Introduction to invertebrate monitoring

Version 1.0

This introduction was prepared by Alison Evans in 2016.

Contents

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Department of Conservation
Te Papa Atawhai

Introduction

This introduction provides a basic context for conducting inventory, monitoring and/or research on invertebrates in New Zealand. Invertebrates present considerable challenges for inventory and monitoring but these can be overcome by using careful planning and design.

Why are invertebrates important?

Worldwide, invertebrates comprise over 99% of all animal species and are amongst the most important components of biodiversity. According to Landcare Research taxonomists, New Zealand has at least 30 000 species of insects but only about a quarter have been described (named) so far. We know even less about the ecology of New Zealand's invertebrates: the way they interact with other species and the ecosystem services they provide. Given this state of relative ignorance, it is very difficult to determine the conservation status of many of New Zealand's invertebrate species. The sampling methods available (e.g. pitfall trapping) are often crude in comparison to the precise ecological questions being asked (e.g. What impact do aerial 1080 poison operations have on native invertebrate species in forests?) This situation limits what can be inferred about cause and effect (e.g. the effect of 1080 on forest invertebrates during pest mammal poisoning operations). However, invertebrates are often sensitive to environmental change, making them good indicators of ecosystem health.

Invertebrates usually make up the largest component of animal biomass in terrestrial ecosystems. For example, earthworms comprise the largest component in New Zealand forests (Brockie & Moeed 1986). Insects and other invertebrates provide food for many vertebrates and perform vital ecosystem services such as nutrient cycling, soil turnover and pollination. Without such services, ecosystems would collapse. The huge diversity of invertebrates also provides ecosystem resilience (the ability to survive change) by increasing the number of alternative pathways in foodwebs.

What is special about New Zealand invertebrates?

- The great majority of New Zealand's invertebrates are endemic and they include many threatened species.
- Gigantism is relatively common (e.g. giant wētā, flax snails and kauri snails) and components of the fauna are exceptionally diverse for a temperate country. For example, New Zealand has an estimated 1350 species of land snail—most are very small—compared to fewer than 500 in the British Isles.
- New Zealand's fauna have evolved in the absence of mammalian predators, although predation pressure was still provided by birds and reptiles. The absence of native mammals in New Zealand made them particularly vulnerable to introduced mammalian predators. The effects on large invertebrate species have been most obvious; for example, the extermination of giant wētā from Northland (Gibbs 2001) and the depredations of possums on *Powelliphanta* snails in the South Island (Walker 2003). Mammalian herbivores have also had an effect by modifying the habitat. A summary of the various effects that introduced

mammals have had on native invertebrates and other fauna can be found in 'Impacts of 1080-poisoning of introduced mammalian pests on native wildlife' (doccm-396877). Consequently, the majority of invertebrate monitoring is centred on pest control operations and ascertaining effects on invertebrate communities.

Inventory, monitoring and undertaking research on invertebrates

Invertebrates are often overlooked in monitoring programmes because they can be difficult to identify, cryptic and hard to find, and their numbers can vary considerably over short periods of time. Typically, only a few insect species are common and most are rare (especially the ones of conservation interest). Often their ecological requirements are not always well matched to the current habitat conditions. These dynamic characteristics over spatial and temporal scales mean that rare species may suddenly become common if habitat conditions change to meet their ecological requirements (e.g. numbers of giant land snails can increase substantially after removing their introduced mammalian predators (Sherley et al. 1998). Thus single species and whole insect communities are continuously responding to changes in the environment in ways we frequently do not understand. Invertebrate communities can also change on a micro-scale so that different species occur within metres of each other. And finally, many of the standard methods used for sampling invertebrates are passive (e.g. pitfall trapping, Malaise trapping) and depend on how active the invertebrates are. These present challenges for the inventory and monitoring of invertebrates, which can be redressed by the experimental design (e.g. sufficient replication, careful experimental controls before and after treatment) and by using standard methods, sampling at an appropriate scale and over a sufficient (long) time. For example, when passive trapping is used, the traps are usually opened for long periods to smooth out changes in activity due to temperature and other meteorological variables, they are set in the same places and at the same time of year, and the data from them are used as a relative index of abundance or change such as over time or between treatments. Finally, we emphasise that any sampling method used records presence only, and not finding a species does not necessarily imply that it is absent at that locality.

