

Introduction to monitoring freshwater fish

Version 1.1



This introduction was prepared by Natasha Grainger, Jane Goodman and Dave West in 2013.

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Disclaimer

This document contains supporting material for the Inventory and Monitoring Toolbox, which contains DOC's biodiversity inventory and monitoring standards. It is being made available to external groups and organisations to demonstrate current departmental best practice. DOC has used its best endeavours to ensure the accuracy of the information at the date of publication. As these standards have been prepared for the use of DOC staff, other users may require authorisation or caveats may apply. Any use by members of the public is at their own risk and DOC disclaims any liability that may arise from its use. For further information, please email biodiversitymonitoring@doc.govt.nz



Synopsis

This introduction gives an overview of how to undertake inventory and monitoring of freshwater fish to help you select the most appropriate method(s) for your study objectives. It overviews a comprehensive range of methods available, but specifications have only been written for methods frequently used by DOC staff.

The general principles that should be considered when designing an inventory or monitoring study are outlined in 'A guideline to monitoring populations' (docdm-870579). This introduction is designed to provide additional information specific to the inventory and monitoring of freshwater fish populations in New Zealand.

This introduction identifies some of the difficulties that may be encountered in measuring distribution and population size of freshwater fish, outlines the issues that need to be considered when choosing an appropriate method, and provides decision trees to assist with selection of appropriate methods for different species or functional groups of fish in a variety of habitats. It also considers some of the issues that need to be considered in the detailed planning of a project.

Freshwater fish and habitats

Freshwater fish are generally visually cryptic and difficult to detect, thus being one of the more difficult taxonomic groupings to obtain measures of distribution and population size. There is no single method (nor is there ever likely to be) that can be applied to all species or populations given the variety of practical and statistical problems that are encountered in different situations.

New Zealand freshwater fish inhabit a range of habitats including lakes, rivers, streams, wetlands, estuaries and the ocean at various stages of their lifecycle. Obviously, some monitoring techniques are more suited to particular habitats, and the way in which freshwater fish use their habitats at various times further complicates choice of the most appropriate technique. Even the most robust method can be compromised by poor design, inadequate understanding of the assumptions and inappropriate application. For these reasons a series of decision trees have been provided to help users choose the most suitable and cost-effective way to answer specific inventory and monitoring questions.

Freshwater fish found in New Zealand (native and introduced) have been grouped into 'functional groups' that broadly reflect a common set of ecologies, behaviours or other features that tend to shape inventory or monitoring programmes. The functional groups are:

- Large galaxiids (kōkopu and kōaro)
- Non-migratory galaxiids
- Mudfish
- Inanga and smelt
- Bullies and torrentfish

- Eels
- Lamprey
- Invasive fish (gambusia)
- Invasive fish (rudd, koi carp and catfish)
- Sports fish

Habitats have also been grouped into six types to help determine the best method to use in that particular habitat. Non-wadeable streams have been further defined by their width and their velocity to help narrow the options down for method selection. The six habitat types are:

- Wadeable streams/ivers (< 1 m deep)
- Non-wadeable streams/ivers (> 1 m deep)
- Riparian
- Lakes
- Wetlands
- Estuaries

Methods covered in this specification

Table 1 shows the methods grouped by the type of measure and whether they are covered by the Toolbox. Note that a method may be used for more than one type of measure. If you want to use one of the methods not covered in this module, you may need to seek specialist advice.

Table 1. Methods covered in the 'Freshwater fish' module.

Type of measure	Method name	Covered in this module
Presence/absence	Electrofishing: boat	–
	Electrofishing: fixed reach	✓
	Electrofishing: spotfishing	✓
	Passive nets: fyke nets	✓
	Passive nets: minnow traps	✓
	Passive nets: gill and trammel nets	✓
	Hand-netting	–
	Plankton trawl for larval fish	–
	Redd counts	–
	Seine netting	–
	Spotlighting: fixed reach	✓
	Spotlighting: spotfishing	✓
	Visual search	–
Whitebait nets	–	
Relative abundance: catch per unit effort (CPUE)	Electrofishing: boat	–
	Passive nets: fyke nets	✓
	Passive nets: minnow traps	✓

