weblink:	http://www.doc.govt.nz/Documents/science-and-technical/inventory-monitoring/im-toolbox-bats/im-toolbox-bats-counting-away-from-roosts-automatic-bat-detectors.pdf
Protocol use notes:	Protocol needs updating in line with latest equipment and methods.

Bird acoustic monitoring

Summary:	Automated recording of audio from fixed points across the study area and subsequent identification of bird species from audio files. Currently requires a human observer to listen to files/view spectrograms but this may be at least partly automated in the future.
Ecosystems:	Forest and Scrub, Wetlands and Estuaries, Rivers and Streams.
Activity monitoring:	0
Outcome monitoring:	Improved native wildlife.
Questions:	What bird species are present? How has bird abundance changed?
Protocol:	Under development.

Criteria	Score	Comment
Scientific robustness	2	Protocols are still under development but available for some species (e.g. bittern see O'Donnell and Williams 2015). Wide use of this method in research projects.
Broad applicability	2	Suitable for cryptic or nocturnal birds where there is not too much background noise.
Skill level	3	Simple method to collect the data, but significant skill level in interpretation of calls. However, lots of work is being done on automated/machine learning approaches to bird identification from audio.
Precision/sensitivity	2	Not as sensitive as a human observer generally, so may need more recorders than observers, but able to collect much more data so bigger samples and greater detection rates of uncommon species.
Data management	1	No widely used standard data storage at present. Groundtruth have developed songbird database, spectrograph and crowd sourcing ID platform.
Data analysis	2	Currently not a good standard system in place. Various spectrogram software is used to analyse the sound files, e.g. raven. Considerable work underway on this which could yield automated analysis over time.
Cost/equipment	1	Recorders required. Depending on intensity of sampling several required at around $400 each. May also need to purchase analysis software/ licence.
Time	1	Not too much time to capture data but requires two visits (to deploy and retrieve) and takes a lot of time to analyse. Analysis time will be reduced when analysis software becomes available.
People	3	Can be done with one person (two for safety).
Safety	3	No specific safety issues but depends where you need to set up/access.
Permit	3	No permit required.

Scores: 3 = high suitability, 2 = moderate suitability, 1 = lower suitability

Scale issues:	Potential for use at individual project/area level and also for summary results, etc. to be used much more widely at regional, etc. level.
Limitations:	Large amounts of audio recording data need to be interpreted. Does not provide a spatial count in the way a five-minute bird count does, so less effective at assessing changes in abundance.
Notes:	Valuable and rapidly developing technique. There are a number of questions around data management, analysis and protocols to be answered. These are likely to be resolved in the medium term. Simplicity of data capture is an attraction as is ability to capture calls at all times of day/night and without human influence. However need better systems to automate analysis.
Related methods:	0
Weblink:	http://www.doc.govt.nz/Documents/science-and-technical/docts38entire.pdf
Protocol use notes:	0

Call playback

Summary:	Taped calls of birds that are cryptic (hard to see or hear) are played out loud in a suitable habitat to encourage them to reply to the potential 'intruder' and reveal their presence. Cryptic birds include rails and crakes.
Ecosystems:	Wetlands and Estuaries, Rivers and Streams.
Activity monitoring:	0
Outcome monitoring:	Improved native wildlife.
Questions:	What cryptic (secretive) bird species are present?
Protocol:	Protocols are under development by the Department of Conservation and will likely be made publicly available on their website.

Criteria	Score	Comment
Scientific robustness	2	NZ protocols are under development by the Department of Conservation and have been tested by Auckland Council via their regional wetland monitoring programme.
Broad applicability	1	Limited to target bird species, usually cryptic birds known to respond to calls (fernbird, crakes, rails).
Skill level	2	Some training, but users need only to listen for the call they just played.
Precision/sensitivity	2	Can only generate incomplete counts (presence/relative abundance estimates), risk of de-sensitising local birds if used too frequently.
Data management	1	No national data storage system currently.
Data analysis	2	Fairly simple examination of changes in relative numbers or presence but may need statistician to assist with sampling design and data analysis to undertake population trend analysis.
Cost/equipment	2	Can be done with smartphone with good speakers or cheap bluetooth speakers. May need gps (or smartphone) to re-location stations for repeat visits. Will need suitable audio files but can download from NZ Birds Online, Whatbird or DOC website.
Time	2	Not too much time to capture data and quick to analyse. Would only need to do twice per year. Most of the time would be in getting to the monitoring site.
People	3	Should be done with two people for safety.
Safety	3	No specific safety issues but depends where you need to set up/access.
Permit	3	No permit required.

Scores: 3 = high suitability, 2 = moderate suitability, 1 = lower suitability

Scale issues:	Potential for use at individual project/area level and also for summary results, etc. to be used much more widely at regional, etc. level.
Limitations:	Over use in the same location can desensitise target birds to taped calls. Only suitable for a selected suite of birds. Not suitable for Australasian bittern, see O'Donnell and Williams 2015 for bittern-specific protocols. http://www.doc.govt.nz/Documents/science-and-technical/docts38entire.pdf
Notes:	Easy to use but relies on the target bird responding to calls (may have gender bias?) and most suitable for diurnal species.
Related methods:	Bird acoustic monitoring.
Weblink:	Likely to be published on: www.doc.govt.nz/our-work/biodiversity-inventory-and-monitoring/
Protocol use notes:	Avoid over use of method to ensure no negative impacts on bird behaviour or desensitising to calls.

Camera traps

Summary:	Camera traps are installed across the project area. These motion triggered cameras capture images of pest species moving through their field of view. 'Capture' rates can be used to monitor relative abundance of pests.
Ecosystems:	Forest and Scrub, Wetlands and Estuaries, Dunes and Beaches.
Activity monitoring:	Pest animal control.
Outcome monitoring:	0
Questions:	What pest animal species are present? How is pest animal abundance changing?
Protocol:	No standard protocols at present.

Criteria	Score	Comment
Scientific robustness	2	Several studies have shown the potential of camera traps but there are no clear protocols for their use for ongoing monitoring at present.
Broad applicability	3	Potentially wide applicability across different ecosystems and with a range of different pest species.
Skill level	3	Need for knowledge in set up of cameras but fairly straightforward. Can be skill involved in image identification although help can be sought through e.g. Nature Space.
Precision/sensitivity	2	Rapidly increasing in use in NZ. Not widely used for monitoring at this stage – more just one off observations/surveillance. Major potential for use as a monitoring tool with more research and development.
Data management	1	No established system for data storage and management at present. Large amounts of data collected in images and videos.
Data analysis	1	Not well developed at present. Mainly used for one off observations. Considerable potential with research and development. Significant work in viewing and interpreting large numbers of photos and video. Some experimental development of crowdsourcing sites has been undertaken.
Cost/equipment	1	Likely to need several cameras, each around $400, for reasonable quality plus memory cards and security stays. Potential for shared/rental of cameras.
Time	1	Low time requirements for data capture, but can be significant effort in viewing and interpreting images and video.
People	3	Can be done with one person (two for safety).
Safety	3	No specific safety issues.
Permit	3	No permit required.

Scores: 3 = high suitability, 2 = moderate suitability, 1 = lower suitability

Scale issues:	Good for use at small individual area/project scale. Potential to scale up/ amalgamate results once protocol and standard approach for monitoring is available.
Limitations:	Potential theft in areas where people present. Can be significant work classifying images.
Notes:	A method with major potential which will develop rapidly with improvements in technology. Also potential for continuous, ongoing live monitoring stations transmitting images and video.
Related methods:	0
Weblink:	No standard protocols at present
Protocol use notes:	0

Chew cards

Summary: Standard baited chew cards are placed across the study area over a number of nights. Pest animal species present and level of activity is assessed by the animal bite marks on cards. Species are identified by the type of bite marks.

Ecosystems: Forest and Scrub, Wetlands and Estuaries, Dunes and Beaches.

Activity monitoring: Pest animal control.

Outcome monitoring: 0

Questions: What pest species are present?
How is pest animal abundance changing?

Protocol: NPCA 2015 for possums, Landcare Groups 2012.

Criteria	Score	Comment
Scientific robustness	2	Protocol present in a number of forms (NPCA for possums). Quite widely used and some comparative studies done between this chew card and other methods.
Broad applicability	2	Suitable for several pest species – possums, rats, mice and possibly others, e.g. wēta.
Skill level	3	Simple technique. Some skill in interpretation, but visual guides available.
Precision/sensitivity	3	Similar to tracking tunnels, reasonably sensitive with good design/ deployment placement.
Data management	2	No well established data management system. Summary spreadsheet for calculating indices available. Has recently been included in monitoring in Trap.NZ
Data analysis	3	Summary spreadsheet for calculating indices available from NPCA.
Cost/equipment	2	Some cost if purchasing pre-baited cards, otherwise can obtain materials cheaply (e.g. old election hording corflute panels).
Time	2	Relatively quick to put cards out and retrieve, depending on access/ terrain, may need to repeat one-four times per year.
People	3	Can be done with one person (two for safety).
Safety	3	No specific safety issues.
Permit	3	No permit required.

Scores: 3 = high suitability, 2 = moderate suitability, 1 = lower suitability

Scale issues: Suitable at small area scale. However, need to make sure sampling appropriate for small area. Can also use and report results at region wide level.

