Procedural Guideline No. 4-3 Sampling benthic and demersal fish populations on sediments

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Background

Sedimentary habitats range from those in high energy, frequently shallow, environments with a coarse substratum to low energy, enclosed and sometimes brackish areas of fine mud. The dominant benthic and demersal fish species in these diverse habitats differ markedly, as do successful strategies for sampling them. In deeper water, some species such as *Lesueurigobius friesii* and *Cepola rubescens* live in burrows but most species live on the sediment surface.

On medium to coarse substrata the dominant benthic fish species in shallow water are the plaice (*Pleuronectes platessa* L.), sand goby (*Pomatoschistus minutus* (Pallas)) and the dab (*Limanda limanda* (L.)). On muddier substrata flounder (*Pleuronectes flesus* L.) and sole (*Solea solea* (L.)) may predominate

Purpose

To provide as accurate an estimate as possible of the abundance, species richness and age structure of benthic and demersal fishes on shallow water sediments.

Applicable to the following attributes

Sampling fish populations will be appropriate for attributes concerning biotope quality in terms of species richness and the abundance of species and for detecting whether areas of impact away from point sources are expanding or contracting. Generic attributes are:

- Measure the species richness in the biotope and/or abundance of key species (rare, fragile, declining, representative) in biotopes.
- Measure the quantity of particular species of conservation importance (rare, fragile, declining species – those for which the site is 'special').

Also applicable to the following baseline survey objectives:

- Establish/re-establish the species which are present in biotopes at a site including their abundance and biomass within statistical limits.
- Establish the species present in biotopes and their density within defined statistical limits.
- Establish/re-establish the species which are present along a gradient of change away from a point source of disturbance including their abundance and biomass within statistical limits.

Methods

Beach seining

Seine nets consist of a wall of netting weighted at the bottom and provided with floats at the top. They can vary in length from over 100m to less than 10m. The mesh size usually decreases from the wings

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towards the centre which is sometimes extended into a bag to assist retention of the fish. Efficiency has been shown to vary with species, fish behaviour, fish size and the bottom type (Gibson 1999). Seines perform optimally in areas with flat, smooth substrata containing no obstacles. Beach seines are less efficient at sampling benthic species than beam trawls but are preferable where only a localised area is free of obstructions and where a beam trawl could not easily operate. Samples are best taken at low tide because at this time tidal migrants are concentrated at lower levels on the beach and the net will also sample those species that do not migrate intertidally.

Equipment

- seine net (Bridport Gundry, Bridport, Dorset)
- boat
- board for carrying and shooting the net
- measuring board/scales
- plastic buckets
- protective clothing (rubber gloves, waders, oilskins, etc.)

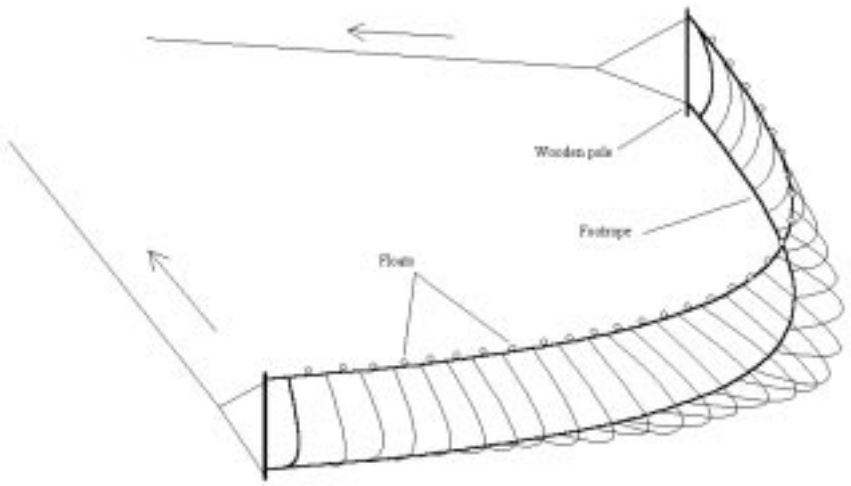

Figure 1 Seine net during hauling

Personnel

At least two staff depending on net size and deployment method.