Choosing a method

Before starting it is very important to carefully think out why you are doing the inventory or monitoring, and therefore identify explicitly what question or questions you are addressing. DOC staff must complete a 'Standard inventory and monitoring project plan' (doccm-146272).[1] The decision trees will guide you through these considerations and assist with selecting the most appropriate collection method for the invertebrate groups that you are interested in studying.

Some common questions asked concerning invertebrates are:

- Is a particular species or community responding to predator control?
- What is the distribution of a rare species?
- Is a population expanding or contracting?

[1] http://www.doc.govt.nz/Documents/science-and-technical/inventory-monitoring/im-toolbox-standard-inventory-and-monitoring-project-plan.doc

- How does modification of the habitat affect the invertebrates?
- Have we included sufficient representative invertebrate communities when protecting more land (e.g. for Protected Natural Area, reserve design, high country leasehold tenure review)?

No single collection method can sample all invertebrate species present at a site and if a more complete inventory is required, then a number of different methods will be needed.

Often a single species or a particular group of species are targeted for inventory and monitoring rather than attempting to sample every species at a locality. Selecting the sampling method involves the following considerations.

Use the three decision trees and the comparative table below to assist you to choose a method.

Considerations before you start

- Have other relevant monitoring or research projects been done at this site or elsewhere?
- What management actions are planned for this site which might impact on your project?
- Is the sampling method likely to detrimentally affect non-target species or species of conservation value?
- Have you allowed sufficient time? There is no point in monitoring the effects of, for example, rodent control on invertebrates if you have not left time to do sufficient sampling before control started. You will also need time to plan your sampling and do a preliminary trial.

There is no point in taking samples if they will not answer your question.

- Consider the behaviour of the targeted species. For example, whether an insect species is captured or not in a particular trap depends on its individual behaviour—such as whether it actively flies, is nocturnal or diurnal, what light wavelengths (colours) it is attracted to, etc. Even if the Herculean task of sampling every insect species could be achieved, the amount of equipment and effort involved would be prohibitive because no single collection method can sample all species (Henry & Disney 1986).
- Potentially large numbers of invertebrates can be sampled and more data than necessary can be gathered. Hence, when sampling communities, consider whether a few easily sampled species will answer the question rather than sampling numerous species. For example, when looking at the effects of rat predation it is common practice to target larger known prey species or at least only species longer than 5 mm.
- Consider the value of additional qualitative information or covariate data. For example, the description of the vegetation within which a pitfall or Malaise trap was set may be crucial to interpreting results because invertebrate communities can vary on a micro scale.

A comprehensive account of sampling invertebrates is available in Southwood & Henderson (2000). Some additional reading with reference to New Zealand examples includes Moeed & Meads (1985), McGregor et al. (1987), and Hutcheson (1999).

Designing the sampling procedure and analysing your results

Inventory is easy—you have the option of everything from placing traps wherever you like if it is a casual survey or, if a more complete inventory is required, placing them systematically (such as on a grid, or randomly, or putting a pre-determined number in different habitats). By taking replicate samples either over time or at the same place you can then estimate the total number of species present—or more accurately, the total number of species present that are catchable in your traps. This is a randomisation process which can be done in a variety of programmes such as 'R' or 'PC-ORD'. Once this is done then you can estimate the proportion of the total number of catchable species that you have collected.