Limitations:	With high pest numbers it can be difficult to distinguish species. Potential for confusing mice and wēta damage – more research needed on that.
Notes:	A good alternative to tracking tunnels. An advantage in some areas where you don't want to leave tunnels out, etc. and in wet areas. Has advantage compared to tracking tunnels that also assesses possum.
Related methods:	0
Weblink:	https://www.naturespace.org.nz/sites/default/files/u4/82817287-Chew-Card-Landcare-Protocol-Feb-2012.pdf https://www.landcareresearch.co.nz/__data/assets/pdf_file/0011/151598/chew-track-card-interpretation.pdf NPCA protocol for possums at: http://www.npca.org.nz/images/stories/NPCA/PDF/a1_possum%20monitoring_2015-nov_lr.pdf
Protocol use notes:	Information on interpreting bite marks is available at: https://www.landcareresearch.co.nz/__data/assets/pdf_file/0011/151598/chew-track-card-interpretation.pdf

Cultural health index – stream health

Summary: An index that allows iwi/hapū to assess the cultural and biological health of a stream or catchment of their choosing.

Ecosystems: Rivers and Streams.

Activity monitoring:

Outcome monitoring: Mātauranga Māori

Questions: What is the overall cultural health of the waterway?

Protocol: A cultural health index for streams and waterways: A tool for nationwide use. Gail Tipa and Laurel Teirney (2006).

Criteria	Score	Comment
Scientific robustness	2	Relatively new NZ-specific method, but developed and tested by MfE as part of Environmental Indicators programme.
Broad applicability	3	Wide range of indicators measured to assign index value.
Skill level	2	Will require training for consistent application. User guide does not provide detailed key to selecting appropriate score (only extreme values have descriptions).
Precision/sensitivity	2	Testing showed high level of agreement across users although relies on selecting a one-five score which can be subjective and user guide provides descriptions only for the extreme values.
Data management	2	No national storage database, security of traditional knowledge important so data likely to be held by the relevant iwi/hāpu, but software is available for data input, Takiwā available from Ngāi Tahu.
Data analysis	3	Clear and simple protocol provided for users. Simple comparison of scores for each attribute.
Cost/equipment	3	Basic equipment.
Time	2	Requires site visit to record a range of indicators to generate the index.
People	1	Requires involvement of large number of people to compile traditional knowledge, five-six for field data collection.
Safety	2	Some additional hazards from working around waterways.
Permit	3	No permit required.

Scores: 3 = high suitability, 2 = moderate suitability, 1 = lower suitability

Scale issues:	Designed to be reliably applied throughout a catchment on streams of different sizes and types. It is also a reliable measure for streams in catchments where land use varies from indigenous forest, planted forest, tussock, grazed pasture, scrub and bare ground. Results can be aggregated for regional or national picture.
Limitations:	0
Notes:	Can be used by any iwi at sites on streams of any size or river type.
Related methods:	Cultural health index – Mahinga kai (not included in this version of the guide). All Waicare methods (e.g. water chemistry, water physical properties, stream visual check – SO SMART, inanga spawning.
Weblink:	http://www.mfe.govt.nz/publications/cultural-health-index-streams-and-waterways-feb06 or pdf http://www.mfe.govt.nz/sites/default/files/chi-for-streams-and-waterways-feb06-full-colour.pdf
Protocol use notes:	0

Dune health check

Summary: A scoring system (one-five) for a set of attributes that define dune health, e.g. extent of indigenous vegetation, damage by livestock or vehicles, infestation of weeds. Scored on the basis of visual clues during a site visit and useful as a baseline and Quick Health Check.

Ecosystems: Dunes and Beaches.

Activity monitoring:

Outcome monitoring: Quick Health Check

Questions: General check-up on a range of aspects of dune health.

Protocol: In preparation – Auckland Council.

Criteria	Score	Comment
Scientific robustness	1	Protocols under development expected release in 2018. Early drafts indicate it will be similar to WETMAK WOF. Being developed by a consortium of councils, DOC, and external experts and has been subject to testing across NZ. Assessment score likely to increase to a 2 when the method is released.
Broad applicability	2	Covers a wide range of indicators (vegetation, animal pests, weeds, livestock damage, dune extent).
Skill level	3	Relatively simple, some knowledge in relation to species identification (e.g. to apply weed score).
Precision/sensitivity	2	Gives broad indication of major changes in condition and threats.
Data management	1	No standard data management or storage system currently available.
Data analysis	2	Simple comparison of scores for each attribute.
Cost/equipment	3	No special equipment needed, access to historic air photos (e.g. council GIS layer) helpful.
Time	3	Does not need to be done frequently, every five years or so. May take a team half a day to complete depending on size of management area.
People	3	Can be done with one person (two for safety). Often better done as a group to develop scores by consensus.
Safety	3	No specific safety issues.
Permit	3	No permit required.

Scores: 3 = high suitability, 2 = moderate suitability, 1 = lower suitability

Scale issues:	Useful to compare trends over time at individual sites, but can also assess total index score for different dune sites across the region (e.g. % of assessed dune lands with xy score for stock damage).
Limitations:	Subjective scoring based on visual assessment – some level of judgement required where hard data is not available to apply a health score for a particular attribute.
Notes:	Useful method to establish as a baseline and quickly determine priority areas for action (e.g. weeds vs stock damage vs pests).
Related methods:	Can use WETMAK WOF for quick check of back-dune wetlands.
Weblink:	Method not yet published. Contact Auckland Council biodiversity coordinators for update.
Protocol use notes:	0

Estuary WOF check

Summary:	Provides an assessment across a range of aspects of estuary health and influences on estuary from surrounding areas. A useful starting point in obtaining an overview of the key issues for an estuary.
Ecosystems:	Wetlands and Estuaries.
Activity monitoring:	0
Outcome monitoring:	Quick Health Check
Questions:	What is the general health of the estuary? What areas need the most attention?
Protocol:	Estuary WOF check – Turning the Tide Estuary Kit – Landcare Trust.

Criteria	Score	Comment
Scientific robustness	2	Unclear how widely used given that protocol was developed for an Otago-based estuary monitoring group. Protocol was developed with input from estuary specialists at Cawthron.
Broad applicability	3	Can be used in many different locations, with estuaries of varied size, condition, etc.
Skill level	3	Low skill required, though best to do as a small group of people who know the estuary (e.g. presence and location of sewerage outflows, etc). Some groundtruthing may be required to determine locations/extent e.g. of sediment types.
Precision/sensitivity	2	Some subjectivity in visual assessment reduces precision. Broad scale assessments e.g. repeat five yearly.
Data management	1	No national database.
Data analysis	3	Relatively simple documentation of variables.
Cost/equipment	3	Free access to good images on the council GIS layer, including a range of time periods for historical comparison. Also Google Earth time series. More costly if choose to get up-to-the-minute drone footage.
Time	3	Can take two-three hours as requires walk-over/overlook and feature analysis, but only have to do every five years or so.
People	2	Should be done as a group exercise.
Safety	3	Some additional hazards from working in/around waterways.
Permit	3	No permit required.

Scores: 3 = high suitability, 2 = moderate suitability, 1 = lower suitability

Scale issues:	0
Limitations:	0
Notes:	0
Related methods:	0
Weblink:	http://www.landcare.org.nz/Publications/Reports-Kits/Turning-the-Tide
Protocol use notes:	0

Fish spotlighting

Summary: Involves consistently visually assessing set reaches of a stream at night with a powerful spotlight to identify fish species present.

Ecosystems: Streams and Lakes.

Activity monitoring: 0

Outcome monitoring: Improved native wildlife.

Questions: What fish species are present?

Protocol: Freshwater fish spotlighting – Spot fishing, Richard Alibone 2013. DOC Monitoring toolkit.

Criteria	Score	Comment
Scientific robustness	2	Has been quite widely used, but protocols are still quite general.
Broad applicability	1	Best for a range of nocturnal fish species and where a stream has pools and relatively clear water, but does enable use for a range of species in these situations.
Skill level	2	Relatively straightforward but does require skill to identify species.
Precision/sensitivity	2	Uncertain how sensitive the method is. Will probably depend on particular area (what portion of fish population can be seen) and observer's skills.
Data management	2	National fish record system is present for individual species records (NIWA). But observations only.
Data analysis	3	Simple data. No particular summary/analysis methods.
Cost/equipment	3	Need a good spotlight and battery, otherwise no special equipment.
Time	2	Occasional searches of stream, not major time input, probably two-three hours per search.
People	3	Should be done with two people for safety as working around waterways.
Safety	2	Some additional hazards from working at night and around waterways
Permit	3	No permit required.

Scores: 3 = high suitability, 2 = moderate suitability, 1 = lower suitability

Scale issues: Good for understanding your local stream. Could be used for broad summary information on species present.

Limitations:	Not suitable in muddy streams or streams without pools. Good for simple overview of level of fish and diversity. More difficult for accurate assessment of change.
Notes:	A fun method that can provide useful overview information. Good for understanding and studying your local stream.
Related methods:	0
Weblink:	http://www.doc.govt.nz/Documents/science-and-technical/inventory-monitoring/im-toolbox-freshwater-fish/im-toolbox-freshwater-fish-spotlighting-spotfishing.pdf
Protocol use notes:	0

Five-minute bird count

Summary: An observer counts all birds seen and heard at a fixed point over a five minute period. Requires an understanding of the method and ability to identify bird species from their calls as well as visually.

Ecosystems: Forest and Scrub, Wetlands and Estuaries.

Activity monitoring: 0

Outcome monitoring: Improved native wildlife.

Questions: What bird species are present?
How has bird abundance changed?

Protocol: Birds: Incomplete counts – five-minute bird counts, Version 1.0. Lynette Hartley and Terry Greene (2012). DOC Inventory and Monitoring Toolbox.

Criteria	Score	Comment
Scientific robustness	3	Well established protocol. Widely used with many scientific papers based on it.
Broad applicability	3	Can be used across most terrestrial ecosystem types. Not sensible in colony, open riverbed, etc. systems. Best suited for forest and scrubland ecosystems.
Skill level	2	Requires good bird identification knowledge, including ability to identify birds from their calls and detect noise direction. Training in consistent use of the method needed.
Precision/sensitivity	3	Well-proven sensitivity to pick up particular changes in bird relative abundance. Good understanding of levels of sampling for different levels of precision.
Data management	2	Established data format/standard but no standard data storage at present.
Data analysis	2	Analysis relatively straightforward but no specific analysis tools available at present.
Cost/equipment	3	No special equipment.
Time	2	Quick counts. Time in travel between counts is more significant. Generally only twice per year.
People	3	Done by one person.
Safety	3	No specific safety issues.
Permit	3	No permit required.