Technique

Attach one length of rope to a weighted wooden pole attached to each end of the seine net and fold the net neatly on to a flat board. Secure one end of the rope (normally held by an assistant) to the shore and place the board and net in the bows if using a powered boat or in the stern if using a rowing boat. Ensure the net will run out smoothly from the boat. Propel the boat away from the shore paying out the rope behind it. When the length of rope has been paid out, turn the boat parallel to the shore and deploy one end of the net. Moving slowly parallel to the shore deploy the rest of the net. Once the full length of the net is deployed turn 90 degrees and return to the shore trailing the other length of rope. The net and rope should delineate a rectangle (see Figure 1). If no boat is available the net is deployed by hand by wading out to a suitable depth and deploying the net from a board or large bin. Once it is set, slowly pull the ropes in and recover the net, the midpoint of which will be last to be drawn ashore and will contain most of the captured fish. During hauling the people pulling on the ropes should move gradually towards one another, slowly closing the net. It is essential that the weighted footrope stays on the bottom at all times and precedes or stays level with the head rope during hauling. Once the net begins to come ashore, and assuming four people are available, two should keep the footrope close to the ground whilst the others pull the headrope. If only two people are available and to ensure the footrope stays close to the bottom the net should be pulled up the beach until it is completely out of the water. The length of rope and the net length determine the area swept. The area covered by a beach seine net can be calculated by following the procedure given by Kubecka and Bohm (1991) and Ross *et al.* (1987) which, together with estimates of efficiency (Kjelson and Colby 1976; Pierce *et al.* 1990; Ross *et al.* 1987; Weinstein and Davis 1980) can be used in the calculation of absolute fish densities.

Cost and time
A 40m beach seine costs about £200 excluding ropes for hauling. The time required for one haul depends on the size of the net and the presence of weed fragments or obstructions on the bottom and the speed of any currents. As a rough guide, a net of 40m can deployed and recovered within 15 minutes.

Advantages

- easy to operate
- cost effective

Disadvantages

- efficiency depends on species and size
- difficult to deploy in rough conditions or where currents are strong
- ineffective if weed and boulders are present

Beam trawling/push netting
The beam trawl is the standard gear for sampling benthic and demersal fish on coarse substrata. The beam trawl consists of a net bag mounted between two 'runners' which are pulled across the sediment like a sledge. A wooden or metal beam connects the runners and forms a strong frame for the attachment of the top of the net. To improve efficiency for certain species one or more lengths of chain can be stretched between the runners positioned c. 15cm in front of the footrope. The chain disturbs the sediment and helps to lift the fish from the bottom where they can be gathered by the net. Commonly, the width of beam trawls used in fish surveys is c.a 2m (Kuipers *et al*. 1992; Rogers and Lockwood 1989). Small trawls can be pulled by hand in shallow water or, more commonly, towed by a boat. A push net (Potts and Reay 1987; Rogers and Millner 1996) is of a similar design to a beam trawl except it is smaller, lighter and pushed from behind by one person. Its design and construction is described by Holme (1971). As a consequence of the short trawl hauls associated with scientific sampling, fish caught are usually undamaged and in good condition, particularly if the net is emptied into a container of water.

Equipment

- boat (dory type with 15–20 hp outboard)
- beam trawl (Netherlands Institute for Sea Research, PO Box 59, 1790 AB Den Burg Texel, The Netherlands; or Frithvale Ltd, Marine Sales, Battery Green Road, Lowestoft NR32 1DE)
- push net (aluminium frames manufactured by Lyte Ladders Ltd, Ballihane Industrial Estate, Ballasalla, Isle of Man)
- measuring boards
- buckets
- protective clothing (gloves, oilskins, etc.)
- deep tray or large bowl for sorting the catch

Personnel
Two or three people depending on the trawl size and subsequent sorting required.

Technique
With the boat slowly underway and under the direction of the boat skipper, the trawl should be lowered to the bottom ensuring the net is streaming cleanly behind the boat. The tow rope should be c. 5 times the water depth and the trawling speed should be 30–35m/min^{-1} (Riley and Corlett, 1966) with trawls lasting c. 5–10 minutes. If possible the boat should slowly continue in motion while the net is being hauled. Bottom obstructions should be avoided and, where assessing change in fish populations over time and when practical, the same area should be trawled during each sampling. Even with experienced operators, towing for the same distance on replicate trawls is difficult and it is recommended that the distance is judged using appropriate marks on the shore or towing between two pre-positioned buoys.

Cost and time

Two-metre beam trawls and push nets cost in the region of £200. Shooting and hauling the net will take aproximately 15 minutes for short hauls. Sorting the catch varies according to the amount of weed and debris present and may take up to 30 minutes.

Advantages

- efficiencies for some species have been calculated (Kuipers *et al*. 1992; Rogers and Lockwood 1989; Wennhage *et al*. 1997)
- easy and inexpensive to operate
- fish caught can usually be returned alive if tows are short

Disadvantages

- beam trawls require a reasonably powerful and suitably equipped survey vessel (inflatables are not recommended as they do not have sufficient 'grip' on the water)
- may cause, or be perceived as causing, damage to the substratum (may not be suitable for sampling on maerl, for example)

Drop trapping

Drop traps are essentially bottomless boxes that are dropped onto the seabed to enclose a known area. They are suitable for repetitive sampling of small fishes in shallow water.

