THE FISHERIES (ELECTRICITY) COMMITTEE

ELECTRICITY ACT 1989

Guidance to Developers of Hydro Schemes

These notes are issued for guidance purposes only. Developers will require to consider each proposed scheme individually to account for differing site conditions.

Purpose of the Committee:

The Fisheries Committee is a statutory body originally created by the North of Scotland Hydro Electricity Board Act in 1943 and continued by the Electricity Act 1989. It was constituted to protect fishery interests which were recognised as important both environmentally and commercially despite the exigencies imposed by circumstances prevailing in 1943.

The purpose of the Committee is to protect fishery interests and fish stocks and advise on mitigation whilst facilitating the development of hydro-electric schemes. As a public body, the Committee has a statutory duty to further the conservation of biodiversity. Its interest includes, *inter alia*, migratory fish, resident fish, preservation of migratory routes and opportunities, spawning and nursery areas (including incubation habitat) and feeding areas. It covers all freshwater fish including, amongst others, eels, lampreys, Arctic charr and other salmonids as well as the entire ecosystem to support all these. The impact of development of hydro electric schemes on hydrology, sediment processes, water quality, aquatic life and habitat together with the effect on the riparian ecosystem are all, of necessity, included in the assessment of the potential impact of any proposed development.

The Committee's statutory remit applies to all hydro schemes although there are differences in the statutory obligations associated with the development of schemes greater than 1MW. Whilst all schemes will be subject to Controlled Activities Regulations administered by SEPA, only those in excess of 1MW are subject to section 36 consent from the Minister. As a designated Responsible Authority (in terms of the Water Environment and Water Services Act 2003) the Committee will liaise with SEPA on matters affecting the water environment that come within its statutory function

Issues of Concern to the Committee:

Each life stage of each fish species has its own environmental and habitat requirements and life cycles depend upon the maintenance of a series of critical habitats and of free movement of fish between them. Growth, numbers and survival depend on a suite of factors that interact in a complex manner and fish integrate all of these signals. The Committee is concerned, therefore, with issues such as water quality (including temperature and inert suspended solids), habitat structure and discharge in its broadest sense. Discharge alone is not a very good indicator of impact because fish respond in different ways to the three components of discharge (water depth, water velocity and wetted area) either separately or in various combinations and these elements, in turn depend upon such variables as channel roughness, channel cross section and gradient. In addition, discharge fluctuations act, together with sediment supply and dynamics and bed movement, potentially with further impacts upon fish populations.

Atlantic salmon and trout occupy a range of flow-sensitive habitat types that vary with life stage. The distribution of spawning by adult salmonids in rivers and streams has an important influence on the level of habitat uptake, survival and production of their progeny. Much is known about the spawning and incubation requirements of both species. On a larger scale (e.g. reach or catchment), the interaction between slope, discharge and sediment supply exerts a strong influence on both the temporal distribution and accessibility of critical habitats and the success of spawning and incubation.

Spawning occurs during the autumn and winter months. Local timing depends upon a number of factors including local population characteristics. Spawning salmonids are known to require particular combinations of water depth and velocity. But all require a sufficient depth of water to gain access to areas of gravel of suitable calibre and condition for spawning. In upland streams, the levels of flow required for successful migration, dispersal and spawning often exceed those required simply to maintain wetted areas in channels. A range of flows is often necessary to allow access and utilisation of sites that are distributed throughout areas affected by flow alteration. Insufficient levels of regulated discharge may act to prevent access to key spawning sites leading to a reduction in juvenile distribution and population production.

Rapid changes in discharge are known to disrupt spawning. Generation operations should therefore not act to artificially exaggerate natural hydraulic responses of rivers and streams where and when spawning is likely to occur

Successful incubation of salmonid eggs and alevins depends, amongst other factors, upon gravel of suitable composition and an intragravel (also known as hyporheic) water flow of adequate velocity and oxygen concentration. The rate of oxygen consumption by the embryos varies with each stage of development and temperature and the rate of oxygen supply will vary with intragravel flow and oxygen concentration. These, in turn, depend upon conditions above the gravel, especially water flow, oxygen concentration and bed topography. The intragravel flow rate will be influenced by the rate of deposition within the gravel of fine solids. In addition, the embryos can be damaged by the passage of people and vehicles over the gravel beds. Embryo survival is, therefore, influenced by a complex of factors that may be adversely affected by engineering activities and changes in flow regime. The duration of the incubation process is influenced by temperature and may last up to seven months in some upland waters.