Scores: 3 = high suitability, 2 = moderate suitability, 1 = lower suitability

Scale issues: Useful at local and wider scale. Can easily use data at different levels. Needs attention to sampling approach with smaller areas as not big enough to include multiple count stations.

Limitations:	Most suited to bush environments. Not suitable in open areas with large numbers of birds – e.g. waders, etc. Requires experience in bird identification from their calls.
Notes:	Very widely used and understood method.
Related methods:	0
Weblink:	http://www.doc.govt.nz/Documents/science-and-technical/inventory-monitoring/im-toolbox-birds-incomplete-five-min-counts.pdf
Protocol use notes:	0

Habitat assessment (streams) – Waicare

Summary: Index of stream habitat quality for aquatic fauna, based on a score allocated for quality and diversity of six features (in-stream cover, pool variability, sediment deposition, bank erosion/stability, bank protection and riparian cover). The physical habitat of a stream describes the characteristics that provide a suitable living space for aquatic plants and animals. If the water quality is good enough to allow aquatic organisms to survive, then it is the physical habitat that determines what kind of biological community will live there.

Ecosystems: Rivers and Streams.

Activity monitoring: 0

Outcome monitoring: Improved water characteristics.

Questions: How good is the stream habitat?

Protocol: Waicare habitat assessment. Waicare field manual.

Criteria	Score	Comment
Scientific robustness	2	Waicare protocol, four point scale for six indicators of stream habitat diversity/quality for aquatic life.
Broad applicability	3	Covers a wide range of parameters.
Skill level	2	Would require training to interpret the key for applying scores.
Precision/sensitivity	2	Four point scale, and subject to variation among users. Some factors may change rapidly (e.g. after storm event), others may be very slow to change.
Data management	3	Waicare website has space to store data.
Data analysis	3	Simple data, relatively easy to interpret/compare.
Cost/equipment	3	No special equipment.
Time	2	Relatively quick to do (under three hours) and does not need to be done very frequently.
People	3	Should be done with two people for safety.
Safety	2	Some additional hazards from working in/around waterways.
Permit	3	No permit required.

Scores: 3 = high suitability, 2 = moderate suitability, 1 = lower suitability

Scale issues: 0

Limitations:	0
Notes:	Part of the Waicare Kit.
Related methods:	Stream Visual check – SO SMART, stream shape (cross section), water clarity, inanga spawning, cultural health index.
Weblink:	https://waicare.org.nz/Files/3%20-%20Field%20Manual.pdf
Protocol use notes:	0

Inanga – Assessing spawning habitat – Whitebait Connection

Summary:	A quick assessment of potential suitability of a streambank site for inanga spawning. It rates 12 attributes a score of one-three (e.g. bank material, vegetation type). Designed to assess quality of potential spawning site but if repeated at same location could be a broad monitoring tool.
Ecosystems:	Rivers and Streams.
Activity monitoring:	0
Outcome monitoring:	Improved native wildlife.
Questions:	How suitable is my site for inanga spawning?
Protocol:	Inanga spawning habitat assessment – Whitebait Connection.

Criteria	Score	Comment
Scientific robustness	2	General assessment method for scoring a number of habitat features on the basis of suitability for inanga spawning. Uncertainty over level of robustness.
Broad applicability	1	Covers a range of attributes but focussed on spawning suitability.
Skill level	3	Easy to learn and apply. Some attributes may need a little training (e.g. to measure bank slope or identify plant types).
Precision/sensitivity	2	Coarse scoring system (one-three) so would need significant changes in some attributes to change the score (e.g. vegetation from 50% cover to 75% cover).
Data management	2	Whitebait Connection may store data at national level. Contact local co-ordinator.
Data analysis	3	Simple comparison of scores for each attribute to determine which factors need action, and sum of scores for measure of spawning suitability.
Cost/equipment	3	No special equipment needed, just a ruler to measure vegetation height/bank angle.
Time	3	Relatively quick to do in the field, but may take some time to assess fish access (depending how far from the sea the site is and how accessible the water is to assess culverts, etc.).
People	3	Should be done with two people for safety.
Safety	2	Some additional hazards from working in/around waterways. Varies with survey location.
Permit	3	No permit required.

Scores: 3 = high suitability, 2 = moderate suitability, 1 = lower suitability

Scale issues:	Potential to compare trends over time at individual sites to determine if habitat enhancement has improved spawning potential. Can assess total index score for multiple sites across the region (e.g. % of assessed sites that score 90 or above indicating good spawning potential).
Limitations:	0
Notes:	Developed as part of the Whitebait Connection kit.
Related methods:	Stream Visual check – SO SMART, Stream habitat assessment, cultural health index.
Weblink:	https://www.whitebaitconnection.co.nz/images/wbc/resources/inanga/WBC-NISP_2C_habitat_assessment_v2_18OCT.pdf
Protocol use notes:	0

Litter count records

Summary:	Records of litter type and amount collected via a community clean-up day, whether from a beach or stream/stream-bank. Useful for documenting community effort to funders, but also as a record of the types of litter accumulating at the site to compare change over time, and a good basis for targeting waste sources or for education.
Ecosystems:	Rivers and Streams, Dunes and Beaches.
Activity monitoring:	Litter clean-ups.
Outcome monitoring:	0
Questions:	How much litter was removed? What length of stream margin/ area of beach was cleared of litter? What types of litter were collected?
Protocol:	No specific NZ protocol. See Ocean Conservancy International Coastal Cleanup protocol. NIWA developing a simple protocol.

Criteria	Score	Comment
Scientific robustness	2	Some standard protocols have been developed internationally, e.g. Ocean Conservancy International Coastal Cleanup.
Broad applicability	2	Sorting and recording can provide information on types of litter and their likely source to help target education/action.
Skill level	3	Very low skill levels required, just a safety briefing.
Precision/sensitivity	1	Weight, volume and count will vary with the type of litter collected (e.g. hardwood vs beach jetsam).
Data management	2	No national data storage system – Zero Waste/ Sustainable Coastlines, etc. initiatives may store data. Ocean Conservancy in the USA will collect data internationally.
Data analysis	3	Basic, tonnes of waste or number of standard rubbish bags filled, or number of items collected per person hours or per unit area searched.
Cost/equipment	3	None, just rubbish bags to store rubbish (part of the costs of the clean up rather than the monitoring).
Time	3	Usually an hour or two effort once per year.
People	3	Usually involves a large number of people, but community engagement is often a key goal.
Safety	3	As long as basic personal protective gear and back-saving protocols are observed it's reasonably safe.
Permit	3	No permit required.

Scores: 3 = high suitability, 2 = moderate suitability, 1 = lower suitability

Scale issues:	Data collected are specific to the site and level of community effort, however, litter is generally transported to streams and beaches from other sites, so the types of litter collected is an indication of litter present in the wider environment.
Limitations:	0
Notes:	0
Related methods:	0
Weblink:	https://oceanconservancy.org/trash-free-seas/international-coastal-cleanup/start-a-cleanup/do-it-yourself-cleanup-kit/ https://oceanconservancy.org/wp-content/uploads/2017/04/OC-DataCards_volunteerFINAL_ENG.pdf
Protocol use notes:	0

Macroinvertebrate sampling – Waicare

Summary: A method to measure the abundance and diversity of aquatic macroinvertebrates collected by kick-nets and sweep-nets to indicate the overall health of the water body and level of biotic integrity. Use nets to collect aquatic invertebrates and assess the results by calculating a score. Part of the Waicare Invertebrate monitoring protocol (WIMP).

Ecosystems: Rivers and Streams.

Activity monitoring:

Outcome monitoring: Improved native wildlife, Improved water characteristics.

Questions: What groups of aquatic macroinvertebrate species are present? Does the aquatic macroinvertebrate community include groups requiring high water quality?

Protocol: Waicare macroinvertebrate sampling.

Criteria	Score	Comment
Scientific robustness	2	Waicare-derived method, simplified version of MCI (Macroinvertebrate community index) which is a well-respected method.
Broad applicability	2	Mostly presence/absence of aquatic invertebrates, also some water quality indicator information.
Skill level	2	Some familiarity with sampling and identifying aquatic invertebrates.
Precision/sensitivity	2	Relies on effective sampling technique.
Data management	3	Waicare website has space to store data.
Data analysis	3	Options and explanations on Waicare website.
Cost/equipment	2	Need some special equipment but mostly low-cost or items found around the home.
Time	2	Probably one-two hours to sort through sample, plus time to set up, but does not need to be done frequently (a couple of times a year).
People	3	Should be done with two people for safety.
Safety	2	Some additional hazards from working in/around waterways.
Permit	3	No permit required.

	Scores: 3 = high suitability, 2 = moderate suitability, 1 = lower suitability
Scale issues:	0
Limitations:	Suitable for wadable waterways only – streams with a depth of 20 to 50cm.
Notes:	Part of the Waicare Kit.
Related methods:	Stream habitat assessment – Waicare, stream visual check – SO SMART, water chemistry, water physical properties, water clarity, shuffle sediment test, total coliform and E. coli.
Weblink:	https://waicare.org.nz/Files/3%20-%20Field%20Manual.pdf

Protocol use notes:

Mapping wetland vegetation – WETMAK

Summary: Method involves creating a series of maps (bird's eye view plans) from air or satellite photos over the years to show changes in vegetation extent (amount of each type) and distribution (where each type occurs). Standard methods are used to classify and label vegetation type to ensure each map is consistent – the only differences should be real change on the ground.