Equipment

- drop trap of known area
- strong long-handled hand nets
- containers for holding the catch
- measuring board
- notebook and pencil

Personnel

Two people are required, although if many samples are to be taken more than two will make sampling less tiring.

Technique

The trap (usually $1m^2$) is attached to a long pole and raised above the water surface. It is then dropped onto the seabed and the enclosed animals are netted out using the hand nets. Hand netting is continued until no more individuals are caught on three successive sweeps. The technique is fully described by Pihl and Rosenberg (1982) and Wennhage *et al.* (1997).

Cost and time

The drop traps are made from sheet aluminium which costs approximately £25 per square metre from sheet metal suppliers. It is recommended that if this technique is to be used, specially made hand nets are constructed from thick wire and strong wood as they are subject to considerable strain and wear in use. Operating the trap takes only a few minutes per drop. Sampling the contents can take up to 10–15 minutes per sample.

Advantages

- unselective and very efficient (>90%).

Disadvantages

- unwieldy to transport
- tiring if many samples are to be taken
- only suitable for use in shallow water (<1m)
- can only be used on clean sediment, as stones prevent the trap penetrating the sediment

Fyke netting

Fyke nets consist of one or more leader nets which direct fish into a conical-shaped net funnel held open by metal rings. The conical net comprises a series of interconnecting nets with one-way entry doors which trap the fish (Van der Veer *et al.* 1992) (see Figure 2). Although they can be used singly, fyke nets are usually sold in pairs. Fleets of fyke nets can be joined together into a line and used to sample a much larger area. In some circumstances it may be desirable to distinguish fish that have encountered the leader net from different directions; the net described by Baelde (1990) could easily be modified to produce information on fish direction. To prevent otters entering the net and drowning, otter boards should be attached. Fyke nets are not suitable for use in areas of strong currents. Where the net is likely to be exposed to moderate currents it should be very firmly attached to metal stakes hammered into the substratum (where possible) or heavily weighted. Currents are likely to interfere with the performance of the leader net (by pushing it over) and may cause the net funnel to roll over the substratum. Fyke nets can be used for short periods, and where strong tidal currents are likely the nets should be used during slack water.

Equipment required

- fyke net (Collins Nets, Bridport, Dorset) and otter boards
- boat
- shot weight (at least 10kg per pair of fyke nets)
- protective clothing (gloves, oilskins, etc.)

Personnel

At least two staff (plus a boat skipper)

Technique

Sew the otter boards into the mouth of the net funnel as directed by the manufacturer. Attach the shot weight to the closed end of one of the nets and then lower it to the bottom using the net (there is no need to attach an additional length of rope). When the weight reaches the bottom the rest of the fleet can be paid out as the boat slowly reverses. Most fish in the rocky subtidal move parallel to the shore, and therefore the net should be orientated perpendicular to the shore. It is useful to survey the site visually, prior to deploying the fleet, to check for obstacles. Areas with large boulders, very steep slopes/cliffs and detritus which could become entangled in the net should be avoided. If deploying the net on a steeply sloping substratum attach an extra long shot line and use a larger buoy. This layout reduces the chances of losing the net if it is deployed slightly off site and its weight pulls the marker buoy under the water. Recovery is achieved by lifting the buoyed rope and fish can be removed easily by untying the ends of the net.

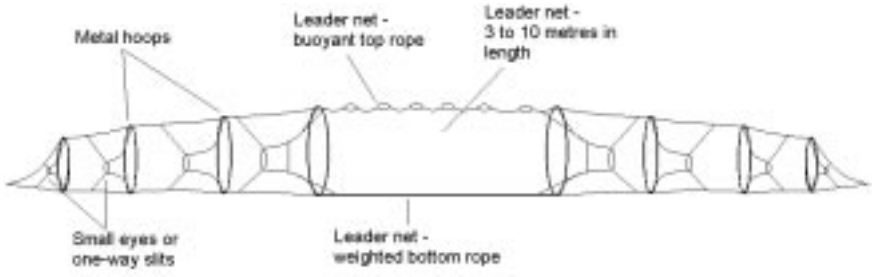

Figure 2. Fyke net

If the net is to be deployed intertidally stake out the net during low tide and ensure the leader nets are not tangled.

