Freshwater fish: passive nets—minnow traps

Version 1.0

This specification was prepared by Michael Lake in 2013.

Contents

Department of Conservation
Te Papa Atawhai

Synopsis

Minnow traps are small fish traps that typically consist of two funnel-shaped entrances at either end of a mesh box or cylinder. The standard minnow trap design used for ecological data collection in New Zealand is the Gee's minnow trap. Minnow traps are a type of passive sampling gear because they rely on fish to willingly encounter and enter the trap (Hubert 1996). They can be used to sample freshwater fish in a wide range of environments including lakes, wetlands, rivers and streams.

The efficiency and selectivity of minnow traps is influenced by the probability that fish will encounter, enter and be retained within the trap until it is retrieved (Portt et al. 2006). The size of fish captured in minnow traps is limited by the size of the entrances, which are typically very small (20–30 mm). Minnow traps are considered to be the optimal method for sampling New Zealand mudfish species (Ling et al. 2009). Minnow traps are known to be highly effective for capturing small freshwater eels when baited (Chisnall 1996). The species and habitat decision trees in the 'Introduction to monitoring freshwater fish' (docdm-1008026) should be used to identify whether minnow trapping is the appropriate method for sampling your species or communities of interest.

Unlike gill nets, most fish can be released alive after being captured in minnow traps and predation within the traps is likely to be less than with fyke nets. Because of their small size, minnow traps can also be set amongst complex habitat and in very small and shallow pools of water.

The capture efficiency of minnow traps is primarily influenced by the diameter of the trap entrances and mesh size. Standardisation of sampling gear within a survey or monitoring programme is important for obtaining relative abundance data that can be compared spatially and temporally. It is recommended that Gee's minnow traps be used for any minnow trap studies unless there are compelling reasons to use another type of trap.

Minnow traps can be used for inventory surveys where the objective is to estimate taxa richness or the presence/absence of fish species at a location. Because minnow traps are very selective for small fish sizes it is recommended that minnow trapping be carried out in combination with fyke netting when undertaking inventory surveys. Gill nets may also need to be used to sample habitats where fyke nets will be less effective, such as extensive areas of deep, open water (see 'Freshwater fish: passive nets—fyke nets'—docdm-997948).

Minnow traps can also be used to collect relative abundance data based on calculations of catch per unit effort (CPUE). Minnow trap CPUE, as with other passive netting methods, is usually expressed as number of fish caught per net per unit of time (e.g. hours or nights). The accuracy of CPUE as an index of abundance is primarily determined by whether catch efficiency, or 'catchability', remains constant and unaffected by other factors (Hubert & Fabrizio 2007). Unvarying catch efficiency is one of the key assumptions made when assessing differences in relative abundance. In reality, however, a wide range of factors can influence catch efficiency when using minnow nets. It is important to take a cautious approach and consider potential differences in catch efficiency when comparing relative abundance data over time and space.

Standardising net types and sampling protocols is critical for obtaining reliable relative abundance data. Standardised national protocols for using a combination of fyke nets and Gee's minnow traps in New Zealand wadeable streams have been developed by Joy et al. (2013). It is recommended that, where appropriate, those protocols be adopted by DOC staff when sampling stream environments using minnow traps.

If you are targeting pest fish species, further guidance is provided in 'Protocols for pest fish inventory and monitoring best practice guidance' (docdm-756153).

Assumptions

Where the data are used to determine presence/absence:

- *Methodology is standardised to account for variation in detection probability.* It is important to use a consistent and legitimate spatial sampling framework. That is, that the number of nets used is large enough to capture the range of fish that are present in the area that is represented by the sample.

- *Species of interest are truly absent from the sample area when none are detected.* This assumption will be violated when species are present but inactive or occur at densities that are undetectable by minnow trap methods. For example, eel activity is very low at temperatures less than about 10°C so minnow trap samples collected in winter may fail to detect these species. Similarly, at very low densities fish may fail to encounter any minnow traps during the sampling period and therefore evade capture and detection. Because of their small size, the height at which minnow traps are set will also have a significant influence on the species caught. Because minnow traps are species-selective, only those species known to be susceptible to capture using this method should be considered as being sampled.

Where the data are used to compare relative abundances:

- *The relationship between number of individuals collected (index) and number of individuals present (density) is linear.* This is unlikely to be the case in many instances with passive netting techniques because of their dependence on fish behaviour, which may be highly variable, and the effects of gear saturation (Hubert & Fabrizio 2007).

- *Capture efficiency is independent of environmental conditions, fish species, population structure and operator proficiency.* These assumptions should be carefully considered when making comparisons over time or between sites, as many of these factors are known to strongly influence catch efficiency (Hubert 1996; Portt et al. 2006).

- *There is no movement into or out of the sample reach or any sub-reaches during sampling (i.e. the population is demographically closed).* This assumption is less likely to hold when traps are set for longer periods of time, or when highly mobile species (e.g. Īnanga or smelt) are being sampled. The assumption is more likely to be valid for more sedentary species such as bullies or mudfish.

Advantages

Advantages of minnow traps:

- They can be set in very small and shallow bodies of water.

- They can easily be set in complex habitat types such as dense aquatic vegetation or amongst coarse woody debris.

- They can be set on steeply sloping and uneven substrates.

- They are more portable than other passive netting techniques.

- There is far less fish mortality and injury compared with gill nets and most fish can be released. However, fish can become injured through abrasion against the trap entrances and side mesh. Very small fish can also become wedged in the sides of coarse meshed traps.