If you want quantitative data—for example, you might want to estimate a population or compare numbers in different treatment areas—then we recommend that you refer to the 'Introduction to statistical analysis of invertebrate monitoring data' (doccm-525907)[2] and consult a statistician *at the start of the study*. You will probably also have to undertake a preliminary trial or pilot study to determine how many samples to take when doing the definitive sampling. The data from a pilot study will be used to do a power analysis to check that your sample size will be sufficient to detect differences between your different sites or treatments. However, every invertebrate study is different and so we cannot specify a pre-determined formula of how to design your study or analyse the data.

BEFORE YOU START

A checklist of things you should do or plan:

- First, you will need to decide what question you are asking and what method to use (using the decision trees below will help to determine the methods that are most suitable for your study).
- Do you have sufficient time to do the work?
  - Is a preliminary pilot study required—have you allowed time for this?
  - Is before and after sampling (e.g. a Before–After Control Impact (BACI) design) required —is there time for this?
- If your question requires quantitative data, you next need to consult a statistician to help design the sampling procedure and thus ensure that you do not waste your time.
- Next you will need to plan how the samples will be sorted and identified. Who will do it? If an external contract is required for sorting specimens or for taxonomic identification (the usual

[2] http://www.doc.govt.nz/documents/science-and-technical/inventory-monitoring/im-toolbox-statistical-analysis-of-invertebrate-monitoring-data.pdf

situation), you will need to obtain an estimate of the cost and a budget. See 'Invertebrates: advice and diagnostic support' (doccm-2686377).[3]

- You need to determine what happens to the samples after they have been sorted and counted. Some specimens may need to be stored in the New Zealand Arthropod Collection or a similar repository (see 'Invertebrates: advice and diagnostic support'—doccm-2686377)[3]. Check which is the best way to preserve these specimens. The samples are Government property—legally, you commit an offence if you throw them away without the proper authority.

Comparative table

Table 1. Recommended techniques for the inventory and monitoring of invertebrates. **Method precision** (relative to objectives): ✓✓✓ Good; ✓✓ Medium; ✓ Poor; × Not Recommended; **–** Not Applicable. **Resources:** L = Low; M = Medium; H = High. Methods that are blacked out are under development.

	Inventory Objectives*	Resources			Monitoring Objectives†			Resources		
Method	Suitability for inventory	Equipment costs	Personnel costs	Skills required	Surveillance[1]	Status & trend[2]	Management[3]	Equipment costs	Personnel costs	Skills required
Complete counts										
Complete counts (true census)	–	–	–	–	✓	✓✓	✓✓	L	H	M/H
Plot sampling (e.g. quadrats)	–	–	–	–	✓✓	✓✓✓	✓✓	L	M	M/H
Relative abundance										
Pitfall-flight-intercept trapping	✓✓✓	M	M	H	✓✓	✓✓	✓✓	L	M	M
Pitfall trapping	✓✓	L	M	H	✓✓	✓✓	✓✓	L	M	M
Hand searching (visual or manual)	✓✓	L	M	H	✓✓	✓	✓	L	M	H
Sweep netting	✓✓✓	L	M	H	✓	✓	✓	L	M	H
Foliage beating	✓✓✓	L	M	H	✓✓	✓	✓	L	M	H
Search and extraction	✓✓✓	L	M	H	✓	✓✓	✓	L	M	H
Light trapping	✓✓✓	L	M	H	✓✓	✓	✓	L	M	H

[3] www.doc.govt.nz/documents/science-and-technical/inventory-monitoring/im-toolbox-invertebrates-advice-diagnostic-support.pdf

	Inventory Objectives*	Resources			Monitoring Objectives†			Resources		
Method	Suitability for inventory	Equipment costs	Personnel costs	Skills required	Surveillance[1]	Status & trend[2]	Management[3]	Equipment costs	Personnel costs	Skills required
Malaise trapping	✓✓✓	L	M	H	✓✓	✓	✓	L	M	H

* Inventory is a one-off survey or assessment with no intention to re-measure. If inventory of a site is repeated in the future this can be considered monitoring. Typical inventory objectives include: What species are present at a site and how are they distributed over a landscape? What are the species habitat relationships? What is the wildlife value/significance of an area (Site of Special Wildlife Interest (SSWI), etc.)? Is this a baseline survey? Interpretation of results must be based on the understanding that these are single surveys.