Ecosystems: Wetlands and Estuaries.

Activity monitoring: Weed control.

Outcome monitoring: Improved vegetation.

Questions: How is wetland vegetation changing?

Protocol: WETMAK – Mapping wetland vegetation module.

Criteria	Score	Comment
Scientific robustness	2	Protocol developed by Ward and Lambie 1999 and presented in WETMAK which recommends the Atkinson classification system for vegetation type naming. Singers and Rogers is a newly developed non-hierarchical national system that could be used for nomenclature and is recommended by Auckland Council.
Broad applicability	2	Includes vegetation cover, but also abiotic features, e.g. mud, sand, water.
Skill level	2	Would need some guidance to tease out the key species and variants, and to interpret air photos. Also need digitising skills though relatively easy to do using Google Maps/Google Earth.
Precision/sensitivity	1	Spatial extent changes would only be detected over long periods of time (other than catastrophic change such as fire, flood, mangrove clearance).
Data management	1	No national database. Council may have capacity to store community generated maps on their GIS.
Data analysis	3	Relatively simple documentation of extent of each type, assuming consistent typology applied to each time period.
Cost/equipment	3	Free access to good images on the council GIS layer, including a range of time periods for historical comparison. Also Google Earth time series. More costly if choose to get up-to-the-minute drone footage.
Time	3	Can take two-three hours as it requires walk-over/overlook and feature analysis, but only have to do every five years or so.
People	3	Can be done with one person (two for safety).
Safety	3	Can sometimes be done entirely indoors if good maps available, but usually requires groundtruthing, general safety requirements around navigation, etc.
Permit	3	No permit required.

Scores: 3 = high suitability, 2 = moderate suitability, 1 = lower suitability

Scale issues:	Method can be applied at local or regional scale, but for regional scale will require skills in remote sensing and will be time-consuming.
Limitations:	0
Notes:	Can be used for other ecosystem types such as dune, forest or scrub vegetation.
Related methods:	Permanent plot – WETMAK
Weblink:	http://www.landcare.org.nz/files/file/806/Module%204%20Mapping%20Wetland%20Vegetation.pdf
Protocol use notes:	0

Marine metre squared

Summary: Assessment of a square metre area of the intertidal area in sandy or muddy seashore or rocky shore. Substrate, plants and animals are assessed and counted in the square.

Ecosystems: Wetlands and Estuaries, Dunes and Beaches.

Activity monitoring: 0

Outcome monitoring: Improved native wildlife.

Questions: How has intertidal shore life changed?

Protocol: Marine metre squared, Marine Studies Centre, University of Otago.

Criteria	Score	Comment
Scientific robustness	2	Based on standard quadrat methods, developed by Otago University into a Citizen Science project.
Broad applicability	2	Can be used for estuarine soft-shore or for rocky intertidal platforms.
Skill level	3	Quick briefing and identification cards mean can be done by schools with assistance.
Precision/sensitivity	2	Subject to variable skills in spotting/identifying species.
Data management	3	National data storage system (Otago Uni Marine Studies Centre).
Data analysis	2	Presumably simple counts of taxonomic groups.
Cost/equipment	2	Just need a quadrat frame and species identification cards.
Time	2	Takes about one hour per quadrat, twice per year, monitoring sites usually easy to access, depends how many quadrats will be sampled.
People	3	Designed for group/community use, but could be done by two people.
Safety	3	As long as tides are observed it's reasonably safe.
Permit	3	No permit required.

Scores: 3 = high suitability, 2 = moderate suitability, 1 = lower suitability

Scale issues: 0

Limitations: 0

Notes: 0

Related methods: 0

Weblink: https://www.mm2.net.nz/home

Protocol use notes: 0

Photopoint

Summary:	Photos of points of interest taken from the same vantage at regular intervals to give a visual record of changes in a site.
Ecosystems:	Forest and Scrub, Wetlands and Estuaries, Dunes and Beaches, Rivers and Streams.
Activity monitoring:	Weed control, restoration planting, improved vegetation.
Outcome monitoring:	Improved vegetation.
Questions:	What area of restoration planting is successfully established? How is forest canopy condition changing over time? How is understorey changing over time? How is wetland vegetation improving over time? How has weed density changed over time?
Protocol:	See photopoint modules in FORMAK, WETMAK, also QE2 Trust photopoint guide. Auckland Council photopoint resource.

Criteria	Score	Comment
Scientific robustness	2	Well accepted and used across a range of organisations. Used occasionally in scientific papers, long history of use but limited quantitative analysis options.
Broad applicability	2	Can show multiple features, e.g. weeds as well as native plant establishment. Can be used in most ecosystem types where key features are easily visible.
Skill level	3	Can be easily picked up on the job by following simple protocol. Good video by WETMAK on how to do this.
Precision/sensitivity	1	Provides good general information on changes, but not suitable for identifying small changes or changes that are non-visual or obscured from view.
Data management	2	Data storage is available in a number of systems but is not necessarily standardised. Storage is becoming simpler and more effective through cloud based data storage.
Data analysis	3	Analysis basically limited to side-by-side visual comparison. Some free apps e.g. Re-photo can assist.
Cost/equipment	3	Basic digital camera or phone with good quality camera and a marker post is only equipment in most cases.
Time	3	Quick to undertake. Just careful relocation of photopoint and taking photo. Only done once per year.
People	3	Can be done with one person (two for safety).
Safety	3	No specific safety issues. Can pre-select photopoint locations that are safe/easy to access.
Permit	3	No permit required.

Scores: 3 = high suitability, 2 = moderate suitability, 1 = lower suitability

Scale issues:	Good at a local level. Would require scoring of change for wider reporting, but no such standard protocol exists. Useful for people to engage and look across a range of different sites. Good for demonstrating outcomes for funders and volunteers.
Limitations:	Doesn't provide quantitative measures. Cannot record features that are not easily visible (e.g. too small to see or behind foreground). Over time the scene could become obscured by foreground vegetation growth and no longer useful. No national storage system. See video produced for WETMAK: http://www.landcare.org.nz/wetmak/hub
Notes:	Suitable for showing vegetation change in terrestrial and wetland habitats, weed growth/control, stream bank erosion/re-vegetation, water colour/clarity/ macrophytes, etc. It is recommended to take a photo of a form with metadata (date, location, time, camera, etc.) prior to each image and store it with the image.
Related methods:	
Weblink:	http://www.landcare.org.nz/wetmak http://www.openspace.org.nz/Site/Managing_your_covenant/Photopoints/default.aspx Email: biodiversity@aucklandcouncil.govt.nz for photopoint guidelines.
Protocol use notes:	0

Plant survival counts

Summary: Counts and assessment of survival of plants established in restoration plantings. Generally undertaken through measurement of simple sample plots, but no established protocol at present. Critical monitoring in order to assess if restoration plantings are effective.

Ecosystems: Forest and Scrub, Wetlands and Estuaries, Dunes and Beaches.

Activity monitoring: Restoration planting.

Outcome monitoring:

Questions: How many plants have survived?

Protocol: No standard protocols at present. However, see WWF Habitat Protection Fund, Project Monitoring Toolkit.

Criteria	Score	Comment
Scientific robustness	2	No widely used and reported approach, but likely to be simple and robust.
Broad applicability	2	Only applicable to planting, but across different ecosystems.
Skill level	3	Counting and assessment of survival.
Precision/sensitivity	2	Will depend on sampling, but likely to give good estimates of survival with the right sampling approach.
Data management	1	No data management system at present.
Data analysis	2	No data system. Only simple counts and % survival assessed, so data analysis straightforward.
Cost/equipment	3	No special equipment.
Time	3	Quick counts.
People	3	Can be done with one or two people.
Safety	3	No specific safety issues.
Permit	3	No permit required.

Scores: 3 = high suitability, 2 = moderate suitability, 1 = lower suitability

Scale issues: Data can be used at a range of scales to report on a project or wider survival across a larger programme.

Limitations:

Notes:

Related methods: Can use vegetation plots for longer-term, more detailed assessment.

Weblink: http://assets.wwf.org.nz/downloads/hpf_monitoring_toolkit.pdf

Protocol use notes:

Planting records

Summary: Record of plant species and numbers planted per zone/date in a restoration site. Can be coupled with plant survival records to analyse effectiveness of planting and which species performed well, which should be reconsidered at the site, which areas need replanting in future seasons. Useful for demonstrating activity efforts to funders/volunteers.

Ecosystems: Forest and Scrub, Wetlands and Estuaries, Dunes and Beaches.

Activity monitoring: Restoration planting.

Outcome monitoring:

Questions: What length or area has been planted?
How many plants have been planted?

Protocol: No specific protocol but see WWF Monitoring toolkit.

Criteria	Score	Comment
Scientific robustness	3	Simple record-keeping of plants per location per season.
Broad applicability	2	Applicable only to plants, but also a measure of the area (or stream /dune length) re-planted or enhanced.
Skill level	3	Simple recording of plant number by species in a spreadsheet or similar, and map of planting zone to measure coverage.
Precision/sensitivity	3	Accurate data based on nursery orders or counts prior to planting sessions.
Data management	2	No national system, just need to keep a record in spreadsheet or log book. Can log planting records on Nature Space website.
Data analysis	3	Fairly simple running total of species and number over time, or map of area planted.
Cost/equipment	3	No special equipment needed.
Time	3	Simple entry of plant numbers and area covered as part of re-vegetation planning.
People	3	Only one person, desk job.
Safety	3	No specific safety issues.
Permit	3	No permit required.

Scores: 3 = high suitability, 2 = moderate suitability, 1 = lower suitability

Scale issues: Useful at project scale and also for summarising at national and regional level to gauge community efforts.