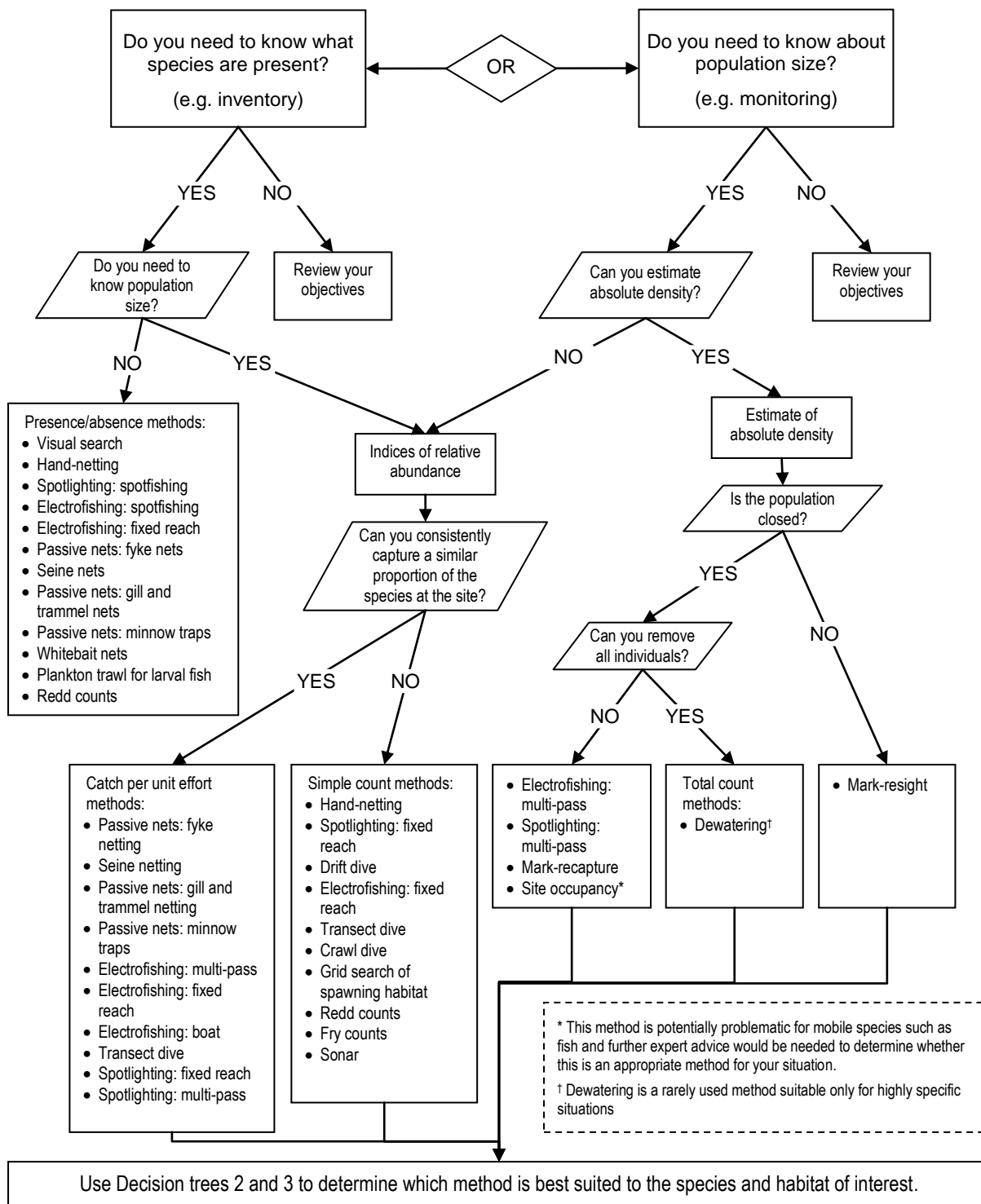
	Passive nets: gill and trammel nets	✓
	Seine nets	–
	Transect dive	–
Relative abundance: simple count	Crawl dive	–
	Drift dive	–
	Electrofishing: fixed reach	✓
	Fry counts	–
	Grid search of spawning habitat	–
	Hand-netting	–
	Redd counts	–
	Sonar	–
	Spotlighting: fixed reach	✓
Absolute density	Electrofishing: multi-pass	✓
	Mark-recapture	–
	Mark-resight	–
	Site occupancy	–
	Spotlighting: multi-pass	✓
Total count	Dewatering	–