† Monitoring assesses change or trend over time and requires re-measurement of parameters at some pre-determined frequency. Typical monitoring objectives include:

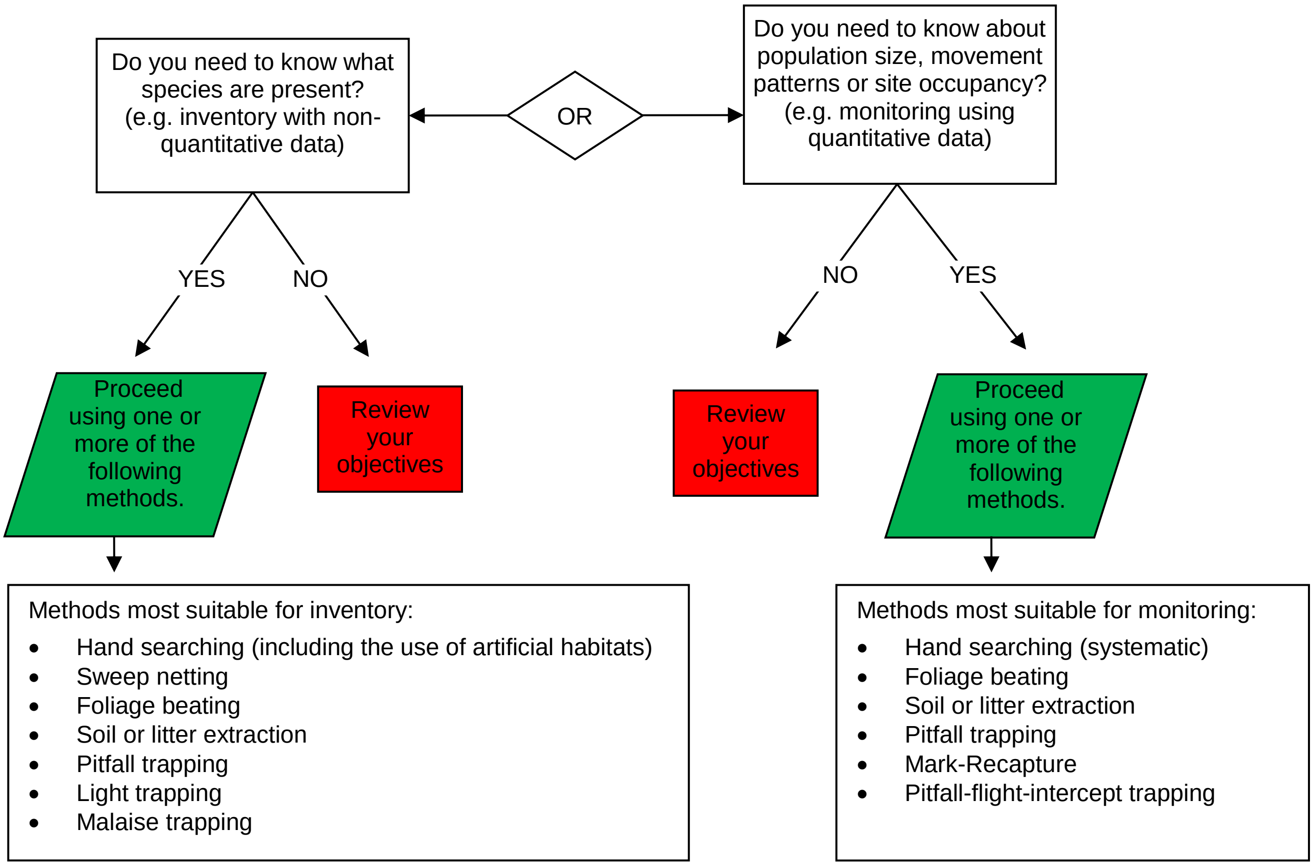
[1] What species have moved into an area? Have range extensions occurred for a species of interest (e.g. monitoring for biosecurity risk—illegal introductions)?