Limitations:	Only half of the story if follow up checks of plant survival are not conducted – important to know which species performed well, which areas need further attention/re-planting.
Notes:	Useful for reporting back to funders and can be used to assess plant survival as part of re-vegetation success.
Related methods:	Vegetation plots can be used for plant survival rates by species.
Weblink:	http://assets.wwf.org.nz/downloads/hpf_monitoring_toolkit.pdf

Protocol use notes:

Shuffle sediment test

Summary: A method to measure the degree of suspendible fine sediment on the streambed, based on the amount of sediment stirred up by a five-second foot shuffle in the stream bed (score out of five based on visibility and duration of resulting sediment plume).

Ecosystems: Rivers and Streams.

Activity monitoring:

Outcome monitoring: Improved water characteristics.

Questions: What are sediment levels like, and how are they changing?

Protocol: Cawthron re-suspendible sediment – shuffle index protocol.

Criteria	Score	Comment
Scientific robustness	3	Tested against other methods by NIWA, good correlations with other well-established methods, published protocol.
Broad applicability	2	Limited to sediment as a direct measure but has been correlated with stream macroinvertebrate biota so can give an indication of the state of aquatic life.
Skill level	3	Easy with brief training.
Precision/sensitivity	3	Instant results. Score out of five but public surveys have shown just one point difference is sensitive enough to decrease perceived swimming value from acceptable to unacceptable.
Data management	1	No known national data storage system.
Data analysis	3	Simple index score based on a visual assessment of coverage of a white tile.
Cost/equipment	3	Only need a white tile and a tape measure, waders desirable.
Time	3	Very quick, five minutes per test though may need to take several samples.
People	2	Should be done with two people for safety.
Safety	2	Some additional hazards from working in/around waterways.
Permit	3	No permit required.

Scores: 3 = high suitability, 2 = moderate suitability, 1 = lower suitability

Scale issues: Would only apply to stream length assessed. At larger catchment scale scores may be different (diluted by variation).

Limitations: Suitable for wadable waterways only – streams with a depth of 20 to 50cm.

Notes: 0

Related methods:	Water clarity, stream visual check – SO SMART, stream habitat assessment – Waicare.
Weblink:	http://www.cawthron.org.nz/media_new/publications/pdf/2014_01/SAM_FINAL_LOW.pdf

Protocol use notes:

Site assessment – FORMAK

Summary:

Ecosystems: Forest and Scrub.

Activity monitoring:

Outcome monitoring: Quick Health Check

Questions: General check up on a range of aspects of forest health.

Protocol: Forest General Surveillance Checklist. Native Forest Monitoring (Handford 2000).

Criteria	Score	Comment
Scientific robustness	1	There is a useful 'general surveillance checklist' version in Native Forest Monitoring Guide (Handford 2000). A range of different versions are used. Intended usually as a guide in terms of general condition and change in these.
Broad applicability	3	Gives broad assessment across a whole range of indicators within an ecosystem. Is ecosystem-specific generally.
Skill level	2	Requires some level of understanding and skill to make visual judgements. Some guides available – e.g. FORMAK visual assessment guide.
Precision/sensitivity	1	Gives broad indication of major changes in condition and threats.
Data management	1	Individual data management systems. There is a system established for FORMAK visual assessment data entry – however this needs significant upgrade.
Data analysis	2	Simple data analysis – but no formal systems set up.
Cost/equipment	3	No special equipment.
Time	3	Quick visual assessment across whole area.
People	3	Can be done with one person (two for safety).
Safety	3	No specific safety issues.
Permit	3	No permit required.

Scores: 3 = high suitability, 2 = moderate suitability, 1 = lower suitability

Scale issues: Data from multiple assessments can be used to look at broad condition and threats across a wider area as well as specific e.g. small reserve.

Limitations:	
Notes:	Useful if consistently undertaken and for simple checks of condition, e.g. check of forest covenants, etc.
Related methods:	
Weblink:	
Protocol use notes:	Complete parts one-six of assessment. Vegetation, simple counts and birds are less useful.

SO SMART – Quick visual check (streams) – Waicare

Summary: An indication of the life-supporting capacity of the stream and pressures from adjacent land use. Habitat assessment along a stretch of the stream. Each parameter is given a score.

Ecosystems: Streams and Lakes.

Activity monitoring:

Outcome monitoring: Quick Health Check

Questions: What is the overall state of the stream like?

Protocol: Waicare

Criteria	Score	Comment
Scientific robustness	2	Waicare protocol, simple three point scale for seven indicators of stream health assessed visually or by smell.
Broad applicability	3	Gives broad assessment across a whole range of indicators within a stream ecosystem.
Skill level	3	Easy with brief training.
Precision/sensitivity	2	Coarse scale (three point) scores, but highlights what areas have changed.
Data management	3	Waicare website has space to store data.
Data analysis	3	Easy to interpret, simple three point score system.
Cost/equipment	3	No special equipment.
Time	3	Quick visual assessment across whole area, two-three hours but would not have to be done more than annually.
People	3	Should be done with two people for safety.
Safety	2	Some additional hazards from working in/around waterways, but can be done entirely from stream banks.
Permit	3	No permit required.

Scores: 3 = high suitability, 2 = moderate suitability, 1 = lower suitability

Scale issues: Would only apply to stream length assessed. At larger catchment scale scores may be different (diluted by variation).

Limitations:

Notes: Part of the Waicare Kit.

Related methods:	Cultural health index – stream health, inanga spawning habitat assessment, water chemistry, water physical properties, water clarity, shuffle sediment test, total coliform and E. coli.
Weblink:	https://waicare.org.nz/Files/3%20-%20Field%20Manual.pdf

Protocol use notes:

Spotlight counts – rabbits

Summary: Number of rabbits seen at night in a spotlight are counted on set routes travelled by a slowly moving vehicle, or on foot where vehicle access is not possible.

Ecosystems: Forest and Scrub, Dunes and Beaches.

Activity monitoring: Pest animal control.

Outcome monitoring:

Questions: How is rabbit abundance changing?

Protocol: Animal pests: night counts for rabbits Version 1.0, Latham, A.D.M (2014). DOC Inventory and Monitoring Toolbox.

Criteria	Score	Comment
Scientific robustness	3	Established protocol. Has been used for some time. See NPCA also DOC. Some interpretation and variability in protocol.
Broad applicability	2	Main focus is rabbits but also ability to pick up cats, etc.
Skill level	3	Simple technique with initial training.
Precision/sensitivity	2	Appears to have satisfactory precision for assessing impacts of control operations.
Data management	2	Fairly simple data. Some standard record cards, etc. available. No wider national database, etc.
Data analysis	3	Simple data and summaries. No established data summary tools.
Cost/equipment	3	If done on foot with spotlight – just the cost of the spotlight. Larger areas requiring motorbike or quad access involve more equipment and cost.
Time	2	Not particularly time hungry, two-three hours for an individual count.
People	3	Can be done with one person (two for safety).
Safety	2	Additional hazards from working at night. More significant if using motorbike/quad – specific training required.
Permit	3	No permit required.

Scores: 3 = high suitability, 2 = moderate suitability, 1 = lower suitability

Scale issues: Can be used at a range of scales to assess relative abundance. Potential to summarise data across wider areas.

Limitations:	Less effective for changes where small numbers of the pest.
Notes:	Useful and accepted method. Potentially more suited to contractor. Modified form on foot that can pick up a range of species is potentially useful.
Related methods:	
Weblink:	http://www.doc.govt.nz/Documents/science-and-technical/inventory-monitoring/im-toolbox-animal-pests-night-counts-rabbits.pdf

Protocol use notes:

Stream flow rate (float and head rod) – Waicare

Summary: A method to measure the volume and speed of water flow. Higher than normal flow velocities may disrupt communities of aquatic organisms, flush away algae and aquatic plants, and increase sediment levels. Lower than normal flows can increase temperatures, lower oxygen levels, concentrate nutrients and increase algae and plant growth.

Ecosystems: Rivers and Streams.

Activity monitoring:

Outcome monitoring: Improved water characteristics.

Questions: How does the stream flow compare to other streams and how is it changing?

Protocol: Waicare – Stream flow.

Criteria	Score	Comment
Scientific robustness	3	Well-tested methods.
Broad applicability	1	Limited to measure of stream flow rate.
Skill level	3	Simple methods to learn.
Precision/sensitivity	1	Values can change rapidly after rainfall events, tied to upstream/catchment rainfall/runoff levels.
Data management	3	Waicare website has space to store data.
Data analysis	3	Options and explanations on Waicare website.
Cost/equipment	3	Basic gear (orange, tape measure, stopwatch).
Time	3	Quick to collect samples (depending on ease of access) and does not need to be done frequently.
People	3	Should be done with two people for safety.
Safety	2	Some additional hazards from working in/around waterways.
Permit	3	No permit required.

Scores: 3 = high suitability, 2 = moderate suitability, 1 = lower suitability

Scale issues: Would only apply to stream length assessed. At larger catchment scale scores may be different (diluted by variation).

Limitations: Suitable for wadable waterways only – streams with a depth of 20 to 50cm.

Notes: Part of the Waicare Kit.

Related methods: Stream shape – cross section.

Weblink: https://waicare.org.nz/Files/3%20-%20Field%20Manual.pdf

Protocol use notes:

Stream shape (cross section) – Waicare

Summary: A method of measuring a cross section of the stream (the shape of the stream bottom from bank to bank) at the same location each time to enable detection of changes in the shape of the stream channel caused by erosion or sediment deposition.

Ecosystems: Rivers and Streams.

Activity monitoring:

Outcome monitoring: Improved water characteristics.

Questions: How does stream shape and flow compare with other streams and how is it changing?

Protocol: Waicare – Stream shape.

