Procedural Guideline No. 4-4 Sampling fish in rockpools

Thomas A. Wilding, Robin N. Gibson and Martin D.J. Sayer,
Dunstaffnage Marine Laboratory[1]

Background

Rockpools make convenient sampling units for assessing intertidal fish populations and several sampling techniques are available, all with attendant advantages and disadvantages. The most accurate methods are intrusive and involve the application of anaesthetics, whilst techniques such as visual assessment have negligible affects on the pool but lack accuracy. Mark-recapture techniques have also been used but they are not considered applicable for SAC surveys for reasons discussed below. As with all fish sampling, the strategy chosen for sampling rock pools should reflect the objectives of the survey.

The commonest fish found in UK rock pools are rock goby (*Gobius paganellus* (L.)), shanny (*Lipophrys pholis* (L.)), butterfish (*Pholis gunnellus* (L.)) and sea scorpion (*Taurulus bubalis* (Euphrasen)). Corkwing (*Crenilabrus melops* (L.)) juveniles and fifteen-spined sticklebacks (*Spinachia spinachia* (L.)) may also be common in weedy pools.

Purpose

To provide as accurate an estimate as possible of the abundance, species richness and age structure of intertidal fishes in rock pools

Applicable to the following attributes

Sampling to collect the cryptofauna of turfs will be appropriate to assessing quality in terms of species richness and the abundance of species. 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.

Also applicable to the following baseline survey objectives:

- Establish/re-establish the species present in the biotopes at a site, including their abundance.
- Establish/re-establish the species present in biotopes at a site, including their density within statistical limits.

Methods

Selection of pools for sampling

Rock pools as near to the low water mark as possible, and preferably those only exposed during spring tides, should be selected to maximise the range of species that can potentially be caught. Pool selection will depend on availability, accessibility and the estimated time the sampling will take, since sampling must be completed before the tide returns. Low pressure and onshore winds can significantly reduce the ebb tide and this factor should be considered when selecting pools. Do not select, for example, those at the bottom of the spring tide range, as under certain weather conditions they will remain covered even during spring tides.

1 P.O. Box 3, Oban, Argyll, Scotland PA34 4AD.

To reduce variability between pools those that are similar in terms of area, depth and shore level should be sampled whenever practicable. Whether the same rock pools are visited repeatedly depends on practical considerations including the frequency of sampling. In areas with relatively few convenient pools there may be no alternative to sampling the same pool. During a period of frequent sampling the sampling process is likely to affect the fish assemblage adversely. This factor should be considered when designing the sampling strategy. In general, rock pool, especially exposed pool, fish assemblages recover quickly (within weeks) from disturbance. However, the number of times the same rock pool can be sampled per unit time without affecting the survey results has not been determined experimentally and repeat sampling should be undertaken with this consideration in mind.

If sampling the same pools is the chosen strategy it is advisable to mark the pools to facilitate return visits. The nature of the marker depends on the exposure of the location and the intended length of the survey. In exposed locations where sampling will cover several years a stout metal post should be hammered into a suitable crevice. This post can be then be labelled to identify the pool. The post should not attract undue attention to the pool or pose a hazard to members of the public.

Estimating pool volume

Rough estimates can be made by making approximate length, width and depth measurements. A simple measuring stick can be dipped into representative parts of the pool to estimate mean depth. A more accurate method is to disperse a non-toxic dye within the pool and remove a small sample. The concentration of dye in the sample can be measured photometrically and used to calculate the pool volume (Green 1971; Pfister 1995). Other methods are outlined by Gibson (1999).

Sampling by anaesthetisation

Rock pools offer an ideal environment for the anaesthetisation of the fish they contain because flushing is often negligible during low tide and a fairly accurate estimate of the pool volume can be made. With careful use (correct concentration), and in conjunction with hand searching and netting, anaesthetics can be used to catch 80–90% or more of the rock pool fish (Gibson 1967); sampling is therefore much more accurate than many alternative techniques.