[2] What is the population abundance or density of a species or community? Is this stable over time? What are the population trends? Does this relate to habitat use?

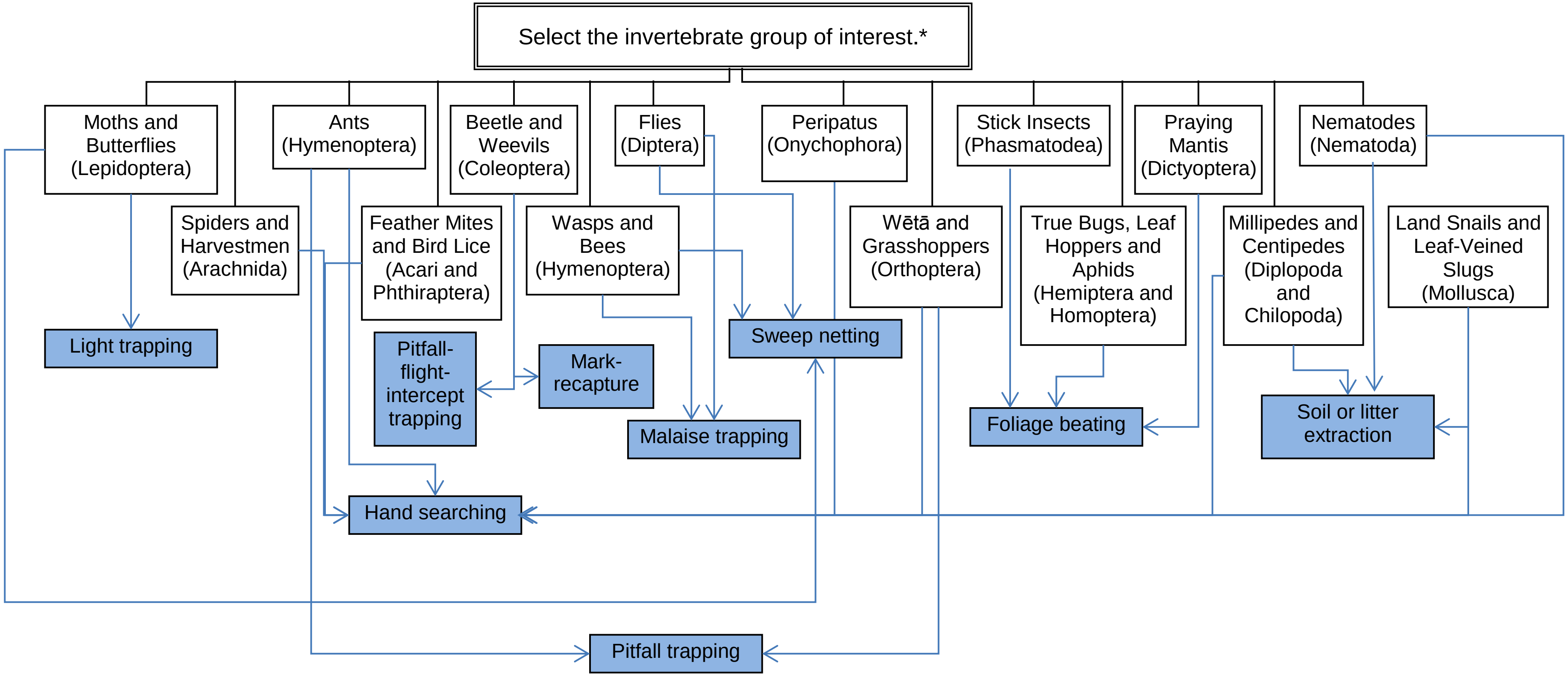
[3] Do population estimates of density and abundance change as a result of management action? Over what time-scale does this occur? Has a species translocation succeeded? Has management been effective? Has species composition altered as a result of management? What are the visitor impacts?