- Does not require a high level of technical expertise or specialist training (although the experience of field staff will influence catch efficiency).

- Mortality rates for captured fish are low if set properly. Predation may be an issue but large predators will be excluded.

- There is no risk to diving birds or other non-target organisms.

- They are the most effective method for sampling adult New Zealand mudfish species, and are also known to be effective for sampling juvenile eels (Chisnall 1996) and kōura, particularly when baited.

Advantages of passive netting in general:

- Sampling is relatively unaffected by turbidity or electrical conductivity which can limit the use of methods like spotlighting or electrofishing.

- Samples are taken continuously over a long time period. This has the advantage of dampening the effects of any diurnal variations in fish behaviour (Hayes 1989).

- It allows sampling in habitats that are not wadeable because water depth or sediment depth is too great.

- Does not require a high level of technical expertise or specialist training.

- It causes less disturbance in shallow habitats than some active methods such as seining or electrofishing.

Disadvantages

Disadvantages of minnow traps:

- Catch variance can be high; however, this may simply reflect high spatial variability in the small fish species that minnow traps target (Balcombe & Closs 2000).

- They are highly selective for small fish, with maximum girth limited by the size of the cone-shaped openings.

- They can be species-selective (Layman & Smith 2001).

- Catches of some species can be affected by the presence of other species (He & Lodge 1990).

Disadvantages of passive netting in general:

- It provides a less accurately defined unit of effort compared with active techniques because no spatial measure is included (Hayes et al. 1996).
- It is biased towards more active fish species. The more active a fish is the more likely it is to encounter the net.
- Catch rates and taxa richness can vary with time of day depending on diurnal patterns of fish behaviour (Portt et al. 2006). This can be overcome by setting gear over a 24-hr period.
- It requires a return trip to retrieve gear, which may increase the level of resources required to collect data, particularly for remote sites.

Suitability for inventory

This method is appropriate for inventory:

- In shallow wetland habitats
- Where active fishing methods cannot be implemented or resourced (e.g. in non-wadeable, turbid or structurally complex habitats)
- When combined with other sampling methods, which overcome some of the species biases inherent in Gee's minnow trap samples. Minnow traps should be combined with fyke nets and potentially also gill nets and/or boat electrofishing to ensure large-bodied fish species can be detected.

Suitability for monitoring

This method is appropriate for monitoring:

- Small-bodied fish species, especially cover-seeking benthic species
- Where active fishing methods cannot be implemented or resourced (e.g. in non-wadeable, turbid or structurally complex habitats)

Skills

Field operations

The setting of minnow traps does not require any specialist skills or training; however, it is recommended that at least one team member has some prior experience with setting these types of traps. A boat may be required to set minnow traps in deeper habitats. Appropriate training and certification in the operation of boats will therefore be required (refer to the standard operating procedure: 'Boat competency SOP'—docdm-346005). Survey teams should contain at least one

person able to identify freshwater fish to species level and who has experience in handling fish to minimise any unnecessary injury or mortality and speed up fish processing.

Design and analysis

Staff involved in the development of survey programmes should be familiar with basic principles of good sampling design. 'A guideline to monitoring populations' (docdm-870579) will assist with understanding these principles. It is important that input from statisticians is obtained during both the design and analysis stages to ensure that the data collected are scientifically robust. Good statistical design is especially critical when developing monitoring programmes as they tend to be complex and have high ongoing running costs. It is much harder to improve design after data collection has started or been underway for some time than it is to put time into the initial planning. Putting effort into designing a programme well at the outset ensures that the running costs are justified and will result in useful information that meets the monitoring objectives.

The ability to use a spreadsheet software package such as Microsoft Excel is a minimum skill required for data entry, data checking and analyses. The ability to use statistical software packages is desirable but not mandatory provided support from statisticians is available. Staff involved in data analysis must be conscious of the underlying assumptions of minnow trapping when undertaking their analyses and cautious of the level of inference derived from any results.

Resources

- Survey team. In most habitats minnow traps can easily be set by one person. Even when a boat is required it is possible for the boat operator to set minnow traps single-handedly; however, for safety reasons, a two-person team may be required. If significant numbers of fish are caught then a second team member can speed up fish processing.
- Minnow traps (and clips if using Gee's minnow traps).
- Personal flotation devices and any other boat safety equipment if a boat is being used.
- Lengths of rope or cord to secure traps.
- Flagging tape to mark the location of traps.
- Buckets or fish bins. At least one bucket or bin is required for holding captured fish for processing.
- Aerator if captured fish are to be kept alive for long periods.
- Measuring board (if fish are to be measured).
- Voucher jars for fish samples / fin clips filled with 70% ethanol.
- GPS unit.
- Water quality field meter(s). As a minimum, water temperature should be recorded but dissolved oxygen and pH are also useful parameters to measure.
- Rain-proof data sheets with clipboard and pencils, including New Zealand Freshwater Fish Database forms.

- Freshwater fish identification book, e.g. *The Reed Field Guide to New Zealand Freshwater Fishes* (McDowall 2000).

- Waders are optional but recommended where water temperatures are cold or where water quality is poor. If waders are used then staff should be trained in wader safety; see 'Wading safely' (olddm-566603) for guidance.[1]

No permits are required for survey work for DOC staff. Access permission may be required depending on the location of the survey reach.