Equipment

- quinaldine (2-methylquinoline (90–95%, Sigma); solution diluted 1 part quinaldine to 4 parts acetone or ethanol (by volume): methylated spirits could be substituted for ethanol
- fine mesh (knotless) 10–15cm hand-net
- ruler/measuring board, scales
- protective clothing (rubber gloves, waders/boots, oilskins)
- plastic dispenser bottle and buckets
- notebook and pencil

Personnel

At least one person experienced in the use of quinaldine. Other staff as required to collect, identify, measure and record the fish.

Technique

Move any overhanging weed in the rock pool to the sides of the pool to assist in the uniform dispersion of the quinaldine and the recovery of anaesthetised fish. Using estimates of rock pool volume, add quinaldine to give a final concentration of ~5–10 p.p.m. (equivalent of 25–50ml quinaldine solution per cubic metre of sea water). Quinaldine can be administered using a flexible polythene bottle (washing-up liquid or similar) with ~30cm of flexible tubing attached. The tubing can be directed under stones and into cracks and crevices. After application to any one area in the pool the water should be agitated to assist in dispersion in the immediate vicinity and to prevent the quinaldine floating to the surface. The total volume of quinaldine should be administered in this way or, where applicable, be added to water flowing into the rock pool. After addition of the quinaldine the whole pool should be thoroughly mixed (Gibson 1967). Pools lowest on the shore should be sampled first to minimise the time the fish are exposed to the anaesthetic before the pools are flushed by the incoming tide.

Fish will appear from their hiding places within 1–10 minutes after application of the quinaldine, depending on species. The pool should be searched by feeling by hand around weedy areas, under stones and in crevices. Affected fish should be carefully collected using a fine hand net and then transferred to buckets of clean sea water for recovery (in hot weather the buckets should be kept cool) or to treated water taken from the pool if continued anaesthesia is required. Any measurements should be done on anaesthetised fish. If further laboratory analysis is required fish can be preserved in alcohol or formalin. Alternatively, fish should be returned to the same pool.

Cost and time

Quinaldine currently (March 2000) costs £26.60 for 0.5 litre and is available from Sigma.
Pool location and tides will dictate the amount of time available to carry out the work. As a rough guide, a pool of 2m x 1m x 0.5m would normally take approximately 15–30 minutes to sample. Reducing pool volume (by bailing) may reduce the time required to carry out the work.

Advantages

- high accuracy (most fish will be collected this way)
- fish returned to clean water recover quickly and, provided the appropriate concentrations are used, mortality is negligible

Disadvantages

- quinaldine is an unpleasant compound with which to work (see 'Health and safety' section)
- possibly an unacceptable technique on SAC sites
- unknown effects on other pool occupants (e.g. Crustacea)

Sampling by bailing/hand netting

This technique is particularly applicable to pools that have a low rugosity and/or minimal weed cover or where the use of anaesthetics would be unacceptable. These techniques may also be preferable where an absolute measurement of fish number is not required and where it can be assumed that catchability is similar between years. It is not acceptable when comparing fish numbers between seasons as changes in fish behaviour rather than abundance may result in differing catches. Hand netting without anaesthetics is likely to be subject to higher investigator variance and this will make comparisons between surveys carried out by different teams less reliable. Bailing can be used to reduce the volume of water in a rockpool and thereby reduce sampling time. Bailing can be done with buckets or, if faced with a larger volume, a pump powered by a small petrol engine can be used.

Equipment

- fine-mesh (knotless) 10–15cm hand-nets available from pet shops
- ruler/ measuring board
- buckets/pump and hose
- notebook and pencil

Personnel

At least two, of whom one must be experienced in the capture technique.

Technique

The net should be worked around the base of weed and into cracks and crevices. Two people, both using nets, are likely to be more effective in catching highly motile species. Where appropriate, stones and boulders can be turned to reveal fish concealed beneath, but these must be replaced to minimise damage.

Cost and time

Minimal cost unless a pump is used. Pumps can be hired from tool hirers. Time required is dependent on the survey objectives, experimental design and rock pool location. A rough guide for a 2m x 1m x 0.5m pool is 15–20 minutes.