Decision trees

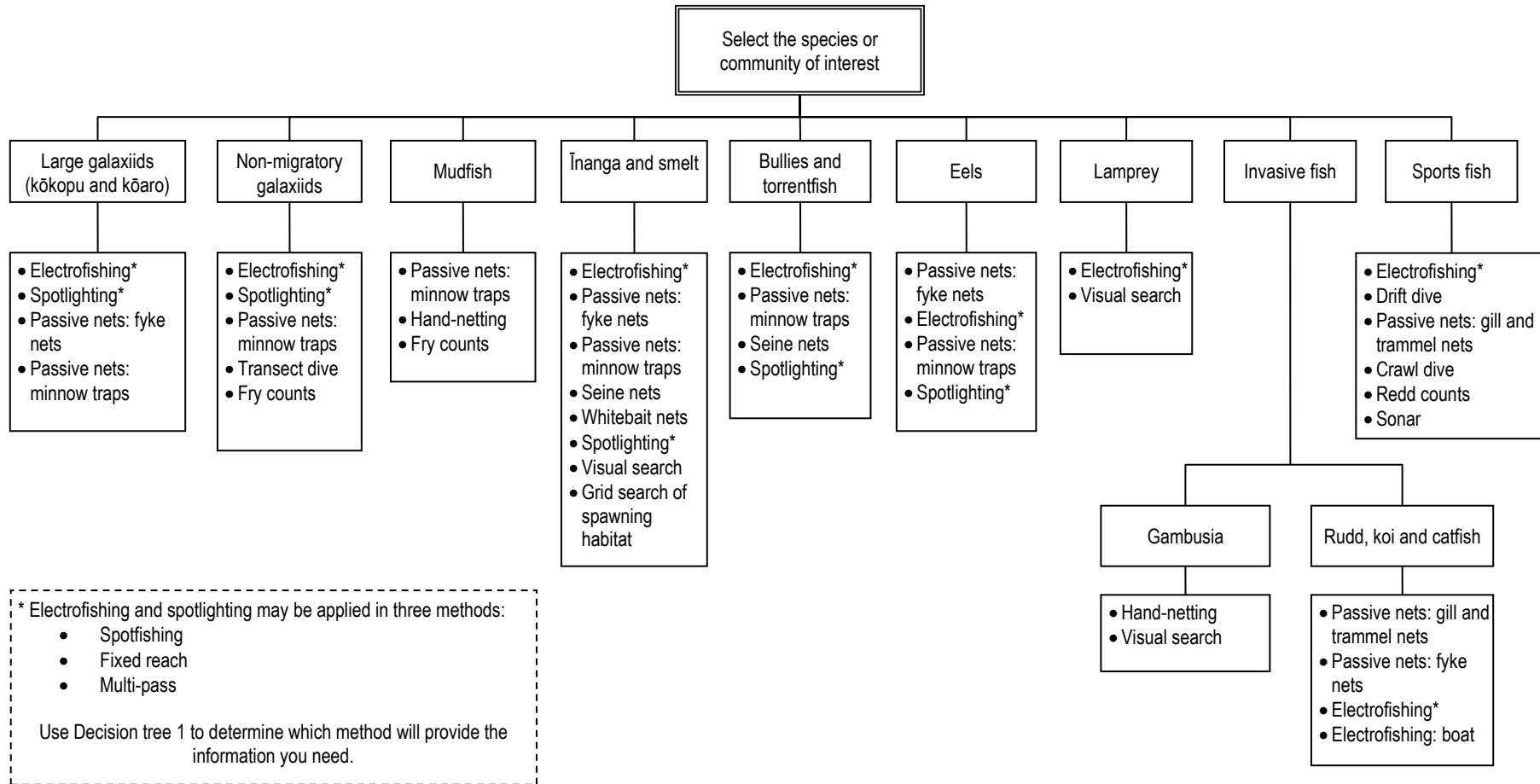
Step One: Use 'Decision tree 1' to help confirm that the objectives of the study are clearly defined. This will lead to a group of methods that will need to be explored further.