Criteria	Score	Comment
Scientific robustness	3	Well-established method.
Broad applicability	1	Limited to stream profile, needed for measuring stream flow (volume).
Skill level	3	Simple methods to learn.
Precision/sensitivity	1	Would pick up major change such as bank slumps or major erosion scouring but only captures data at one location. Used more for calculating flow than as a stream morphology monitoring tool.
Data management	3	Waicare website has space to store data.
Data analysis	3	Options and explanations on Waicare website.
Cost/equipment	3	Just a tape measure and measuring rod needed.
Time	2	Would take a few hours to set up and collect data, depends how many cross sections are taken.
People	3	Should be done with two people for safety.
Safety	2	Some additional hazards from working in/around waterways.
Permit	3	No permit required.

Scores: 3 = high suitability, 2 = moderate suitability, 1 = lower suitability

Scale issues: Would only apply to stream length assessed.

Limitations: Suitable for wadable waterways only – streams with a depth of 20 to 50cm.

Notes: Part of the Waicare Kit.

Related methods: Stream flow float and head rod, Stream habitat assessment.

Weblink: https://waicare.org.nz/Files/3%20-%20Field%20Manual.pdf

Protocol use notes:

Total coliform and E. coli – Waicare

Summary: Methods developed for community groups to detect the concentration of E. coli – a type of bacterium that is widely used to assess faecal pollution of waters.

Ecosystems: Rivers and Streams.

Activity monitoring:

Outcome monitoring: Improved water characteristics.

Questions: How are microbiological contaminant levels changing?

Protocol: Waicare (though will be replaced by a new NIWA protocol).

Criteria	Score	Comment
Scientific robustness	3	Well-tested methods, developed/used by Crown Research Institutes e.g. NIWA. Studies have been done on their effectiveness as a measuring/monitoring tool.
Broad applicability	1	Used only for measuring bacterial contamination, but can apply results at small or large scale.
Skill level	2	Not suitable for schools (H&S issues), but can be used by adults with some training.
Precision/sensitivity	2	Varies with level of expertise. Indicates there is a problem but not sensitive enough to highlight what type.
Data management	3	Waicare website has space to store data.
Data analysis	3	Options and explanations on Waicare website.
Cost/equipment	2	Some specialist equipment needed, possible issues around disposal of cultures.
Time	2	Quick to collect samples (depending on ease of access to the sampling site). Need to wait 24 hours for culture to grow.
People	3	Should be done with at least two people for safety.
Safety	1	Additional hazards from working around waterways, and working with bacterial cultures, issue with safe handling and disposal, not suitable for schools.
Permit	3	No permit required.

Scores: 3 = high suitability, 2 = moderate suitability, 1 = lower suitability

Scale issues:

Limitations: Not suitable for schools (health and safety issues).

Notes:	Part of the Waicare Kit. Ability to compare results to reference values/values for typical Auckland streams provided by Waicare.
Related methods:	Stream visual check – SO SMART, water chemistry, water physical properties, water clarity, shuffle sediment test.
Weblink:	A new protocol is being developed by NIWA. For now use Waicare Kit: https://waicare.org.nz/Files/3%20-%20Field%20Manual.pdf

Protocol use notes:

Tracking tunnels

Summary:	Tunnels with inked cards in their base are placed across the monitoring area. Small mammals leave their tracks as they pass through tunnels. The percentage of tracked tunnels gives an index of activity for different species.
Ecosystems:	Forest and Scrub, Wetlands and Estuaries, Dunes and Beaches.
Activity monitoring:	Pest animal control.
Outcome monitoring:	Improved native wildlife.
Questions:	What pest animal species are present? How is pest animal abundance changing? How has pest abundance changed? Are geckos or skinks present?
Protocol:	Animal pests: Tracking tunnel indices of small mammal abundance Version 1.0. Craig Gillies (2013) DOC Inventory and Monitoring Toolbox. Native wildlife: Society for Research on Amphibians and Reptiles of New Zealand (SRARNZ) – Toolkit, section two monitoring and survey.

Criteria	Score	Comment
Scientific robustness	3	Widely used and established protocols.
Broad applicability	3	Useful for pest monitoring of a number of species – mice, rats, stoats, weasels. Can give information on lizards, birds, frogs and invertebrates.
Skill level	3	Easy method to learn to deploy/collect tracking cards. Some skill in identifying tracks – particularly if seeking to distinguish invertebrate or lizard prints.
Precision/sensitivity	3	Well-designed studies can detect useful changes in pest levels.
Data management	2	Has been up to individuals to have their own systems. DOC have a data spreadsheet that also calculates indices. More recently Trap.NZ has added tracking tunnels.
Data analysis	2	Relatively simple analysis but no specific routines or software.
Cost/equipment	2	Moderate cost of tunnels but ongoing costs to purchase pre-inked tracking cards.
Time	2	Relatively quick to put cards out and retrieve, depending on access/terrain, may need to repeat one-four times per year.
People	3	Can be done with one person (two for safety).
Safety	3	No specific safety issues.
Permit	3	No permit required.

Scores: 3 = high suitability, 2 = moderate suitability, 1 = lower suitability

Scale issues:	Standard protocol requires relatively large numbers of lines and tunnels. It becomes difficult to do this in small areas.
Limitations:	Tunnels can be disturbed by other species – possums, pigs, people. Need sufficient numbers of tunnels to provide useful information.
Notes:	Good, well known and understood method.
Related methods:	
Weblink:	http://www.doc.govt.nz/Documents/science-and-technical/inventory-monitoring/im-toolbox-animal-pests-tracking-tunnel-indices-of-small-mammal-abundance.pdf http://www.srarnz.org.nz/Toolkit.aspx for lizards
Protocol use notes:	Contact Auckland Council Biodiversity Team biodiversity@aucklandcouncil.govt.nz for advice on protocol use for native wildlife, including SRARNZ toolkit for lizards.

Trapping records

Summary: Records are kept of trapping operations including trapping records for each trap operated. Includes recording of all trap checks as well as individual kills. This allows the number of operational trap nights to be assessed as well as catches so that catch rate can be calculated.

Ecosystems: Forest and Scrub, Wetlands and Estuaries, Dunes and Beaches.

Activity monitoring: Pest animal control.

Outcome monitoring:

Questions: How many pests have I killed?

Protocol: No specific protocol but see standard recording systems, e.g. Trap.NZ, CatchIT

Criteria	Score	Comment
Scientific robustness	2	Widely used method. Needs to be interpreted and corrected in relation to particular operation.
Broad applicability	2	Suitable for any pest animals that are being trapped.
Skill level	3	Just need to follow standard record keeping, several apps available to collect standard data.
Precision/sensitivity	3	Allows tracking of actual catches over time. Needs interpretation as to how this relates to pest levels and management.
Data management	3	National records systems are available with similar data formats. Most widely used is Trap.NZ.
Data analysis	2	Systems for mapping and reporting data are present. Further work around understanding and correction and presentation of data would be useful.
Cost/equipment	3	No additional monitoring equipment beyond existing trapping network.
Time	3	Done as part of trapping operation so little additional time.
People	3	Can be done with one person during trap checking (two for safety).
Safety	3	No specific safety issues – beyond those involved in trapping operation.
Permit	3	No permit required.

Scores: 3 = high suitability, 2 = moderate suitability, 1 = lower suitability

Scale issues: Useful at project scale and also for summarising at national and regional level.

Limitations: Is influenced by the nature of the trapping operation – e.g. density of trapping, frequency of checking, etc.

Notes:	Simple and low cost method in relation to trapping operations. Results need to be understood in relation to stage of trapping project, etc.
Related methods:	
Weblink:	www.trap.nz www.catchit.org.nz
Protocol use notes:	

Vegetation plot – FORMAK

Summary: A permanently marked vegetation plot. Transect plot that is 20m x 4m. Uses many of the same measurements as a 20x20 plot but over a smaller area. Understorey and tree stems are measured.

Ecosystems: Forest and Scrub.

Activity monitoring: Weed control.

Outcome monitoring: Improved vegetation.

Questions: How is forest understorey changing over time?
How has weed density changed over time?

Protocol: FORMAK Vegetation Plot.

Criteria	Score	Comment
Scientific robustness	2	Protocol but has not been used widely in published papers. Uses many aspects of standard 20mx20m plot protocol.
Broad applicability	2	Suitable across different forest ecosystems.
Skill level	1	Requires good botanical knowledge and training in use of technique.
Precision/sensitivity	2	Good sensitivity with appropriate sample size. Focus on understorey means that changes picked up more quickly.
Data management	2	Has been included in original FORMAK database, but this needs significant redevelopment.
Data analysis	1	Complicated analysis and interpretation.
Cost/equipment	2	Tapes and measuring equipment but not difficult or expensive to obtain.
Time	3	Significantly quicker than comparable methods such as the 20x20 veg plot, and does not need to be done frequently (once per year or five yearly).
People	3	Best with two people.
Safety	3	No specific safety issues.
Permit	3	No permit required.

Scores: 3 = high suitability, 2 = moderate suitability, 1 = lower suitability

Scale issues: Can be used at different scales. Data from local scale can be summarised and reported as part of wider e.g. regional results. Quicker plot method means larger, more useful samples can be obtained across smaller areas.

Limitations:

Notes: Quicker and easier plot method to lay out and measure compared to other permanent vegetation plot methods. Uses many aspects of the same protocol as 20x20 plot. Not as widely used as 20x20 plot method.

Related methods:	
Weblink:	http://formak.co.nz/webfolder.html
Protocol use notes:	Use the FORMAK protocol, but simplify by not completing the Canopy and Ground Cover section.