It is vital to recognise that even small streams are important. Much of the spawning and nursery ground in a river system may occur in the tributaries. Therefore, degradation of a succession of tributaries can have a cumulative effect on the health of a whole river system. Consideration of this is often overlooked.

Pre- and Post- Intervention Surveys:

A simple non-quantitative fish census may be adequate as part of a scoping exercise but the final requirement of the Committee is for statistically robust population estimates over several years before intervention and for a number of years after completion. This is in line with the precautionary approach and developers are advised to encourage their fishery and hydrological advisers to provide such robust information over the advised period. Early consultation with the Committee will assist all parties in this. As the interactions involved are complex it is beyond the capabilities of developers, their consultants or the Fisheries Committee to be absolutely sure that the assessment of impacts has been correctly judged or that any measures will be sufficient to give adequate protection to the fish and their habitats.

Therefore, data that are statistically sound and take account of year-on-year variations in fish numbers (and these can be considerable) are needed. These may enable the developer to demonstrate that the scheme has not had any harmful effects or, conversely, may enable the Fisheries Committee to demonstrate an unforeseen effect that requires some form of mitigation.

The Committee will find it helpful if environmental statements include a full tabulation of the raw data collected from fish census work. The Committee can then, if necessary, make its own analysis of the data.

The Committee has noted that the implications of the Habitats (Natura) Regulations are not well understood by some developers. It is essential that there is adequate consideration of the impact of scheme proposals on Natura interests. A number of fish species and river systems within Scotland are designated under this legislation. Particular attention needs to be given to the requirements where proposed developments can have an impact on these species and sites. Further guidance on these matters can be obtained from Scottish Natural Heritage.

Finally, it should be noted that these notes are issued for the purpose of guidance only and each development may require differing site specific approaches. The Committee welcomes approaches from Developers and their advisors on any aspects of these guidance notes if there is felt to be a need for any clarification. Please make contact through the Committee Secretary.

References:

Armstrong, J. D. et al, (2003) Habitat requirements of Atlantic salmon and brown trout in rivers and streams. Fisheries Research 62 pages 143-170.

Crisp, D.T. and Carling, P.A. (1989) Observations on siting, dimensions and structure of salmonid redds. Journal of Fish Biology 34 pages 119-134.

www.snh.org.uk/about/directives/ab-dir03.asp

Guidance on the Information that the Fisheries Committee will require for Consideration of the Effect of a Hydro-electric Scheme on Fisheries and Stocks of Fish

This list of information that the Fisheries Committee might require from the developer is neither prescriptive nor all encompassing. Each scheme is individual and will require separate consideration. What follows is intended as a general guide:

1. There should be a clear statement (ideally with maps and appropriate grid references) of the location of the key elements of the proposed scheme.

2. There should be an assessment of the expected direct or indirect effect on fisheries and stocks of fish of any proposed:
   - abstraction;
   - impoundment;

- changes in flows and wetted areas, in any river or stream;
- changes in levels and wetted areas of any loch;
- changes in hydromorphology;
- volume and patterns of sediment erosion, transport and deposition including continuity of supply through structures; and
- significant changes in the temperature and water chemistry of any waters.

3. The assessment should include a description of the proposed physical structures in the river system or through which water from it will pass and their operation, for example:
   - dams, weirs, and spillways;
   - fish passes;
   - intakes and outfalls – including any screens at them;
   - aqueducts (including pipes and tunnels);
   - turbines or water wheels;
   - stream crossings; and
   - sediment traps

4. There should be an account of how any possible adverse effect on fish or fisheries would be mitigated.

5. It is necessary to give particular attention to water levels, velocities and hydraulic conditions in fish passes at different stages of their operation (e.g. when there is falling or rising water level in the forebay at a dam) and in relation to screening arrangements.

6. The assessment and descriptions should be linked to appropriate hydrological/ hydraulic information. At this stage, the developer may wish to consider the hydrological/hydraulic information required by SEPA in order to reduce the computational effort involved.

7. The assessment should include the extent and location of measured hydrological data including rainfall, river flow and where appropriate, loch/reservoir levels.

8. Where measured data relevant to the scheme are unavailable, a description of the methodology and data used to produce the hydrological assessments should be provided. This may involve for example, Centre of Ecology and Hydrology methodologies for flow estimation in ungauged catchments or estimation using data from a nearby gauged catchment.

9. Descriptions of any modelling work undertaken should be included. This will be particularly important in complex schemes, for example those involving multi-reservoirs or inter-basin transfers.

10. The detailed methodology and the rationale for determining specific flow requirements e.g. compensation or maintained flows, freshet releases, etc. should be stated.