Decision tree 1



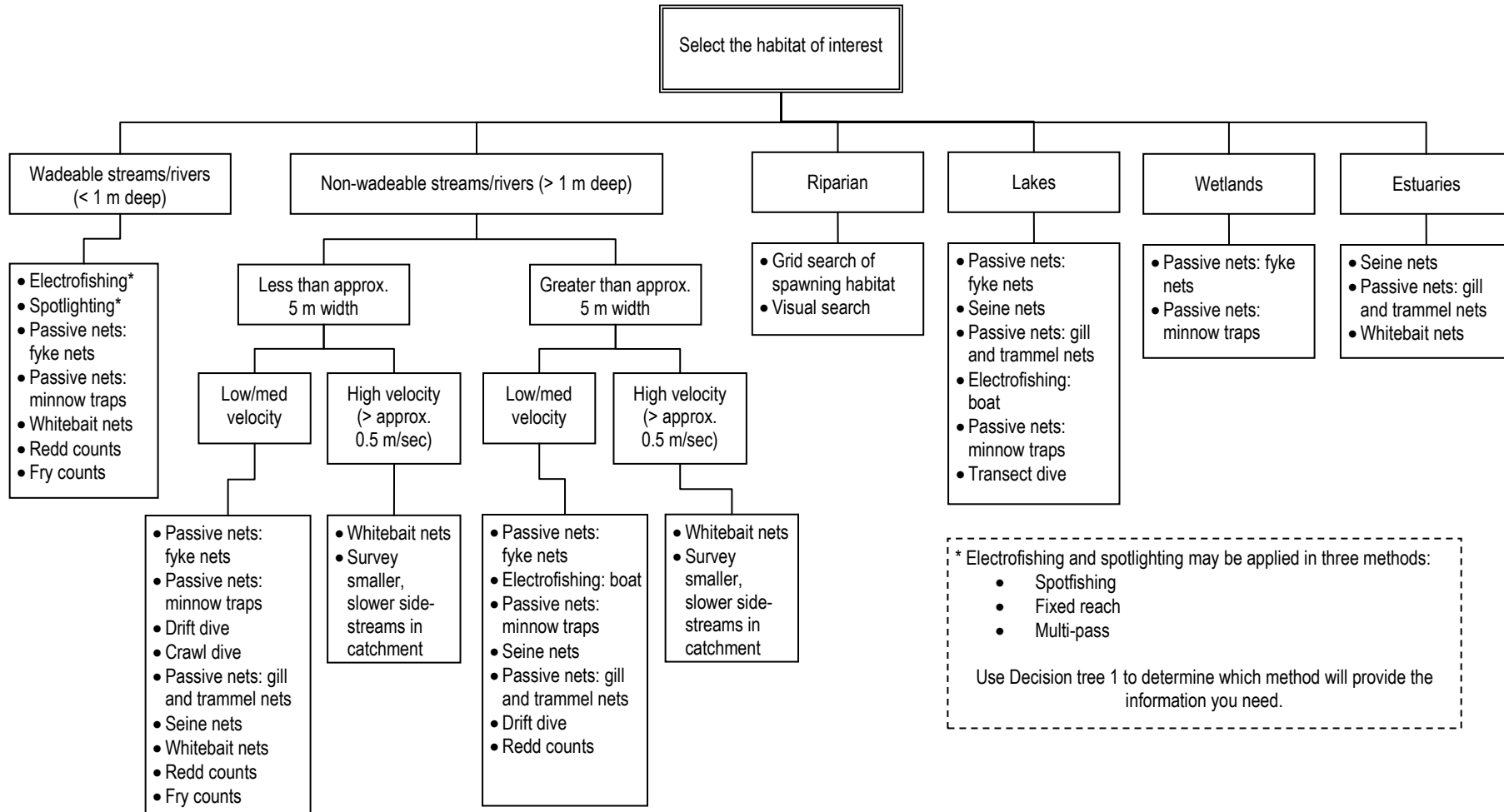
Step Two: If you are targeting a particular *species* then use ‘Decision tree 2’ to choose a method that is suitable for that functional group of fish.

Decision tree 2



Step Three: If you are targeting a particular *habitat* then use ‘Decision tree 3’ to choose a method that will be suitable for that functional group of fish in that habitat.

Decision tree 3



Normally, a decision tree would take you to one method and exclude other possibilities. Unfortunately, there is no way to create a decision tree with mutually exclusive methods, as some methods are suitable in more than one situation. This has led to the decision trees having overlapping endpoints, which means they can only be used to narrow your method selection down, not to identify just one method.

