STARFISH sampling protocol

This protocol will not deal with the theoretical aspects of electric fishing but will deal with the practical application of the theoretical principles. This will be based on “best practice” as determined from published literature. It will deal solely with “classical” electric fishing; i.e. where operators wade in the water whilst fishing with hand-held electrodes.

In general terms there are two choices regarding equipment set-up for electric fishing. The equipment can be set-up to cause the least possible damage to the fish, or the equipment can be set-up to capture the highest proportion or number of fish. Rarely do these two set-ups correspond.

The following deals predominantly with the options and techniques to use in order to minimise damage to fish.

In general, sampling will follow the CEN documentation Water analysis – sampling of fish with electricity (Revision PrEN 14011). For relevance to the STAR objectives, the following protocol should be followed.

Equipment and safety

Equipment and safety procedures must be at or above the safety standards applicable in that country. Risk assessments must be carried out and a suitable Code of Practice developed. Good communication systems need to be in place between anode operators and/or anode operators and bank personnel. This system can be plain speech but in wide or noisy sites some system of either hand signals (difficult if anode in one hand and net in the other) or radio communication is preferable. Modern voice activated radios fitted to head sets are ideal.

Electric fishing by wading is limited to the depth in which wading can be safely carried out. In general, an overall depth of thigh deep with a hip depth maximum should be used as the criteria. Life jackets should be worn if there is a foreseeable risk of drowning.

Electric fishing

Where *possible* fishing should be carried out using direct current (dc) fields. This is because dc has good anodic galvanotaxis, induces tetanus only in the near vicinity of the electrode and has the lowest recorded rate of injury for any waveform type. **However there will be *many* cases where it is not possible to use dc** (high conductivity water, variable electrical characteristics of stream topography, poor fish response to dc field for unspecified causes). **In these cases pulsed direct current (pdc) fields should be used.** Pdc however has poorer anodic electrotaxis and tetanises further from the electrode; possibly preventing some fish from reaching the capture zone. **Pulse frequencies should be kept as low as possible** (Snyder 1992 suggests 30-40 Hz or lower) note however that frequencies below 20Hz may not be good for attracting the fish to the anode. There is also some evidence that high frequencies may be more efficient for capturing small fry.

Despite some evidence that ac waveforms (especially 3-Phase ac) are no worse than pdc with regard to causing injury, most evidence does suggest that ac does cause more injuries and therefore ac fields should not be used for fishing.

All fields should be adjusted to the minimum voltage gradient and current density concomitant with efficient fish capture. Pulse box settings should be adjusted to optimise recovery, capture efficiency should be a secondary consideration and can often be offset by carrying out more runs (ie depletion fishing). This is an area where some measures exist for some trade off between fish capture and fishing efficiency. It should be noted that **it is INCORRECT to increase pulse width (and thus amperage) at deeper sites**. For the same conductivity water this will not increase the field area of the anode but simply increase the power transfer to the fish within the field and thus lead to higher injury. Increasing the <u>voltage</u> at the anode however will increase the size of the voltage field, but will also lead to high gradients near the anode with associated risk to both fish and operators.

Most operators use a “standard” current when fishing. If this “standard” has been determined on the basis of past fishing success and lack of fish injury these standards are probably satisfactory. Personnel using dc for the first time will need to adjust or modify their fishing technique to account for the much smaller effective field found with dc. Voltages can be reduced when having to use small anodes in small high conductivity streams or increased in low conductivity streams (if larger anode diameters are impractical).

The anode head size should be as large as possible. If using dc, available power may influence the size of anode that can be used, but if using pdc available power is rarely an issue. The practicalities of handling large anode heads and the physical size of the stream are more likely to be an issue. In small low conductivity streams, if small physical anode size is required, voltage levels can be increased. Adding metal mesh to the anode can reduce the consequential high voltage gradient that will then exist in the vicinity of the anode. The mesh should not be used for actually capturing the fish however.