11. The assessment should include baseline conditions showing the pattern of river flow and loch/reservoir levels at key locations under a range of hydrological conditions (at least showing average, dry and wet conditions, with these defined), ideally with flow and level duration curve assessments with probabilities assigned.

12. An assessment of the hydrological implications of the scheme and how this differs from the baseline should be included. This should include discussion of the impact of the scheme on hydrology at key times of year, for example in relation to fish migration (adults and juveniles) and spawning.

13. Analysis of operation under wet and average conditions should be undertaken as well as low flow analysis in relation to compensation waters and minimum flows. This will help the developer to establish implications for inundation levels, spates, spill from lochs/reservoirs/weirs, wetted areas etc, so consideration may be given for example, to the impact of the scheme on hydromorphology, volumes and pattern of sediment movements, the spawning and migration of fish, the incubation of their eggs/alevins and the juvenile habitat where these are relevant. Some estimate of the frequency of occurrence of the “dry” and “wet” weather flows being quoted should be provided. A description of how wetted areas have been assessed should be provided.

14. Discussion regarding the uncertainties of the assumptions and methodology and an evaluation of the uncertainty in the assessments should be made.

15. Paragraphs 2 and 14 above require that population surveys need to be fully quantitative and of sufficient duration to provide a good baseline for comparison with post-intervention data, and that there should be a critical appraisal of data quality. The information annexed provides further guidance on the presentation of fish population assessments.

16. Continued monitoring of the hydrological conditions will be expected post-construction in order that further “ground-truthing” of hydrological methodologies can take place over a longer period of record. Hydrological monitoring can help inform post-construction evaluation of the impact of the scheme on fish and fisheries.

ANNEX

Presentation of Fish Population Assessments, with Particular Reference to Electrofishing data

I. INTRODUCTION

Electrofishing is particularly useful for assessing populations of small salmonids in small streams.

In larger rivers relatively specialised equipment is needed for effective electrofishing. It has limited value in larger bodies of water or in water of very high electrical conductivity. Its effectiveness also varies between fish species and their life stages. Where electro fishing is not practicable other methods will be required. Whatever method(s) is/are used the principle of repeatability of observations should be respected as far as possible.

It is important to note that the Committee is concerned with fisheries, in general, rather than simply with Atlantic salmon and trout. A number of other species occur in Scottish freshwaters and some of them have, or are likely in future to have, importance in conservation terms. These include for example lampreys, sparling and whitefish (powan) eels and Arctic char. Where relevant, fish species other than salmonids should be considered in environmental statements.

II. WHAT SHOULD BE PLACED ON RECORD?

a. Date(s) and details of survey(s)

The timing of the survey(s) is important and should be mentioned. For example, a survey in mid- to late summer at a time when 0-group salmonids can be electrofished quantitatively may give some indication from the distribution of these fish between stations as to the positions of spawning areas. Sampling in winter or early spring will occur after substantial dispersal of fish during their first autumn/winter and will be less useful in identifying spawning areas. Details of habitat quality, gradients and National Grid references are helpful.

b. Conditions

Weather and water conditions, including gauged discharge when available, should be given. Electrofishing during high flows may well be both difficult and inefficient. Similarly, when water temperatures are very low salmonids may change their behaviour patterns and may be more difficult to catch.

c. Station details

It is helpful if the length, mean width and area of each sampling station are provided. In some cases further information on stream conditions may be necessary (see e.g. Platts, Megahan & Monshall, 1983).

The number of sampling sites, their positions and the survey design should be such as to give an appropriate overview of the population status.

d. Fishing procedures

The number of successive fishing's and a brief account of the mode of fishing and of the equipment used should be given.

e. Terminology

It is useful to define terminology or to use a widely accepted set of standard terms for salmonid life stages (e.g. Allan & Ritter, 1977).

f. Catch data

Tabulations of the catches in each fishing and an indication of the lengths (to the nearest mm) of the fish captured are desirable.

III. DATA QUALITY & PRESENTATION

a. Basic information

It is helpful to give reference(s) for method(s) used to estimate populations from catches in successive electrofishings. Ideally, salmonid samples should be stratified in some way to allow for differences in probability of capture between fish of different sizes. For small salmonids separate processing of data for 0-group and >0-group is usually sufficient.

Where the fishing has been efficient and two or more successive fishing's have been performed it will usually be possible to estimate total population (N), population density (D) and probability of capture (P). The latter can be expressed as a percentage and can be referred to as "fishing efficiency". It is important to give 95% C.L. (S.E. x 2) for N, D & P as these indicate the degree of reliance that can be placed upon the estimates. For more than two fishing's it is also possible to calculate a value of Chi-squared. Where this has a value of less that 3.8, then the assumption of a constant removal rate (P) has not been violated. Provision of this statistical information indicates that the survey at the station in question was fully quantitative and is very helpful to the Committee. See, for example, Zippin (1956), Carle & Strub (1978).