The final choice of method will be the best overlap of these three decision tables and an assessment of their advantages and disadvantages.

Comparative table

In other Toolbox modules, comparative tables are used to assess the suitability of methods. For this module, the complexity of presenting tables comparing methods and functional groups of species (10 tables required) and comparing methods and habitats (9 tables required) would be overwhelming and unhelpful. Even when habitat and method are combined for each functional species group, the information presented does not add anything more than comparing the advantages and disadvantages of your short-listed methods.

To illustrate this point, the methods and habitats that can be used for eels is presented in Table 2.

Table 2. Recommended techniques for the inventory and monitoring of eels. Method precision (relative to objectives): ✓✓✓ Good; ✓✓ Medium; ✓ Poor; ✗ Not Recommended; – Not Applicable. Resources: L = Low; M = Medium; H = High.

Method	Inventory objectives	Resources			Monitoring objectives [†]			Resources		
	Suitability for inventory	Equipment costs	Personnel costs	Skills required	Surveillance ¹	Status & trend ²	Management ³	Equipment costs	Personnel costs	Skills required
Passive nets: fyke nets in wadeable streams/ivers (< 1 m deep)	✓✓✓	M	L	L	✓✓✓	✓✓✓	✓✓✓	M	L	L
Passive nets: fyke nets in non-wadeable streams/ivers (> 1 m deep), less than 5 m wide and low/med velocity	✓✓✓	M	L	L	✓✓✓	✓✓✓	✓✓✓	M	L	L

Method	Inventory objectives*	Resources			Monitoring objectives†			Resources		
	Suitability for inventory	Equipment costs	Personnel costs	Skills required	Surveillance ¹	Status & trend ²	Management ³	Equipment costs	Personnel costs	Skills required
Passive nets: fyke nets in non-wadeable streams/ivers (> 1 m deep), greater than 5 m wide and low/med velocity	✓✓✓	M	L	L	✓✓✓	✓✓✓	✓✓✓	M	L	L
Passive nets: fyke nets in lakes	✓✓✓	M	L	L	✓✓✓	✓✓✓	✓✓✓	M	L	L
Passive nets: fyke nets in wetlands	✓✓✓	M	L	L	✓✓✓	✓✓✓	✓✓✓	M	L	L
Electrofishing: spotfishing in wadeable streams/ivers (< 1 m deep)	✓✓✓	H	M	H	✓✓✓	✓✓✓	✓✓✓	H	M	H
Electrofishing: fixed reach in wadeable streams/ivers (< 1 m deep)	✓✓✓	H	M	H	✓✓✓	✓✓✓	✓✓✓	H	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? 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 and cage bird releases)?
- 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?

Table 2 shows that electrofishing has higher costs, personnel and skill requirements. This is true in terms of purchasing an electric fishing machine and in training staff but if an electric fishing machine is already owned, or can be borrowed, and staff have been trained it is probably cheaper than fyke netting because the work can be completed in one day rather than returning the next day to retrieve nets.

The way to choose the best method is a cumulative decision, following consideration of a many factors. For example, site constraints (slope, water velocity, presence of vegetation, depth, etc.) are going to influence the method choice, as is catch selectivity (fyke nets do not catch a full size-range of fish but electrofishing will), and will become apparent after reading the method specifications. The ultimate decision is defined by a multitude of considerations that generic comparative tables could not capture.

Section 3.2 of Joy et al. (2013) has a methodology to compare different methods and habitats for a specific objective (evaluation of diversity and relative abundance at a reach scale in wadeable streams for state of the environment reporting). While it is not possible to replicate this for the breadth of objectives, species and habitats in this module, this may provide some guidance.

The format of the comparative tables does not allow the consideration of detail required to make the narrow your options and then read each method specification as there is a list of advantages and disadvantages with each method. If, comparing the advantages and disadvantages of each method for your situation, you are still unsure which method to use, you should talk to someone in the Freshwater Team of the DOC Science & Capability Group.

Other considerations

Field work

It is recommended that fish surveys should be undertaken between December and April (inclusive) to ensure that most migratory species are present and available to be caught. This will also ensure that water temperatures are warm enough for fish to be active. If you are targeting glass eels, mudfish fry, whitebait or whitebait eggs you will need to work out the best time to survey these as they may differ. Charteris (2007), Hammer (2007) and Boubee et al. (2000) have useful tables to use to determine fish migrations and spawning. Use the tables most suited to your region.