Vegetation plot – WETMAK

Summary:	Plots (usually squares of a fixed number of metres) permanently marked with poles, measured and regularly re-visited (e.g. five yearly). Inside each plot plant species are listed, along with their maximum and average height, and approximate cover abundance (as a % of the plot area). Plot data provide robust, numerical data to support general observations and impressions, including information on native and exotic plant species composition, plant height, and plant cover.
Ecosystems:	Wetlands and Estuaries.
Activity monitoring:	Weed control.
Outcome monitoring:	Improved vegetation.
Questions:	How has weed density changed over time? Has restoration planting successfully established? What vegetation species are present? How is wetland vegetation changing?
Protocol:	WETMAK – Vegetation Plot.

Criteria	Score	Comment
Scientific robustness	2	Relatively new technique for community wetland monitoring. No analysis has been done on breadth of use or time series analysis.
Broad applicability	2	Moderate range of indicators, all vegetative, but include native: exotic plant ratios, composition, height, biomass, seedling presence, dieback.
Skill level	2	Requires strong botanical skills and ability to estimate % cover but only need to make one estimate per species (simpler than national protocols). Developed for community groups (WETMAK). Tips in WETMAK for plant ID options.
Precision/sensitivity	2	Can pick up some indicators with good level of precision (e.g. species presence/absence) but is less sensitive to measures such as % cover where observer bias may be greater than real change over the sampling period. Some changes take years to become detectable. More precise than temporary plots or transects.
Data management	1	No current national storage system. Wetland plot data not suitable for upload to NVS (National Vegetation Survey, Landcare Research) as it is based on % cover not stem counts/dbh and different number of height tiers.
Data analysis	2	Some data manipulation required, basic statistics such as average height, native: exotic number % cover ratios. Can use the data for more complicated ordination analyses.
Cost/equipment	2	Basic, easily obtained gear (tape measures, poles, marker tags).
Time	3	Takes up to one hour per plot but don't need to remeasure frequently (five yearly), time mostly depends on accessibility and number of plots.

People	3	Best when done by two people (safety and to lay out plot).
Safety	2	Some additional hazards from working in/around waterways. Varies with survey location, can be moderately dangerous if water level high.
Permit	3	No permit required.

Scores: 3 = high suitability, 2 = moderate suitability, 1 = lower suitability

Scale issues: Can do multiple plots to represent different vegetation types. Plot size can be varied to vegetation type (smaller plots in shorter vegetation).

Limitations: Not a high precision tool for measuring things like weed incursion, distribution or spread, because they could occur just outside the permanent plot, but useful for re-vegetation projects to measure survival, growth rates, self-seeding, weed shading and general measures of naturalness.

Notes: Could be used for dunes or other areas of generally low, non-woody vegetation if protocols are not available for those ecosystems.

Related methods:

Weblink: http://www.landcare.org.nz/wetmak

Protocol use notes:

Visual bird counts

Summary:	Birds are counted visually across a known area that can be easily reassessed, such as an estuary area or beach, or a length of waterway. Is used for wading birds, or birds nesting in colonies that can be easily seen and counted.
Ecosystems:	Dunes and Beaches, Wetlands and Estuaries, Rivers and Streams.
Activity monitoring:	
Outcome monitoring:	Improved native wildlife.
Questions:	What bird species are present? How has bird abundance changed?
Protocol:	Protocol guidance given in Birds: complete counts – plot sampling, Green 2012 in DOC Inventory and Monitoring toolkit. However, particular situations vary and specific protocol may need to be defined further.

Criteria	Score	Comment
Scientific robustness	3	Has long been used for wader bird and shore bird census surveys (e.g. by OSNZ), see Dowding and Green 2012. DOC monitoring toolbox. Potentially robust if well managed.
Broad applicability	2	Suitable for wader birds/water fowl or colony nesting birds.
Skill level	2	Requires training in the technique prior to survey.
Precision/sensitivity	3	If well managed and undertaken can provide an almost complete census, so good sensitivity to change.
Data management	1	No specific data management. OSNZ may store data collected by community groups.
Data analysis	2	Fairly simple examination of changes in total numbers.
Cost/equipment	2	May require a spotting scope for distant birds.
Time	2	May take two-three hours per session for each person at a given site, usually done a couple of times per year.
People	2	Involves a number of people allocated to different beach areas – but is a relatively pleasant monitoring job.
Safety	3	No specific safety issues.
Permit	3	No permit required.

Scores: 3 = high suitability, 2 = moderate suitability, 1 = lower suitability

Scale issues:	Able to assess changes on local beach/lake as well as scale up to look at population across the region.
Limitations:	Only suitable for some species. Needs to be applied carefully and consistently.
Notes:	Has a narrow focus, but is easily understood and undertaken by trained volunteers.
Related methods:	
Weblink:	http://www.doc.govt.nz/Documents/science-and-technical/inventory-monitoring/im-toolbox-birds-complete-counts-plot-sampling-portion-of-study-area.pdf
Protocol use notes:	

Water chemistry (pH, N, P, DO, BOD) – Waicare

Summary:	Water sample analysis to measure multiple water quality parameters including acidity or alkalinity, amount of nitrates or phosphates in the water, amount of oxygen in the water, and the amount of oxygen used by micro-organisms to break down organic matter.
Ecosystems:	Rivers and Streams.
Activity monitoring:	
Outcome monitoring:	Improved water characteristics.
Questions:	How are key nutrients and other aspects of chemistry changing?
Protocol:	Waicare

Criteria	Score	Comment
Scientific robustness	3	Regularly used water quality monitoring method.
Broad applicability	1	Specific to these measures.
Skill level	2	Some training required in correct collection and handling of samples.
Precision/sensitivity	2	Good accuracy and precision if samples collected/handled correctly, but affected by skills of sample collector. Also water properties are sensitive to change over relatively short periods or locations so samples must be taken at the same location and time of year, and repeated samples needed to enable trend analysis.
Data management	3	Waicare website has space to store data.
Data analysis	2	Simple data, but implications of the values takes some skill/experience to interpret.
Cost/equipment	1	Basic gear to collect samples but need to pay for lab analysis and re-agents (chemicals) that need to be replaced.
Time	2	Very quick to do but need multiple replicates to develop robust trend data.
People	3	Should be done with two people for safety.
Safety	2	Some additional hazards from working around waterways.
Permit	3	No permit required.

Scores: 3 = high suitability, 2 = moderate suitability, 1 = lower suitability

Scale issues:	Would only apply to stream length assessed. At larger catchment scale scores may be different (diluted by variation).
Limitations:	Requires multiple samples collected from the same location/season/time of day to be able to assess trends. Automatic data loggers are available for repeated sampling, but are currently expensive to purchase.
Notes:	Part of the Waicare Kit. Ability to compare results to reference values/values for typical Tāmaki Makaurau / Auckland streams provided by Waicare.
Related methods:	Stream visual check – SO SMART, water physical properties, water clarity, shuffle sediment test, total coliform and E. coli.
Weblink:	https://waicare.org.nz/Files/3%20-%20Field%20Manual.pdf

Protocol use notes:

Water clarity (turbidity) test – Waicare

Summary: Method to measure the murkiness of water (relates to the amount of suspended particles in the waterbody and to water colour).

Ecosystems: Rivers and Streams.

Activity monitoring:

Outcome monitoring: Improved water characteristics.

Questions: What are sediment levels like and how are they changing?

Protocol: Waicare

Criteria	Score	Comment
Scientific robustness	3	Regularly used water quality monitoring method.
Broad applicability	1	Specific to this measure.
Skill level	3	Easy with brief training.
Precision/sensitivity	2	Some subjectivity in visual assessment reduces precision. Sensitive to change over relatively short periods or locations.
Data management	3	Waicare website has space to store data.
Data analysis	3	Simple data, relatively easy to interpret/compare.
Cost/equipment	2	Some specialist equipment needed but no further lab analysis required.
Time	2	Quick to do but need multiple replicates to develop robust trend data.
People	3	Should be done with two people for safety.
Safety	2	Some additional hazards from working in/around waterways.
Permit	3	No permit required.

Scores: 3 = high suitability, 2 = moderate suitability, 1 = lower suitability

Scale issues: Would only apply to stream length assessed. At larger catchment scale scores may be different (diluted by variation).

Limitations: Suitable for wadable waterways only – streams with a depth of 20 to 50cm.

Notes: Part of the Waicare Kit. Can convert clarity tube distances into turbidity readings using a graph provided by Waicare.

Related methods:	Shuffle sediment test, stream Visual check – SO SMART, water chemistry, water physical properties, total coliform and E. coli.
Weblink:	https://waicare.org.nz/Files/3%20-%20Field%20Manual.pdf

Protocol use notes:

Water physical properties (temperature, conductivity)

Summary: Use of a thermometer or probe to measure temperature of a stream water sample. Separate assessment of conductivity can also be undertaken but is not part of Waicare protocol.

Ecosystems: Rivers and Streams.

Activity monitoring:

Outcome monitoring: Improved water characteristics.

Questions: How are water physical properties changing?

Protocol: Waicare

Criteria	Score	Comment
Scientific robustness	3	Regularly used water quality monitoring method.
Broad applicability	1	Specific to these measures, although same probe can also measure pH.
Skill level	3	Easy with brief training in use of sensors.
Precision/sensitivity	3	Good accuracy and precision if sensors are well maintained and calibrated, but water properties are sensitive to change over relatively short periods or locations so samples must be taken at the same location and time of year, and repeated samples are needed to enable trend analysis.
Data management	3	Waicare website has space to store data.
Data analysis	2	Simple data, implications of the values takes some skill/experience to interpret.
Cost/equipment	2	Need probe for conductivity but available for < $100, can use cheap thermometers but likely less precise.
Time	2	Very quick to do but need multiple replicates to develop robust trend data.
People	3	Should be done with two people for safety.
Safety	2	Some additional hazards from working in/around waterways.
Permit	3	No permit required.