The cathode should be as large as possible. The commonly used “braid” design of cathode is inefficient. The operators should either revert back to the old expanded mesh design of cathode or use markedly longer lengths of braid (2 m). If multiple anodes are used, cathode area may need to be further increased. Knowledge of the electrode resistance of both anode and cathode will allow intelligent assessment of requirements.

Fishing technique using dc and pdc. When using dc, fishing should be conducted in a discontinuous fashion, in order to use the element of surprise, to improve capture efficiency and in order not to herd or drive the fish. In preference, the operators should switch on when in close proximity to areas such as clumps of weed, tree roots or other likely refuges. Fish will be in the attraction zone and this will have the effect of pulling the fish out from their refugia to where they can be captured. Care should be taken not to have the anode too close to refugia when switching on however as the fish may then be in an immobilisation field and will not be drawn from cover. Sweeping the anode when in areas of open water may encourage fish to seek out areas such as weed beds etc where again the above technique can be used. When using twin anodes, this discontinuous method becomes difficult due to the requirement for both anodes to be powered simultaneously. This problem can lead to the practice of keeping the anode live whilst lifting it from the water; this should not be done. It should be noted that the effective fishing radius of the anode will vary dependent upon the localised changes in the physical attributes of the stream. For this reason it may be difficult to obtain good depletion sampling population estimates (or more fishing's may be required to get adequate confidence limits on the results).

Unlike dc, the tetanising zone of pdc extends some way out from the anode. Thus when using pdc care needs to be taken that the anode is not so close to the fish that the fish is instantly in the tetanising zone of the field or that the fish is tetanised whilst still outside the catching zone. This aspect can however be minimised by using an anode radius suitable for the conditions being fished.

Generally electric fishing teams work in an upstream direction. This reduces the problem associated with stirred-up silt impeding visibility. It can also however reduce the likelihood of herding fish into the bottom stop net and thus biasing the capture efficiency of the first catch (front-loading).

When fishing wide sites, multiple anodes can be used. Fishing techniques that can be used are shown in figure1. Zig-zagging upstream when fishing allows random or target habitat types across the width to be sampled. Moving anodes when fishing side to side and up and down to "draw" fish will also help. **In general one anode for every 5 metres of river width has been found to be effective for quantitative electric fishing surveys of whole rivers.**

Regarding the non-electric considerations when fishing, five major issues arise; water depth, water temperature, water visibility, fish welfare and communication.

The temperature that fishing is carried out in should avoid extremes. Most operators avoid the hottest months but it is also important to avoid the coldest months as well. In general there is a trade off between efficiency (poor at low temperatures) and welfare (poor at high temperatures). A temperature range of 10-20°C is preferred for coarse fish and 10-15°C for salmonid species.

The rule regarding the visibility required for electric fishing is simply "do not put the anode head deeper than you can see". The electrode should be visible and the probe should be near enough to the riverbed for its field to encompass the riverbed. The visibility required will vary for different species (e.g. small benthic fish requiring higher visibility than if surveying larger mid-water fish). In poor visibility more runs may be required to achieve adequate population estimates.

Fish welfare

Fish should be removed from the electrical field as quickly as possible. While length of exposure to the electric field does not appear to increase rate of trauma, length of exposure does increase stress levels. Repeated immersion of fish into an electric field has been shown to increase blood lactate levels (and thus will increase post-exposure muscle acidosis).

A wide variety of techniques are used by operators to ensure good welfare of the fish whilst being held prior to processing. Temperature of water is the main criteria determining steps required to maximise welfare, with greater care regarding maintaining oxygen needed in hot weather. The use of floating mesh cages is considered to be a particularly effective way of keeping the fish in good condition.