Cost and time

Boat deployment and recovery takes around 5 minutes per net pair. Removing the fish takes c. 10 minutes. Fishing time depends on the survey objectives but fyke nets are commonly left in position for one day or one tidal cycle (Treasurer 1996). The net should be checked at every low tide or, if sited sublittorally, every tidal cycle. This is necessary to check for damage and to remove detritus and any trapped fish. Fyke nets cost £50–£300 depending on size (Collins Nets, telephone 013808 427352).

Advantages

- cost-effective
- easy to use
- non-destructive

Disadvantages

- restricted depth range (c. 15m maximum)
- sub-tidal deployment requires a boat
- the catch represents an unknown proportion of the actual population; the catching power of the net is unknown for most species and may vary with season and other factors (Darwall *et al.* 1992)
- cannot be successfully used in areas with moderate to strong currents

Accuracy testing

Where appropriate, methods of assessing sampling accuracy are either outlined or referenced in the description of methods given above.

QA/QC

High natural variability and the problems of capture efficiency mean that standardisation of the techniques used to assess a fish population is essential if other sources of variation are to be minimised. Apparent changes in abundance may simply be caused by a change in catchability (Beja 1995; Costello *et al.* 1995; Sayer *et al.* 1994; Sayer *et al.* 1996) or by movements into or out of the sampling area (Allen *et al.* 1992; Claridge *et al.* 1986; Gibson *et al.* 1993; Ross *et al.* 1987). It is, therefore, difficult to link cause and effect unless extensive background data on the behaviour of the fish species of interest are available or intensive surveys with control sites and sufficient replication can be carried out (Barber *et al.* 1995). The techniques described in this section are well suited to detect inter-annual changes because direct comparisons between years are valid when all other factors associated with sampling are standardised. To reduce experimental error and to make the survey as easy and meaningful as possible the following are recommended:

- Choose well-researched common species and familiarise the survey team with the chosen species' behaviour and ecology.
- Utilise survey methods that are simple, that can be undertaken routinely and where access to the sampling site is easy and reliable.
- Standardise the date and time when the survey is carried out. When annual trends are being investigated carry out the survey as nearly as possible on the same date. More importantly, surveys must be undertaken at the same state of the tide (low tide is preferable) and equivalent point in the diel cycle rather than at a specific time. Dusk, for example, may be at 16.00 in winter but 21.00 in summer. Diving surveys are best undertaken during neap tides because tidal currents are weaker and their influence on fish behaviour is therefore reduced .
- Practise the survey technique (new staff should be trained on 'dummy' sites). Identification skills can be tested using photographs or preserved specimens and, if estimating size visually, using fish models of known length.
- Use, wherever possible, the same survey teams. This is particularly important when conducting visual surveys and manual searches which involve considerable skill.
- Maintain skill continuity during personnel changes by training all members of the survey team in every aspect of the survey technique.
- If spurious results are suspected be prepared to check the fishing gear (if relevant) and possibly repeat the survey. Repeat surveys on successive days to get an indication of day-to-day variability and incorporate these data in any statistical analysis.
- Expect large variation in fish abundance. Where assessing inter-annual variability a minimum of three years data is required.

Data analysis and products

Survey work will normally generate data on species, abundance and size. Analysis will depend on the experimental protocol and should be analysed using standard statistical techniques (Sokal and Rohlf 1995). Fish populations show high inter-annual variability and this must be considered before drawing conclusions regarding cause and effect. Prior to the survey, and depending on the survey objectives, it is advisable to measure the variability of the factors of interest. Carrying out surveys on successive days gives an indication of the reliability of the survey data and these data can be used to predict the number of surveys that will be required to show significant changes (Chapter 9 in Sokal and Rohlf 1995). Comparisons of abundance between species should always take into account their differing catchabilities. If the results of the survey show significant changes in fish abundance and population structure, these changes may be due entirely to natural causes (Henderson and Seaby 1994; Rogers and Millner 1996). Where significant fish population changes have been shown and a cause postulated, it is recommended that additional tests be carried out the nature of which will depend on the postulated cause. Where pollution is suspected as a significant factor the relevant authorities should be contacted (Environment Agency (England and Wales) or the Scottish Environment Protection Agency).

Health and safety

The primary rule in any fieldwork is 'Never Work Alone'. When working in areas covered in seaweed care should be taken to avoid slipping. Unusually large waves can catch the unwary when working near the tide line; waders can become swamped, making escape very difficult and increasing the chance of an accident.

Members of staff employed to undertake diving survey work must be suitably qualified and obey the rules and regulations as stipulated by the Health and Safety at Work Regulations (Dean *et al.* 1997). In addition, appropriate codes of field work conduct appropriate to your organisation must be followed. Note that where employing external diving contractors to undertake diving work your organisation will have considerable responsibilities as the diving contractor.

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