Minimum attributes

Consistent measurement and recording of these attributes is critical for the implementation of the method. Other attributes may be optional depending on the survey or monitoring objective. For more information refer to 'Full details of technique and best practice'.

DOC staff must complete a 'Standard inventory and monitoring project plan' (docdm-146272).

The minimum requirements for a fish survey will largely be determined by the objectives of the study or monitoring programme. Careful consideration of these objectives should be made prior to collecting data. However, for any study the following minimum attributes should be recorded:

- The name of the observers who collected the data.
- The date and time of sampling (including time set and time retrieved).
- The location of each sampling site using a GPS.
- Trap type (including physical dimensions and mesh sizes).
- Number of traps set at the site.
- Water depth at the site.
- Position of traps (i.e. surface, mid-water or benthic sets).
- All fish collected should be identified to species level. If this cannot be done in the field then a voucher sample may be collected and preserved, or a series of detailed photographs taken for further assessment by a qualified expert. A fin clip preserved in ethanol may be taken for mitochondrial analysis.
- The number of each fish species captured.

Measurement of fish length is optional depending on whether information about population structure is part of the survey objectives.

It is important to collect habitat data to describe factors that may influence catch efficiency and therefore the key underlying assumptions of the method. There are a number of guidelines and

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[1] http://www.doc.govt.nz/Documents/parks-and-recreation/places-to-visit/tongariro-taupo/wade-safely-brochure.pdf

protocols available for collecting habitat data. A set of standard national guidelines has been developed by Harding et al. (2009).[2]

Data storage

Data should be recorded on rain-proof field data sheets to ensure that they remain intact and legible. Forward copies of completed survey sheets to the survey administrator, or enter data into an appropriate spreadsheet as soon as possible. Collate, consolidate and securely store survey information as soon as possible, and preferably immediately on return from the field. The key steps here are data entry, storage and maintenance for later analysis, followed by copying and data backup for security.

Summarise the results in a spreadsheet or equivalent. Arrange data as 'column variables', i.e. arrange data from each field on the data sheet (date, time, location, net type, number caught, identity, etc.) in columns, with each row representing the occasion on which a given survey site was sampled. An example of a data entry template for fish data collected using passive netting methods is provided in Appendix B.

If data storage is designed well at the outset, it will make the job of analysis and interpretation much easier. Before storing data, check for missing information and errors, and ensure metadata are recorded.

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 website[3].

Storage tools can be either manual or electronic systems (or both, preferably). They will usually be summary sheets, other physical filing systems, or electronic spreadsheets and databases. Use appropriate file formats such as .xls, .txt, .dbf or specific analysis software formats. Copy and/or backup all data, whether electronic, data sheets, metadata or site access descriptions, preferably offline if the primary storage location is part of a networked system. Store the copy at a separate location for security purposes.

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[2] http://www.cawthron.org.nz/coastal-freshwater-resources/downloads/stream-habitat-assessment-protocols.pdf
[3] http://www.niwa.co.nz/our-services/databases/freshwater-fish-database

Analysis, interpretation and reporting

Seek statistical advice from a biometrician or suitably experienced person prior to undertaking any analysis. Statistical advice should preferably be sought during the design stage of any proposed monitoring programme.

There are several texts available to assist with the analysis of fisheries data. Murphy & Willis (1996) provides a useful introduction into most types of analyses but a more in-depth and up to date text is provided by Guy & Brown (2007).

Datasets obtained from minnow trapping can be used to provide estimates of species diversity and relative abundances. Species diversity can be easily expressed as the total number of species, or taxa richness, recorded at a site. Because minnow trap catches are biased towards small fish species, additional sampling methods capable of targeting larger species (e.g. fyke nets) should also be used when undertaking inventory surveys.

The key variable that will be used to assess relative abundances is catch per unit effort (CPUE), which provides an index of abundance rather than a measure of density. As with all passive netting methods, fishing effort is measured in terms of soak time—the time period over which traps are set. Catch per unit effort for minnow traps is usually expressed as the number of fish caught per trap per night but different time periods can be used (e.g. hours).

When calculating CPUE the catch obtained from each trap should be recorded as individual sub-samples. The mean (or median) CPUE and associated variance can then be calculated for each sampling site. CPUE data tend not to be normally distributed so care should be taken with applying parametric tests (Hubert & Fabrizio 2007). Some researchers recommend using the median rather than the mean as a measure of central tendency for CPUE data (Hubert 1996; Hubert & Fabrizio 2007).

When calculating CPUE for passive capture gear it is important to be aware that soak time is not a proportional measure of fishing effort. This is because catch efficiency is known to decline as more and more fish are caught in a trap through a process called gear saturation. For entrapment type nets, including minnow traps, escapement can also be an issue which affects capture efficiency over time. Some fish species are better at escaping than others and trap saturation can also affect rates of escapement (Portt et al. 2006; Hubert & Fabrizio 2007). This means that setting a net over 48 hours may produce a different catch rate to the same net set over two 24-hr periods. Direct comparisons of CPUE data obtained using different soak times are therefore not recommended unless the relationship between catch efficiency and soak time is well understood.

To use CPUE as an index of abundance it is assumed that there is a positive linear relationship between CPUE and density. This relationship is known to be different for different species and influenced by a wide range of factors including the diameter of the entrance and the mesh size of the trap. All of these variables can influence the ability of CPUE to reflect the relative abundance of species present at a site. It is therefore critical that minnow trap sampling be standardised by using the same sampling design, sampling gear (e.g. trap types) and deployment procedures across the

sites and time periods of interest. Traps tend to produce highly variable catch data and large numbers of trap sets are often required to detect statistically significant differences (Portt et al. 2006).