In practice there may be an irregular pattern of catches between successive fishing's. Such inefficient fishing can result from a number of causes including combinations of one or more of the following:

- fishing in difficult "terrain" -deep water, fast current, large boulders;
- fishing in high flows with water discolouration;
- fishing by an inexperienced team;
- use of substandard or malfunctioning equipment;
- fishing under winter conditions;
- fishing where population densities are very low and there is great scope for development of an irregular catch pattern; and
- when dealing with fish species that are difficult to sample quantitatively such as shoaling species (e.g. minnow) and species whose behaviour patterns make them difficult to catch (e.g. eel).

In such circumstances or when, for some reason, only a single fishing is possible, the result cannot be considered fully quantitative. It is then best to regard the results simply as an indication of presence or absence of a particular species or life stage and take the total catch as a minimum estimate of the number of that particular category. This should be made clear in the main body of the report and also be discussed in the evaluation of the assumptions and methodology.

b. Useful additional information

If there is any information on the growth or the age/size at first sexual maturity of resident brown trout, on the sizes of migrant salmonid spawners, on spawning dates or on the timing of systematic movements such as smolt runs, or the occurrence of sexually mature male parr, this should be made available to the Committee.

The possible need for collection and reading of scales and the measurement of fish weights should be considered. In some instances it may be necessary to separate year classes on the basis of known age rather than ages inferred by the use of length-frequency distributions. In which case, at each sampling site (i.e. transect or area), scales should be taken from a statistically representative sample of fish of known length.

c. Base-line studies

Salmonid population densities in streams can vary considerably from year to year and this should be considered when interpreting the results from a "one-off' electrofishing survey. If the objective is to set a pre-intervention base-line for comparison with the situation after intervention then it is important for both pre- and post-intervention studies to cover an adequate number of years. It is also worth noting that salmonid populations in streams may take up to seven years to fully respond to environmental/habitat changes (Hunt, 1976). A measure of between-years variation is given by the Coefficient of Variation with time (CV_t). This is often expressed as a percentage so that $CV_t = 100s / x$, when x is the mean population value over a number of years and s is its standard deviation. Winstone (1989) gives values of CV_t % of 12 to 28% for 0-group trout and salmon sampled by electro fishing and of 24 to 28% for older trout. These values are based on published data from relatively stable populations. In contrast, 0-group trout in a Welsh mountain stream gave a value of 76% . Winstone used his relatively low estimates of CV_t % to calculate the numbers of years' data from before and after intervention that were required in order to detect different fractional changes as a result of intervention. For 0-group salmon, even if data are available for five years before and five years after intervention, the minimum fractional change that can be detected is a little over 0.3. For higher values of CV_t % and lower numbers of years of observation the minimum detectable fractional change will be much higher.

The implications of this are that relatively long runs of high quality data are needed before and after intervention in order to clearly demonstrate that there has or has not been a quantitative change in populations as a result of the intervention or subsequent management activities. This issue should be taken into account, where relevant, in the design of the census technique(s) and the choice of sampling sites. The recycling of data gathered for other purposes may not be appropriate. The SFCC protocols cover a wide range of applications and are not in the public domain. Therefore, general references to these protocols convey little information and developers or their consultants should give exact details of the methodology used.

d. Incubation periods

It is often important to know or predict the period during which salmonid eggs/alevins are present in the gravel. During this period the avoidance of flows likely to cause "washout" or silt inputs likely to choke redds is particularly important. Many EIAs assume that, in Scotland, spawning is between September and November and fry emerge in April. Evidence shows that, especially in upland areas, emergence by or in April can be an optimistic assumption and it may be as late as June.

Spawning times are often known by local river keepers and others or can be determined by observation. This information, together with water temperature data can then be used to predict dates of hatching and fry emergence for trout and salmon. For details of available models and methodology see Crisp (1992).

There are few water temperature data available for Scottish salmonid waters and the cost of collecting such data was once rather high. It is now possible to purchase robust miniature temperature loggers that can be concealed in streams. They only need to be interrogated once or twice a year and the cost of logger, shuttle and software is only a few hundred pounds. There is, therefore, now no good reason for not producing such data when necessary.

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Hunt, R.L. (1976) A long term evaluation of trout habitat development and its relation to improved management-related research. *Transactions of the American Fisheries Society.* 105,361-364.

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