Advantages

- low cost, easy to carry out
- no requirement for chemicals

Disadvantages

- low catch efficiency, especially in cracks, crevices and dense weed cover
- comparisons between individuals/teams can be unreliable
- stone and boulder turning can damage the environment

Sampling by visual assessment

Simple visual assessment has the advantage over all other methods in that it is non-invasive and has no impact on the pool. If the sampling objective requires only an overview of fish numbers then this technique may be acceptable. Previous research (Christensen and Winterbottom 1981) has shown that cryptic species and those inhabiting crevices were underestimated during visual surveys of rock pools (0–86% were counted). Correction factors should be calculated for every species and those that are rarely observed excluded. The correction factor will differ between observers and its calculation will require the removal and counting of all individuals from a pool using anaesthetics. In the UK, rock pools tend to be dominated by cryptic species and therefore visual assessment is only recommended where all other techniques are unacceptable. The topic has been reviewed by Gibson (1999).

Equipment

Notebook and pencil.

Personnel

Individuals familiar with the species likely to be encountered in the locality.

Technique

Visual assessment involves careful approach to a pool and choosing an inconspicuous viewpoint. The observer should then remain still until fish emerge from their hiding places when they can be identified and counted. Additions of small quantities of bait (crushed mussels or sea urchins) can reveal the presence of previously undetected individuals.

Cost and time

Minimal cost. Time required is dependent on the size and number of pools sampled.

- Advantages
- no effect on the fish or their environment
- suitable for frequent repeat sampling
- Disadvantages
- absolute abundance estimates are not possible
- observation is difficult when the surface of the pool is disturbed by windy weather

Sampling by mark and recapture

This technique involves the marking and subsequent release of individual fish. After a given time the release area is fished again. The number of marked fish recaptured can be used to give an indication of fish population size (Pfister 1996) but has more commonly been used to determine fish movement and refuge fidelity (Moring 1976; Koop and Gibson 1991). The problems caused by the potential movement of marked fish, the relatively short life span of some rockpool species (making interpretation of data more difficult) and the time needed to conduct the research adequately mean that this technique is not recommended. For a review of this technique see Potts and Reay (1987) and references therein.

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 observation and 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 (Claridge *et al.* 1986; Ross *et al.* 1987, Allen *et al.* 1992; Gibson *et al.* 1993). It is therefore difficult to link cause and effect without extensive background data on the behaviour of the species of interest or without carrying out intensive surveys with control sites (Barber *et al.* 1995). The techniques described in these Guidelines are suitable for detecting 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 points 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.
- The timing of sampling is critical and when populations are to be compared between years, samples should always be taken at the same time of year and during similar weather and tide conditions. Equally importantly, surveys must be undertaken at the same state of the tide and equivalent point in the diel cycle rather than at a specific time. For example, in midsummer sampling at 16.00 would be in daylight, whereas sampling at the same time in winter would be at dusk; apparent differences in population size may simply reflect diel behavioural changes.
- Standardise the time spent searching unit volume of water and adhere to this time even when searching could continue.
- 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 repeat the survey. Repeat surveys on successive days to get an indication of day-to-day variability and incorporate these data into 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 done 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, and depending on the survey objectives, it is advisable to measure variability between rockpools in whatever factor is of interest. The measure of variability can be used to predict the number of pools (replicates) that will be required to detect changes in the fish population statistically (Chapter 9 in Sokal and Rohlf 1995). The abundance of rockpool fish is normally expressed as number of fish per unit area (the area of the pool surface) or volume. However, rockpools with differing rugosities will have differing submerged surface areas, reducing the validity of comparisons based on either surface area or volume. Comparisons of abundance between species should always take into account their differing catchabilities. If the results of the survey show a significant change in fish population this may be due entirely to natural causes (Collette 1986). Where significant changes in abundance or assemblage structure have been demonstrated 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 causing significant changes in fish populations the relevant authorities should be contacted (Environment Agency (England and Wales) or the Scottish Environment Protection Agency).

Health and safety

Never do field 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 difficult and increasing the chance of an accident. Quinaldine is very irritating to the eyes and skin; rubber gloves must be used and face protection is advisable when handling the quinaldine concentrate. Quinaldine splashes should be washed off skin immediately. Shores are often exposed and general precautions against the cold, wind and sun should be taken.