When interpreting data obtained from minnow trap catches it is necessary to consider the method-specific biases outlined in the 'Disadvantages' section. When using CPUE data as an index of relative abundance the variables that can affect the relationship between CPUE and actual fish density should always be considered. For example, care should be taken when comparing the CPUE of two species caught at a site if one of those species is known to be more susceptible than the other to capture in minnow traps. Ideally, the ability of CPUE to reflect actual fish density should be validated before reaching any firm conclusions about observed differences in CPUE. Validation would require fish density estimates to be made using mark-recapture or depletion model approaches.

Depending on the objectives of the survey it may be useful to assess population structure using any fish length data that has been collected. Length data is typically used to generate length-frequency histograms, which allow the structure of a fish population to be assessed. Length-frequency histograms can provide an insight into factors that may be affecting fish population dynamics, such as high mortality or recruitment failure (Anderson & Neumann 1996). When interpreting length-frequency histograms it is important to consider potential size biases in sampling and whether sample size is adequate. Many statisticians now recommend density plots as an alternative to histograms because the selection of length category boundaries (i.e. minimum and maximum values) can have a large influence on the appearance of histograms.

Survey results should be reported on in a timely manner to ensure that they are available for future users. Extending the time between data collection and reporting increases the potential for useful information gathered during sampling to be forgotten and lost. A description of the trap types and number of traps used should be included in the report so the survey can be replicated at a future date.

Case study A

Case study A: monitoring Northland mudfish

Synopsis

Ngāwhā Wetland is a small peat bog wetland located near Kerikeri in Northland. Ngāwhā is one of only a handful of wetlands that support Northland mudfish (*Neochanna heleios*), which has a conservation status of 'Nationally Vulnerable' (Allibone et al. 2010). The population of Northland mudfish in Ngāwhā has been monitored annually since 2000 (Macdonald 2008). In late November, 2008, a fire swept through part of Ngāwhā Wetland. The fire affected three of the annual monitoring sites and provided an opportunity to study the response of a mudfish population to the effects of fire events.

Objectives

- Undertake annual monitoring of key mudfish populations under Action 2.2 of the New Zealand Mudfish Recovery Plan 2003–2013 (DOC 2003).

- Assess the effects of the 2008 fire on mudfish populations in Ngāwhā Wetland.

Sampling design and methods

Eight monitoring sites were established in 2000 along a transect that crossed the DOC-administered portion of the wetland. Within each site 10–15 permanent trap locations were established.

Data collection

Each year a single Gee's minnow trap (3 mm) was set at each of the trap locations during the month of August. Traps were set overnight and retrieved the next day. Each trap was processed individually (as a sub-sample) and all Northland mudfish collected were counted and had their length measured.

Results

Individual CPUE recorded over the entire monitoring period between 2000 and 2011 ranged between 0 and 27 fish/trap/night. The data set was heavily skewed because of the high proportion of 0-catches (Figure 1). Site CPUE was used as the measure for comparisons because it was less skewed and allowed differences between sites and over time to be more easily identified.
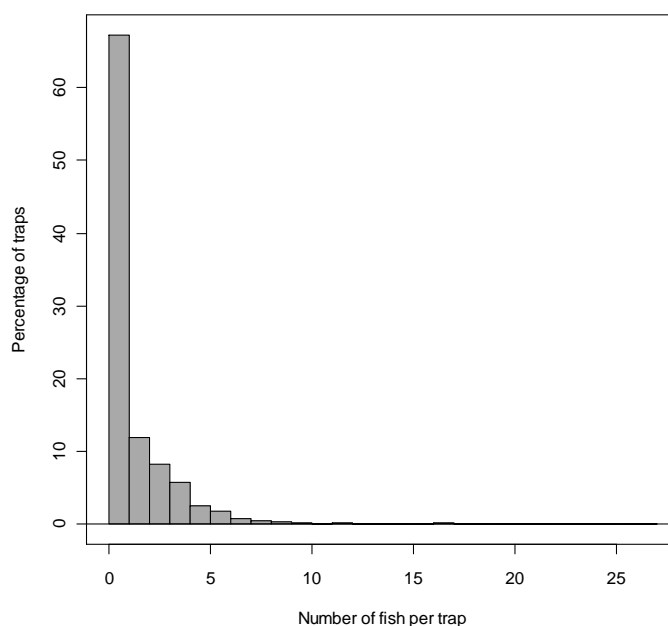

Figure 1. Frequency distribution for the number of fish caught in individual traps set in Ngāwhā Wetland between 2000 and 2012 (N = 1100).