Scores: 3 = high suitability, 2 = moderate suitability, 1 = lower suitability

Scale issues: Would only apply to stream length assessed. At larger catchment scale scores may be different (diluted by variation).

Limitations:	Physical water properties can vary significantly throughout the day or over short distances depending on shade, water depth or other factors, so many samples would need to be collected from the same location and time of day/season to have useful data for comparison over time.
Notes:	Temperature measurement is part of the Waicare Kit. Can get probes that measure temperature, conductivity and also pH (see Water chemical properties method). Changes in conductivity can indicate an industrial discharge due to the presence of metals such as chloride, phosphate and nitrate, and can indicate whether a stream is within the tolerable range for fish or macroinvertebrates. Ability to compare results to reference values/values for typical Tāmaki Makaurau / Auckland streams provided by Waicare. Future work by NIWA is likely to provide standard protocols for measurement of conductivity.
Related methods:	Stream visual check – SO SMART, water chemistry, water clarity, shuffle sediment test, total coliform and E. coli.
Weblink:	https://waicare.org.nz/Files/3%20-%20Field%20Manual.pdf

Protocol use notes:

Weed control records

Summary: Record of weed species and areas controlled per zone/date in a restoration site. Can be coupled with plot data or weed walks to analyse effectiveness of weed control efforts and which areas need weed attention. Useful for demonstrating activity efforts to funders/volunteers.

Ecosystems: Forest and Scrub, Wetlands and Estuaries, Rivers and Streams, Dunes and Beaches.

Activity monitoring: Weed control.

Outcome monitoring:

Questions: What area of weeds has been treated?
What species of weeds have been treated?

Protocol: No specific protocol but see WWF Monitoring toolkit.

Criteria	Score	Comment
Scientific robustness	3	Simple record-keeping of weed control per species per location per season.
Broad applicability	1	Applicable only to pest plants.
Skill level	3	Simple recording of target effort by species in a spreadsheet or similar, and map of treatment zone to measure coverage.
Precision/sensitivity	2	Moderately accurate data based on contractor targets or volunteer efforts, some variation in how operators record infestation targeted (count, extent).
Data management	2	No national system, just need to keep a record in spreadsheet or log book.
Data analysis	3	Fairly simple running total of number of species targeted and area covered, but will require follow up visits to ensure effective control.
Cost/equipment	3	No special equipment needed.
Time	3	Should be covered as part of weed management planning/ reporting.
People	3	Only one person, desk job.
Safety	3	No specific safety issues.
Permit	3	No permit required.

Scores: 3 = high suitability, 2 = moderate suitability, 1 = lower suitability

Scale issues: Useful at project scale.

Limitations:	Need to re-visit to ensure adequate control/no regrowth.
Notes:	Useful for reporting back to funders.
Related methods:	Vegetation plots and Weed Walks (WETMAK) can be used for weed control success and re-invasion rates by species and location.
Weblink:	http://assets.wwf.org.nz/downloads/hpf_monitoring_toolkit.pdf

Protocol use notes:

Weed survey

Summary: Regular weed surveys along predetermined routes to find, and keep on top of, invasive weeds. Method involves use of GPS to locate and record infestations of target species (either count or extent of cover and data on presence of seedlings), and for follow up visits to ensure weeds haven't re-established or that control operations have been effective.

Ecosystems: Forest and Scrub, Wetlands and Estuaries, Dunes and Beaches.

Activity monitoring: Weed control.

Outcome monitoring:

Questions: What weed species are located where? How has weed distribution changed?

Protocol: WETMAK – Weed Survey

- The WETMAK protocol provides good survey technique and methodology which can be easily applied across other ecosystem types where a specific protocol for weed survey has not been written i.e. forest, dunes.

Criteria	Score	Comment
Scientific robustness	1	This was developed for Auckland Council weed surveying on Aotea / Great Barrier Island and adapted for WETMAK. Relatively new technique. Uncertainty over its robustness or level of adoption.
Broad applicability	2	Method could be used for threatened plant species, or other species of particular interest.
Skill level	2	Need to be able to ID target weeds and use a GPS (or smartphone).
Precision/sensitivity	2	Not yet fully tested, will likely work very well for species with discrete distribution and in well defined areas, particularly linear sites like wetland margins.
Data management	2	No existing national system for storing the data other than virtual or physical herbaria records. Auckland Council has it stored as spreadsheets and GIS.
Data analysis	2	Simple reporting on metrics like species present, frequency, total count for tree/shrubs or area covered for spreading weeds, and visual presentation on a map.
Cost/equipment	3	Basic gear, smartphone with gps capability and/or gps and datasheet.
Time	2	Varies with size of the area and number of target species, but each target weed entry is generally very quick. Would probably only do annually.
People	3	Should be done with two people for safety.
Safety	2	Some additional hazards from working in/around waterways. Varies with survey location.
Permit	3	No permit required.

Scores: 3 = high suitability, 2 = moderate suitability, 1 = lower suitability

Scale issues:	Easier to apply in small, well defined areas. Data can be aggregated at broader scale if systematically collected over time and space.
Limitations:	It is only monitoring if you return to the same waypoint time after time and describe the state of the infestation, one-off is a survey, not monitoring.
Notes:	Method can be used for any type of emergent plant, weeds or threatened or otherwise notable plant species.
Related methods:	WETMAK vegetation plot
Weblink:	http://www.landcare.org.nz/wetmak
Protocol use notes:	Protocol suitable for use in many different ecosystem types – wetlands, forest, dunes.

Wēta Motels

Summary:	Artificial wēta roosts are constructed and placed on trees throughout the study area to assess the level/number occupied by wēta and the numbers of wēta using them. Wēta roosts/houses need to be set up for an extended period prior to beginning to monitor trends – as use initially increases as roosts are located.
Ecosystems:	Forest and Scrub.
Activity monitoring:	
Outcome monitoring:	Improved native wildlife.
Questions:	What wēta species are present? How has wēta abundance changed?
Protocol:	No standard protocols at present. Auckland Council has developed a protocol for use by Auckland community groups and is trialling it with groups.

Criteria	Score	Comment
Scientific robustness	2	Appears to be considerable variation in results and value. Widely used, good for advocacy/education purposes, more understanding and value from results is developing.
Broad applicability	2	Potential use for some other large invertebrates.
Skill level	3	Relatively simple, some knowledge in relation to species identification.
Precision/sensitivity	2	Depends on sampling and a range of variables such as pest numbers/ wēta/lizard numbers. Likely to be useful in terms of broad/long-term changes.
Data management	1	No national data storage systems.
Data analysis	3	No standard system, simple count data.
Cost/equipment	2	Some cost for materials to manufacture from timber, added cost of Perspex for less invasive monitoring.
Time	2	Does not need to be done frequently, quick to do each check so just depends on number of covers and terrain/access.
People	3	Can be done with one person (two for safety).
Safety	3	No specific safety issues.
Permit	3	No permit required.

Scores: 3 = high suitability, 2 = moderate suitability, 1 = lower suitability

Scale issues:	Can provide results at project level – use summaries of these at regional level, etc.
Limitations:	Can be difficult to get large sample size. Results can vary. Need to be installed for considerable time before monitoring.
Notes:	Useful method for wēta and some other invertebrates. Relatively simple and engaging. Some controls around its use to avoid harm to fauna.
Related methods:	
Weblink:	Contact biodiversity@aucklandcouncil.govt.nz for a copy of the protocol
Protocol use notes:	

Wetland WOF check –WETMAK

Summary:	Quick health overview that looks at a wide range of wetland pressures (in the catchment) and condition (in the site and around its perimeter where pressures are often first noticed, such as stock trampling, drainage). Assigns a score (one-five) for factors like hydrology, nutrient status, weeds, pests, and human impacts.
Ecosystems:	Wetlands and Estuaries.
Activity monitoring:	
Outcome monitoring:	Quick health check.
Questions:	How is general health of the wetland? What areas need most attention?
Protocol:	WETMAK – Wetland WOF check.

Criteria	Score	Comment
Scientific robustness	2	Based on Clarkson et al. 2004, but simplified terminology for community use and addition of perimeter index.
Broad applicability	2	Ecosystem level assessment for freshwater wetlands, incorporates a range of indicators (hydrology, intactness, pest impacts, stock damage, etc.). Measures condition of wetland and its perimeter and catchment (pressures).
Skill level	2	Simpler than Clarkson et al. 2004 but still relies on application of local knowledge, some measures easier than others to apply, some rely on data collected from other monitoring (e.g. pest).
Precision/sensitivity	2	Uses a five point score. Some indicators respond/change quickly, others are long-term changes.
Data management	1	No national data storage system.
Data analysis	3	Simple comparison of scores for each attribute. Can also report on total score for aggregated attributes.
Cost/equipment	3	Only need datasheet, but may need data collected from other monitoring (e.g. hydrology, pest monitoring) to apply a score.
Time	3	Can apply relatively quickly from a good overlook and walk through, and do not need to remeasure frequently (e.g. one-five years).
People	2	Works best with two-four people for consensus decision-making of appropriate score.
Safety	2	Some additional hazards from working in/around waterways. Varies with survey location
Permit	3	No permit required.

Scores: 3 = high suitability, 2 = moderate suitability, 1 = lower suitability

Scale issues:	Potential to compare temporal trends at individual sites, and can assess total index score for same wetland types across the region (e.g. % of assessed wetlands with xy score for stock damage).
Limitations:	Some indicators rely on compilation of data from other monitoring methods to be able to effectively apply, e.g. pest impact, weed infestation, change in hydrology.
Notes:	
Related methods:	Permanent plots, call-playback, tracking tunnels, chew cards – results from these methods can assist in applying appropriate scores.
Weblink:	http://www.landcare.org.nz/wetmak
Protocol use notes:	

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