References

Allen, L G, Bouvier, L S and Jensen, R E (1992) Abundance, diversity and seasonality of cryptic fishes and their contribution to a temperate reef fish assemblage of Santa Catalina Island, California. *Bulletin of the Southern California Academy of Sciences*, **91**, 55–69.

Barber, W E, McDonald, L L, Erickson, W P and Vallarino, M (1995) Effects of the *Exxon Valdez* oil spill on intertidal fish: A field study. *Transactions of the American Fisheries Society*, **124**, 461–476.

Beja, P R (1995) Structure and seasonal fluctuations of rocky littoral fish assemblages in south-western Portugal: implications for otter prey availability. *Journal of the Marine Biological Association of the United Kingdom*, **75**, 833–847.

Christensen, M S and Winterbottom, R (1981) A correction factor for, and its application to, visual censuses of littoral fish. *South African Journal of Zoology*, **16**, 74–79.

Collette, B B (1986) Resilience of the fish assemblage in New England tidepools. *Fishery Bulletin*, **84**, 200–204.

Costello, M J, Darwall, W R and Lysaght, S (1995) Activity patterns of North European wrasse (Pisces, Labridae) species and precision of diver survey techniques. In *Proceedings of the 28th European Marine Biology Symposium* (eds A Eleftheriou, A D Ansell, and C J Smith), pp. 343-350. Olsen and Olsen, Fredensborg.

Gibson, R N (1967) The use of the anaesthetic quinaldine in fish ecology. *Journal of Animal Ecology*, **36**, 295–301.

Gibson, R N (1999) Methods for studying intertidal fishes. In *Biology of intertidal fishes: Life in two Worlds* (eds M H Horn, K L M Martin and M A Chotkowski). Academic Press, San Diego.

Gibson, R N, Ansell, A D and Robb, L (1993) Seasonal and annual variations in abundance and species composition of fish and macrocrustacean communities on a Scottish sandy beach. *Marine Ecology Progress Series*, **98**, 89–105.

Green, J M (1971) Local distribution of *Oligocottus maculosus* Girard and other tidepool cottids of the west coast of Vancouver Island, British Columbia. *Canadian Journal of Zoology*, **49**, 1111–1128.

Koop, J H and Gibson, R N (1991) Distribution and movements of intertidal butterfish *Pholis gunnellus*. *Journal of the Marine Biological Association of the United Kingdom*, **71**, 127–136.

Moring, J R (1976) Estimates of population size for tidepool sculpins, *Oligocottus maculosus*, and other intertidal fishes, Trinidad Bay, Humboldt County, California. *California Fish and Game*, **62**, 65–72.

Pfister, C A (1995) Estimating competition coefficients from census data: A test with field manipulations of tide pool fishes. *American Naturalist*, **146**, 271–291.

Pfister, C A (1996) The role and importance of recruitment variability to a guild of tide pool fishes. *Ecology*, **77**, 1928–1941.

Potts, G W and Reay, P J 1(987) Fish. In *Biological surveys of estuaries and coasts* (eds J M Baker and W J Wolff), pp. 342–373. Cambridge University Press, Cambridge.

Ross, S T, McMichael, RH and Ruple, D L (1987) Seasonal and diel variations in the standing crop of fishes and macroinvertebrates from a Gulf of Mexico surf zone. *Estuarine, Coastal and Shelf Science*, **25**, 314–412.

Sayer, M D J, Cameron, K S and Wilkinson, G (1994) Fish species found in the rocky sublittoral during winter months as revealed by the underwater application of the anaesthetic quinaldine. *Journal of Fish Biology*, **44**, 351–353.

Sayer, M D J, Gibson, R N and Atkinson, R J A (1996) Growth, diet and condition of corkwing wrasse and rock cook on the west coast of Scotland. *Journal of Fish Biology*, **49**, 76–94.

Sokal, R R and Rohlf, F J (1995) *Biometry: the principles and practice of statistics in biological research*. W H Freeman and Company, New York.