More variation in CPUE was observed between sites than was observed between years over the period 2000 to 2011 (Figure 2). Site G has produced the greatest median CPUE of 2.95 fish/net/night and also had the greatest variation in CPUE over the monitoring period (Figure 2-A). Site D produced the lowest median CPUE of 0.20 fish/net/night between 2000 and 2011. Median CPUE for all sites over the monitoring period ranged between 0.5 and 1.9 fish/net/night (Figure 2-B).
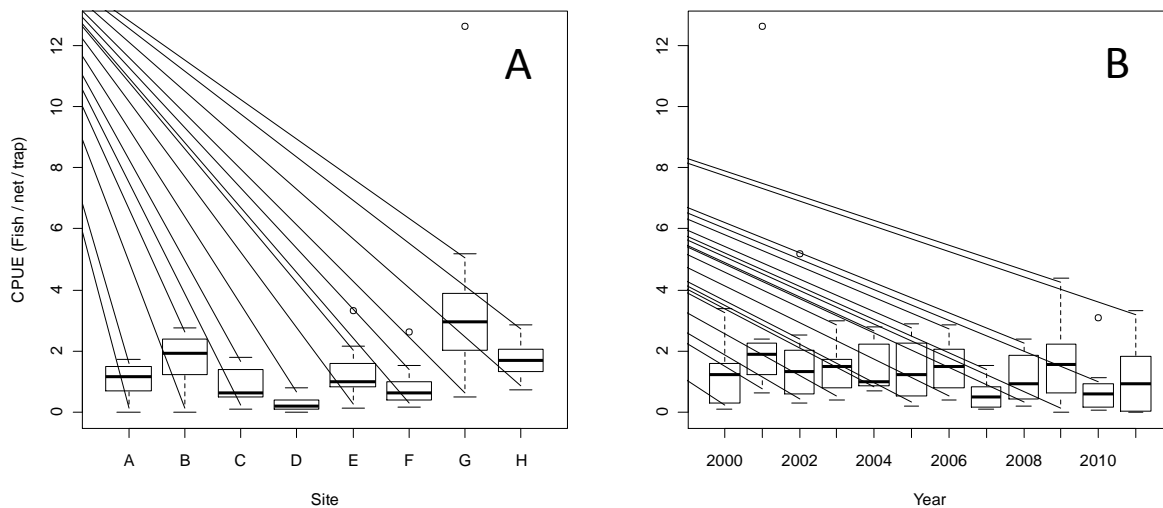

Figure 2. Catch per unit effort (CPUE) for Northland mudfish collected from eight sites at Ngāwhā Wetlands between 2000 and 2011. Plot A shows CPUE aggregated by site and Plot B shows CPUE aggregated by year.

There was a noticeable response in mudfish CPUE at two of the three sites affected by the 2008 fire. In 2009, about 9 months after the fire occurred, there was no obvious change in mudfish CPUE at either of sites A or B that could not be attributed to background variation. The CPUE for Site C in 2009, however, was lower than any recorded over the previous 9 years. A year later in 2010 the CPUE recorded at sites A and B were much lower than had previously been recorded at those sites, but CPUE at Site C had recovered. In the last monitoring episode carried out in 2011 no mudfish were found at either Site A or Site B. Mudfish CPUE recorded at Site C in 2011 remained relatively unchanged from the year before.
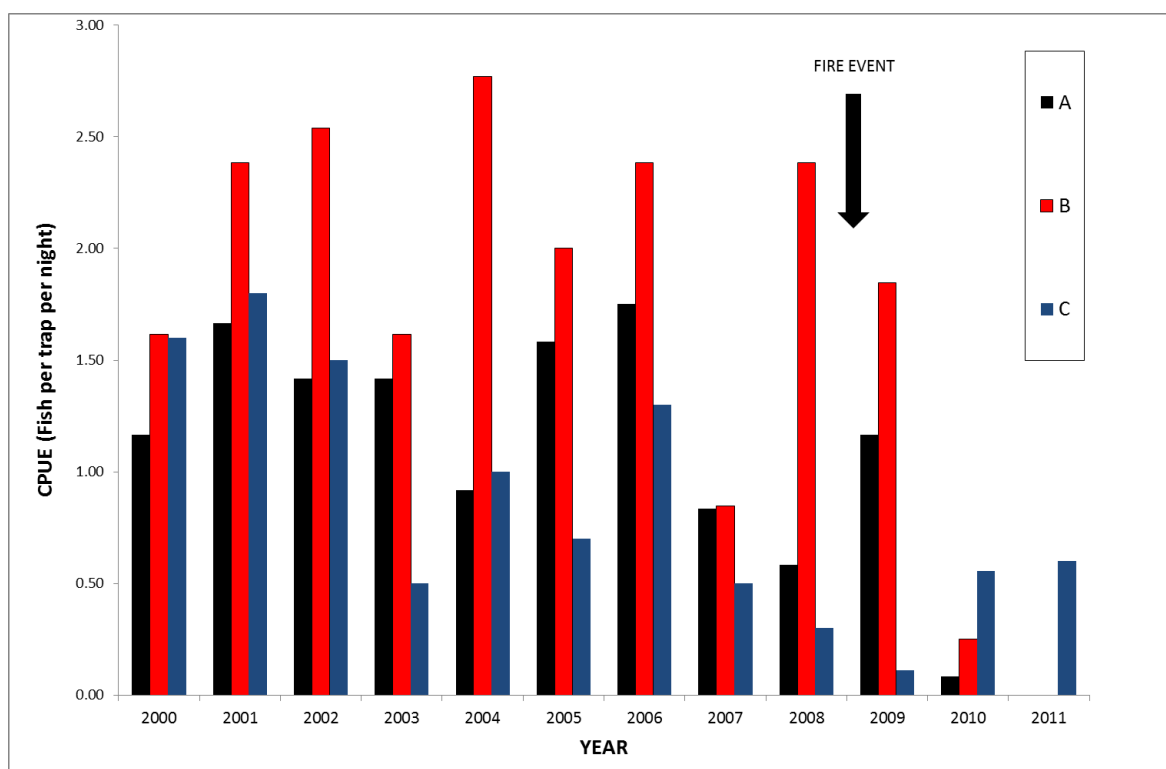
Figure 3. CPUE for monitoring sites A, B, and C, which were affected by the 2008 fire event.