Sampling should not take place during or after rainfall events that are likely to cause higher than normal flows. The best time for sampling is when flows are stable. If rain is forecast in the catchment in the next 24 hours, traps and nets should not be set. Where possible, spotlighting should not be done when the moon is full.

Preventing the spread of pests while surveying

DOC's 'Freshwater fishing net decontamination protocol' (docdm-428359) must be followed for cleaning gear and nets following field deployment. Note: this protocol is more detailed and covers a wider range of species than what is promoted by the 'Check, Clean, Dry' requirements for didymo that the Ministry for Primary Industries is responsible for.

Preventing by-catch of diving birds

DOC's 'Set nets and diving birds: best practice guidance' (docdm-1470778) must be followed to minimise the by-catch of diving birds when setting nets.

Pest fish inventory and monitoring guidance

DOC's 'Protocols for pest fish inventory and monitoring' (docdm-756153) provides general information to help maximise the chances of detecting pest fish when undertaking pest fish inventory and/or post-eradication monitoring. It gives guidance on how to target pest species in more detail than is provided in the method specifications, it discusses multiple methods and it also defines criteria for determining eradication success or failure. The monitoring standards described in the Toolbox are applicable to pest fish as well, but seek specialist advice if you are unsure.

Health and safety

The method specifications make some suggestions for health and safety but these are not a comprehensive review and do not replace DOC's health and safety procedures.

DOC employees and volunteers must follow the following standard operating procedures (SOPs):

- 'Electric fishing: one page SOP' (docdm-676678)
- 'Electric fishing technical document—health and safety' (docdm-752861)
- 'Scientific diving: one page SOP' (docdm-673798)
- 'Snorkelling: one page SOP' (docdm-673820)
- 'Scientific diving and snorkelling: technical document' (docdm-237640)

Data collection and storage

Each method specification gives guidance on how to collect and store data.

The 'Protocols for pest fish inventory and monitoring' (docdm-756153) includes field sheets that might be of more general application for data collection, e.g. a site description form, a job sheet and an aquatic weed surveillance sheet.

Summaries of all fish survey data should also be entered into the New Zealand Freshwater Fish Database (NZFFD) administered by the National Institute of Water and Atmospheric Research (NIWA). The NZFFD is an important national repository for presence/absence data and represents a valuable resource for a range of different applications including research, impact assessments and threatened species monitoring. As a minimum, site location, fishing method and species collected should be recorded in the database forms. Data can be entered electronically using the Freshwater Fish Database Assistant software, which is freely available from the NIWA website¹.

¹ <http://www.niwa.co.nz/our-services/databases/freshwater-fish-database>

References

- Boubee, J.; Williams, E.; Richardson, J. 2000: Fish passage guidelines for the Auckland Region. Technical Publication 131.
<http://www.arc.govt.nz/albany/fms/main/Documents/Plans/Technical%20publications/101-150/TP131%20Fish%20Passage%20Guidelines%20for%20the%20Auckland%20Region%202000%20Part%20A.pdf>
- Charteris, S. 2007: Native fish requirements for water intakes in Canterbury. Unpublished Department of Conservation publication, Canterbury Conservancy, Christchurch. (docdm-27440)
- Hammer, M. 2007. The freshwater fish spawning and migration calendar report. Environment Waikato Technical Report 2007/11. <http://www.waikatoregion.govt.nz/PageFiles/5021/tr0711.pdf>
- Joy, M.; David, B; Lake, M. 2013: New Zealand freshwater fish sampling protocols: part 1—wadeable rivers and streams. Massey University, Palmerston North.

Appendix A

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

docdm-676678	Electric fishing: one page SOP
docdm-752861	Electric fishing technical document—health and safety
docdm-428359	Freshwater fishing net decontamination protocol
docdm-870579	A guideline to monitoring populations
docdm-756153	Protocols for pest fish inventory and monitoring
docdm-237640	Scientific diving and snorkelling: technical document
docdm-673798	Scientific diving: one page SOP
docdm-1470778	Set nets and diving birds: best practice guidance
docdm-673820	Snorkelling: one page SOP