Decision trees

Decision Tree One: Choosing an inventory or monitoring method

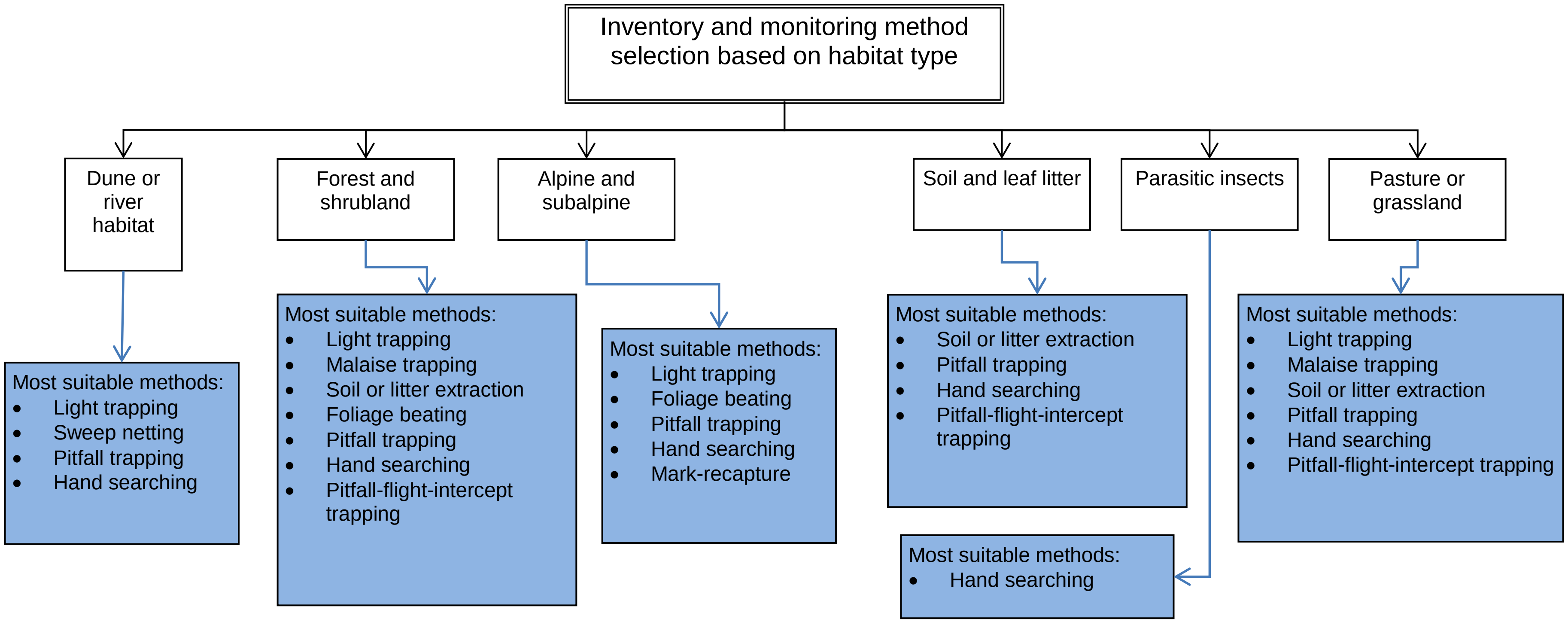


Decision Tree Two: Choosing a method based on taxa



* Not all invertebrate taxa are listed and methodology will differ for some life-stages.

Decision Tree Three: Choosing a method based on habitat type



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Recommended reading

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Appendix A

The following Department of Conservation documents are referred to in this method:

doccm-396877	Impacts of 1080-poisoning of introduced mammalian pests on native wildlife
doccm-525907	Introduction to statistical analysis of invertebrate monitoring data
doccm-2686377	Invertebrates: advice and diagnostic support
doccm-146272	Standard inventory and monitoring project plan