Limitations and points to consider

- Individual trap catches for the Ngāwhā Wetland Northland mudfish monitoring programme are strongly skewed by 0-catches. This is a common problem with CPUE datasets for fish that occur in moderate to low densities (Hubert 1996) and can make statistical analysis difficult.

- There was a large amount of variation in CPUE between sites but overall CPUE was less variable over the 2000–2011 period. This suggests that the density of Northland mudfish in the wetland is patchy but that the population is relatively stable.

- While initially showing little response to the 2008 fire, CPUE for sites A and B had declined to zero by 2011. This is likely to be due to habitat degradation caused by the fire and two dry summers that were subsequently experienced in the wetland (Amy Macdonald, DOC, pers. comm.).

- Even though the data set collected was variable and skewed by 0-catches, the standardisation of sampling and long timeframe of sampling allowed the impacts of the fire be clearly observed. This demonstrates the usefulness of long-term datasets for detecting change in naturally variable ecosystems.

References for case study A

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DOC (Department of Conservation). 2003: New Zealand mudfish (*Neochanna* spp.) recovery plan 2003–13. Biodiversity Recovery Unit, Department of Conservation, Wellington.

Hubert, W.A. 1996: Passive capture techniques. In Murphy, B.R.; Willis, D.W. (Eds): Fisheries techniques. 2nd edition. American Fisheries Society, Bethesda, Maryland.

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Acknowledgements

Full details of technique and best practice

Minnow traps typically consist of a small cylindrical or rectangular box with inward facing funnel shaped entrances at each end (Figure 4). The shape of the entrances allow the small fish to easily enter the trap but make it more difficult for them to exit through the same hole. Whilst fish can, and do, escape these traps, the higher rate of fish entering them tends to result in a net accumulation of fish within the trap. Fish entering Gee's minnow traps sometimes scrape themselves on the steel wire entrances; some surveyors bend back the steel mesh ends and/or add silicon to reduce injury.

Gee's minnow traps are the standard type of minnow trap used for freshwater ecological studies in New Zealand (Figure 4). They are constructed out of galvanised steel and consist of two halves that are joined together using a special clip. The standard Gee's minnow trap is made from a 6 mm mesh but 3 mm mesh Gee's minnow traps are used to sample New Zealand mudfish species because they can capture smaller and more fish (Ling et al. 2009). It is recommended that 3 mm Gee's minnow traps be used for all freshwater fish surveys for this same reason.

While Gee's minnow traps appear relatively robust they will corrode out over time, particularly if set in saline or low pH habitats. The mesh is also prone to separating from the end rings—a process that will eventually cause the traps to lose their rigidity. The 3 mm mesh traps have to be imported into New Zealand which means that they are relatively expensive to procure. It is therefore important that these traps are treated carefully when being used, and cleaned and dried properly on the completion of sampling. While Gee's minnow traps are designed to be stored by stacking trap

halves one inside the other, care should be taken to ensure that they are not tightly compressed together as this makes them difficult to separate without damaging them.

Figure 4. A fine mesh Gee's minnow trap.

An alternative minnow trap design that is occasionally used in New Zealand is commonly referred to as the Kilwell bait trap (Figure 5). These traps consist of fine plastic mesh wrapped around a collapsible wire frame. As with the Gee's minnow traps, Kilwell bait traps have a funnel-shaped entrance at each end. The main advantage of the Kilwell bait traps is that they are much cheaper (less than half the price) and easier to procure than Gee's minnow traps. Killwell bait traps are also far lighter and take up less space than Gee's minnow traps, which is an advantage for back country sampling. However, the disadvantage with Kilwell bait traps is that the funnel entrances are much larger than those in Gee's minnow traps and this is likely to increase the escapement of fish and allow easier entry of predatory eels. The catch data obtained from Gee's minnow traps and Kilwell bait traps are unlikely to be comparable. The use of Kilwell bait traps is not recommended unless resources are very limited or there is a significant risk of gear theft.
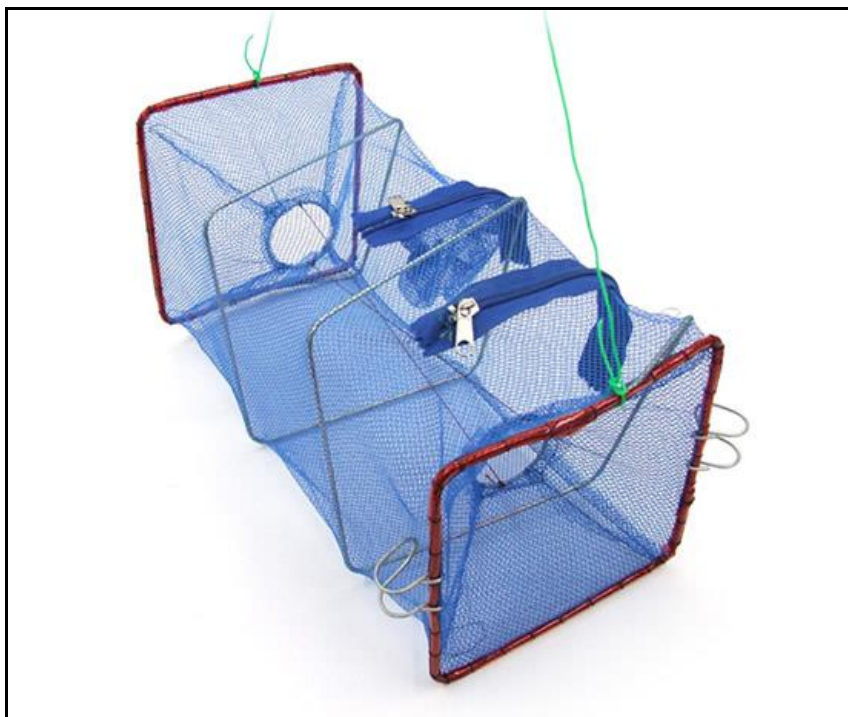
Figure 5. Kilwell bait trap.