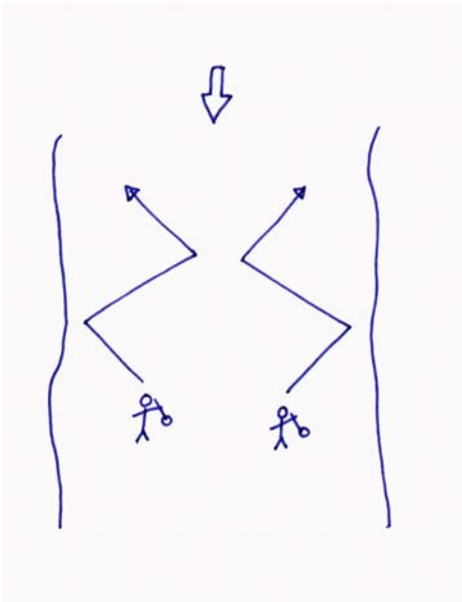
Many operators also separate eel from the catch of other species. The large quantities of mucous these fish produce was felt to lower the water quality (especially if the fish are held in bins) and "clog-up" other fishes gills. Holding eel in damp sacking is considered to be an effective method.

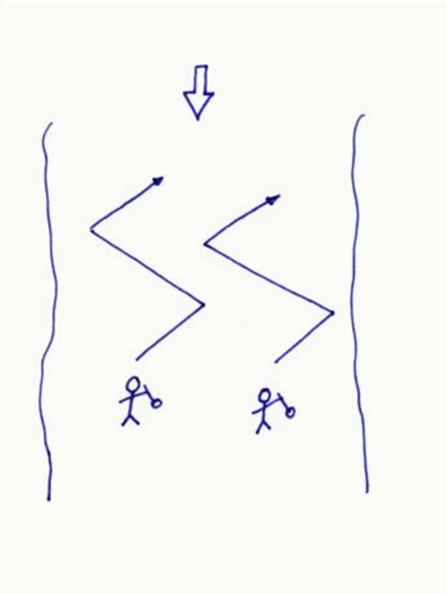
Oxygen levels in holding bins can decline rapidly. With an approximately 50% stocking density (45 litres of water **:** 20 kg (≡20 litres) fish) oxygen levels can decline to 50% of their starting level in 7 minutes. This stocking level in bins should therefore be regarded as maximal. **Remember that the water needs to be agitated to remove CO_2** . It is possible to supply adequate O_2 with a fine diffuser and still build up toxic levels of CO_2 . Remember to check on the welfare of your fish from the first shock before processing the second shock. Replace water if warm or fish seem distressed.

Fish should be returned to the water carefully into suitable areas out of the main flow. As no length/weight data is needed there should be no need to anaesthetise fish for STAR. However these data are considered optional, should anaesthetic be used then fish should have fully recovered before return to the waterbody.

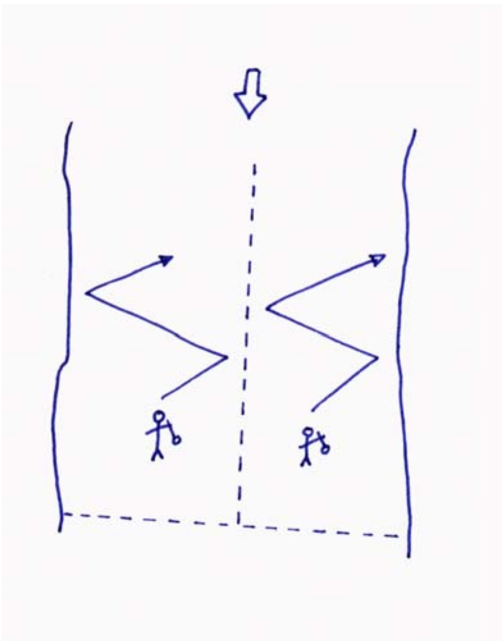
A record should be kept of mortalities and should be recorded as a proportion or percentage of the catch of each species.

Twin anode fishing. Poor method, when anodes move apart fish have an easy escape downstream.	Twin anode fishing. Good method, when one anode moves to margin second anode covers mid-river preventing an easy escape downstream.