Waterproof labels identifying that the nets are being used by DOC and providing a contact phone number should be attached to all nets. These will help prevent well-meaning people from removing nets during sampling.

Minnow trap catches can be increased by baiting; however, baiting should be avoided where possible because it can attract large numbers of predatory fish, and influence the species composition of catches. Catch variability may also be increased because the response of fish may vary with bait quality, currents and appetite at the time of sampling. Baiting of nets may also attract fish from outside of the location of interest (Balcombe & Closs 2000). If baiting is used, care should be taken to ensure that bait type and quality is standardised as much as possible.

Before undertaking any surveys using Gee's minnow traps it is important to identify the trap setting arrangement that you want to use based on the survey objectives, monitoring design and habitat being sampled. All arrangements can use either a two-dimensional scattering of traps within a specified area or a transect, where traps are set along a straight line.

There are three main types of arrangements that may be used.

1. Placing traps in locations where catches rates will be maximised, such as next to habitat structures or within likely movement pathways. This arrangement should be used for inventory-type surveys where data on species presence/absence is sought. Transects may be set across ecological gradients as a way of sampling a greater range of habitat diversity.

2. Placing traps randomly. This type of arrangement should be used where information on relative abundances is sought as it will be least affected by variations in staff proficiency and

habitat. If set along transects, these should not cross ecological gradients (e.g. hydrological gradients in wetlands) as this will increase trap catch variance.

3. Placing traps in exactly the same locations as previous surveys. This has been done for mudfish surveys where there is a concern about damage to fragile wetland habitats or where there is a desire to keep catch efficiencies as constant as possible over time. Trap locations will need to be permanently marked when using this arrangement.

For all of these arrangements, thought should also be given to whether minnow traps will be set at the surface (surface-set) or on the bottom (benthic-set). The depth at which traps are set can have a large influence on the catch rates observed for different species. Black mudfish catch rates, for example, are greatest when traps are set at the surface (McDonald 2006).

The recommended steps for deploying minnow traps are as follows:

1. Assemble the traps and attach the anchor ropes.

2. Place the minnow traps around the sampling site according to the trap setting arrangement selected prior to undertaking the surveys. A minimum of ten traps should be deployed at each site unless habitat is limiting. Have a minimum trap spacing of at least 3 metres to maintain a level of sample independence.

3. Ensure that traps are placed in water that is at least deep enough to cover the trap entrances. It is usually possible to bury minnow traps into the substrate to achieve this in very shallow habitats. In low-oxygen habitats (e.g. wetlands and macrophyte-dominated streams), ensure that traps are set with an air gap at the top.

4. Attach the anchor ropes to a stake, anchor weight, peg or stout marginal vegetation if available. Mark the locations of traps using flagging tape unless they are clearly visible or there is a significant theft risk. Any lost traps will continue to fish until they eventually break down and will therefore potentially result in the death of large numbers of fish.

5. Leave the traps in place over the duration of the required sampling period. Capture rates will be maximised by setting traps overnight to include both the dusk and dawn periods when fish movement is greatest. Setting traps for longer will not necessarily increase catch rates due to gear saturation, predation and escapement effects but may increase injury and mortality rates.

6. Retrieve the traps and process the catch by recording the number of species and any other variables of interest (e.g. length) separately for each trap. Recording these data separately allows more flexibility at the data analysis stage.

7. Measure and record all of the habitat parameters that are relevant to the survey. The minimum parameters that should be recorded are outlined in 'Minimum attributes'. Recommended parameters are outlined in more detail in the sections below.

8. Double-check that all traps have been retrieved.

9. Decontaminate all sampling gear to prevent the spread of pest species. Useful guidance can be found in 'Freshwater fishing net decontamination protocol' (docdm-428359), 'Review of weed transfer risk associated with mudfish sampling and mitigation strategies' (docdm-645392), and on the Ministry for Primary Industries website[4].

Considerations when setting minnow traps in lakes:

*   If traps are being set off-shore then long anchor ropes and large visible floats will need to be used. One option may be to attach individual traps at intervals along a single rope; however, this is not recommended for uneven lake beds with many potential snags.

*   Water depth and distance from shore will be the two key ecological gradients to consider when selecting sampling sites and transect orientation.

*   Habitat variables that should be recorded in conjunction with minnow trap catches include:
    *   Water depth
    *   Water temperature
    *   Dissolved oxygen concentrations (preferably at surface and 1 m off bottom)
    *   Habitat description including presence of any macrophytes or other structure and type of substrate nets were set on

Considerations when setting minnow traps in rivers and streams:

*   Standardised protocols for sampling using a combination of Gee's minnow traps and fyke nets are currently being developed for New Zealand wadeable streams (Joy et al. 2013). It is recommended that these protocols be adopted for any future stream surveys carried out by DOC staff. The advantage of using standardised protocols is that they will provide data that can be more directly compared regionally and nationally. This in turn allows the development of large, long-term datasets with a much greater ability to detect patterns against the high background variability normally associated with fisheries data (Bonar et al. 2009). Finally, standardisation encourages data sharing between organisations and creates synergies between different monitoring programmes (Bonar et al. 2009).

*   It can be difficult to effectively set minnow traps in high-velocity habitats because of issues around securing them in place and deformation of the traps (Portt et al. 2006). Traps will therefore need to be set in slow to medium velocities and this will need to be considered when interpreting catch data.

*   National protocols for assessing habitat in wadeable streams have been developed by Harding et al. (2009) and most regional councils will have appropriate standardised methods that could be adopted. Note that many of these methods won't be applicable to large non-wadeable streams and rivers. Habitat variables that should be recorded as part of minnow trap surveys in rivers and streams are:
    *   Temperature, dissolved oxygen and pH (including time of day measurement was made)
    *   Average stream width and depth
    *   Substrate composition

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[4] http://www.biosecurity.govt.nz/pests/didymo/cleaning

- − Meso-habitat composition
- − Riparian cover and condition.
- − Aquatic macrophyte cover (a useful method has been developed by Collier et al. 2006).
- − Qualitative habitat assessments (e.g. P1 and P2d field sheets from Harding et al. 2009).

Considerations when setting minnow traps in wetlands:

- Minnow traps have been used extensively for sampling New Zealand mudfish species in wetland habitats. Specific protocols for the survey and monitoring of New Zealand mudfish have already been developed by Ling et al. (2009) and should be adopted by DOC staff for use in wetland fish surveys for these species (see 'A revised methodology to survey and monitor New Zealand mudfish'—docdm-1203418).
- Habitat variables that should be recorded in conjunction with minnow trap catches include:
  - − Water depth
  - − Water temperature
  - − pH
  - − Dissolved oxygen concentrations (preferably at surface and 1 m off bottom)
  - − Habitat description including presence of any macrophytes or other structure and type of substrate nets were set on

References and further reading

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Appendix A

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

docdm-346005	Boat competency SOP
docdm-997948	Freshwater fish: passive nets—fyke nets
docdm-428359	Freshwater fishing net decontamination protocol
docdm-870579	A guideline to monitoring populations
docdm-1008026	Introduction to monitoring freshwater fish
docdm-756153	Protocols for pest fish inventory and monitoring best practice guidance
docdm-645392	Review of weed transfer risk associated with mudfish sampling and mitigation strategies
docdm-1203418	A revised methodology to survey and monitor New Zealand mudfish
docdm-146272	Standard inventory and monitoring project plan
olddm-566603	Wading safely

Appendix B

Data entry template for passive netting methods

This is an example of how to enter fish data collected using passive netting methods. This data entry template uses a 'long format' where individual records are entered in rows and variables are entered in columns. While this format can be more time consuming than other formats when entering data, it will save a lot of time and effort when it comes to data analysis. Multiple analyses can be quickly carried out using this one dataset thereby avoiding the need to re-enter the same data. This dataset format can be readily manipulated and summarised using filter, sort and pivot table tools found in Microsoft Excel. Most statistical software packages require that data be entered in 'long format'.

Net type	Net number	Species	Length (mm)	Number of fish	Comment
Type of net or trap used	Number assigned to each net/trap of a given type	Fish species caught. Important to record 'No fish' where none were caught in a net/trap.	Length measured for individual fish	Number of fish in this record. Note that this will always be 1 when the fish is measured.	Any comments regarding record (e.g. any injury or disease observed in fish)
Fyke net	1	*Anguilla australis*	600	1	
Fyke net	1	*Anguilla australis*	600	1	
Fyke net	1	*Anguilla australis*	570	1	
Fyke net	1	*Anguilla australis*	404	1	
Fyke net	1	*Anguilla australis*	506	1	
Fyke net	1	*Anguilla australis*	506	1	
Fyke net	1	*Anguilla australis*	606	1	
Fyke net	1	*Anguilla dieffenbachii*	407	1	
Fyke net	2	*Anguilla australis*	502	1	
Fyke net	2	*Anguilla australis*	505	1	
Fyke net	2	*Anguilla australis*	500	1	
Gee's minnow trap	1	*Galaxias maculatus*	76	1	partially eaten
Gee's minnow trap	2	*Galaxias maculatus*	68	1	partially eaten
Gee's minnow trap	2	*Galaxias maculatus*	67	1	partially eaten
Gee's minnow trap	2	*Galaxias maculatus*	88	1	
Gee's minnow trap	2	*Galaxias maculatus*	79	1	
Gee's minnow trap	2	*Galaxias maculatus*	92	1	
Gee's minnow trap	2	*Galaxias maculatus*	76	1	
Gee's minnow trap	2	*Galaxias maculatus*	74	1	
Gee's minnow trap	2	*Galaxias maculatus*	79	1	
Gee's minnow trap	2	*Galaxias maculatus*	88	1	
Gee's minnow trap	2	*Galaxias maculatus*	63	1	
Gee's minnow trap	2	*Galaxias maculatus*	69	1	
Gee's minnow trap	2	*Gobiomorphus basalis*	60	1	gravid female
Gee's minnow trap	3	*Galaxias maculatus*		14	
Gee's minnow trap	4	No fish			
Gee's minnow trap	5	No fish			