Twin anode fishing. Alternative method, mid-river net lanes off river allowing less chance of fish avoiding anodes and escaping downstream.	Single or twin anode fishing. This method is particularly good for population assessment of benthic fish. Distance between horizontal sweeps across river is based upon effective anode field diameter.



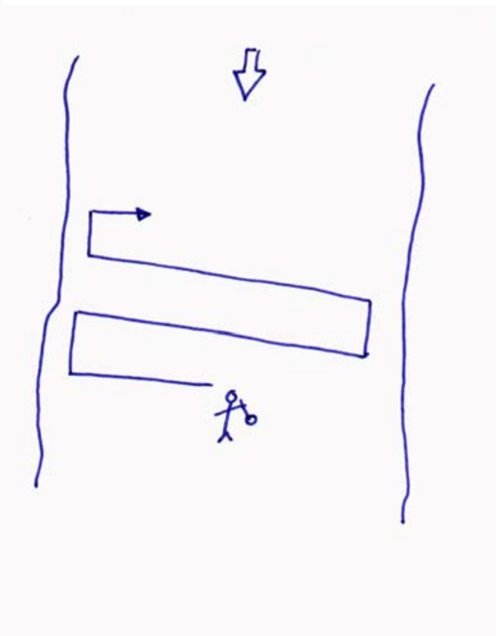


Figure 1 Methods of single and multiple anode fishing

Site selection

- For core stream types 1 and 2, choose shallow reaches (<1.2 m depth i.e. wadeable). Choose rivers where the majority of the habitat is within this depth range (>60%).

- Site length should be 10 times stream width. The minimum distance fished should be100m and must include all habitat types within the depth definition.

Methods

The method should be catch depletion electric fishing with stop nets. As it is very difficult to quantitatively assess small fish when undergoing a general survey, a size limit of 5 cm is recommended for the quantitative element. Species <5 cm and young of the year of larger species can be subjectively assessed into abundant, common and rare categories. Consequently, the nets should be suitable of preventing fish >5 cm from escaping.

A minimum of 2 catches should be employed. The simple formula $N = c_1^2 / (c_1 - c_2)$ (Seber & LeCren 1967) can be used to quickly estimate population number from the two catches. On site, calculate p the proportion caught $(c_1+c_2)/N$. If the proportion caught exceeds the requirement to produce an error of +-10%SE then a third catch is not required. If efficiency is less than that required, a further catch should be carried out. Final population estimates, capture efficiency and standard error of population number should be recorded (‘Remove 2’ software developed for this at CEH can be distributed if wanted). Two catch estimates will use the Seber & LeCren method. Greater than two catch sampling should use the Exact Maximum Likelihood methodology.

Equipment should be disinfected between watercourses to prevent the spread of diseases.

Biological elements needed to be recorded.

- Number of species (Shannon index of species richness)

- Species composition (percentage of each species by number)

- Fish density by species (number of fish per m^2) of individuals other than young of the year. There is no requirement to measure or age fish.

- Young of the year per species (qualitative assessment by class, e.g. abundant, common or rare).

- Ratio between number of phytophils and limnophils (fish species grouped by reproductive guild (Balon 1975, Mann 1996)

- Number of intolerant or sensitive species in terms of functionally descriptive fish species (i.e. salmonids for water quality, migratory species for connectivity etc.)

- Number of endemic species (species which are only present in the river basin under study).

- Number of native species (species known to be present in the watercourses of the country for a long period of time i.e. >200 years).

- Subjective assessment of degree of infestation of external parasites or other diseases

References:

Balon, E. K. 1975. Reproductive guilds of fishes: a proposal and definition. J. Fish. Res. Bd Can. 32: 821-864.

Mann, R. H. K. 1996. Environmental requirements of European non-salmonid fish in rivers. Hydrobiologia 323: 223-235.

Seber & LeCren 1967