Fish and the Ecological Assessment of Lakes and Rivers for the WFD

Proceedings of a workshop held at Edinburgh Conference Centre, Heriot Watt University, Riccarton Campus, 13th - 14th August 2002

Day 1 13th August

Session 1 Introduction

Roger Owen opened the workshop by welcoming participants (listed in Annex I) and reminding them of the primary purpose of the event. This was to assemble a representative sample of relevant UK expertise so that the current state of knowledge regarding ecological assessment of fish populations could be explored and related to the needs of the Water Framework Directive (WFD) for such information.

The output from the workshop is intended to inform the rivers and lakes Technical Advisory Groups (TAG), which will in turn provide information to those involved in the implementation of the WFD, including member state governments. (see Figure 1.)

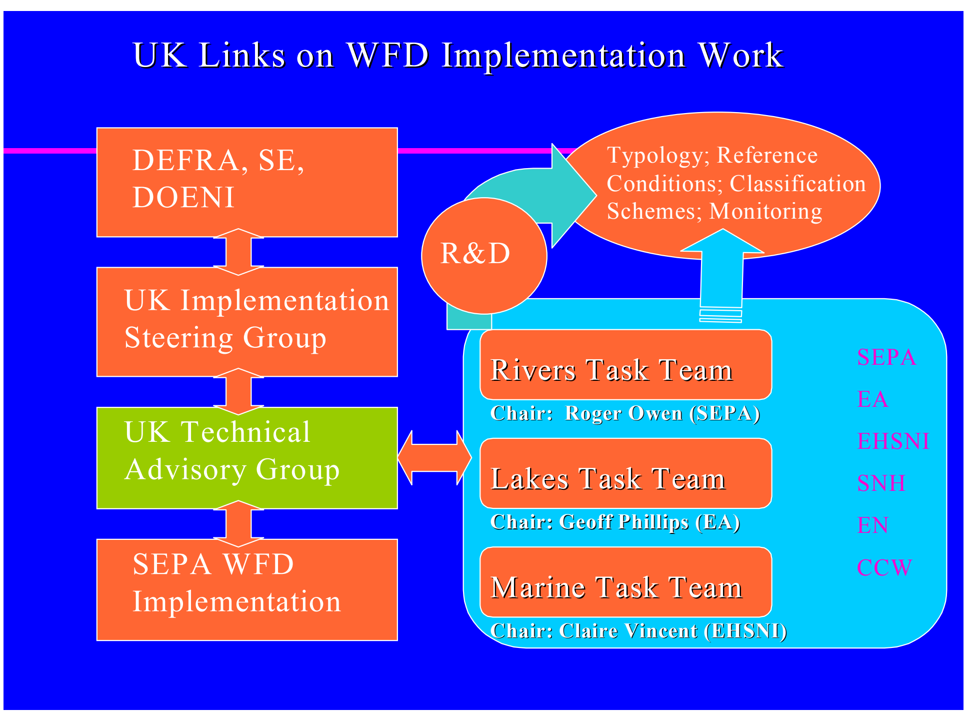

Figure 1.

More specific objectives would emerge for the various workshop sessions, but in general it was expected that sessions would meet the following objectives:

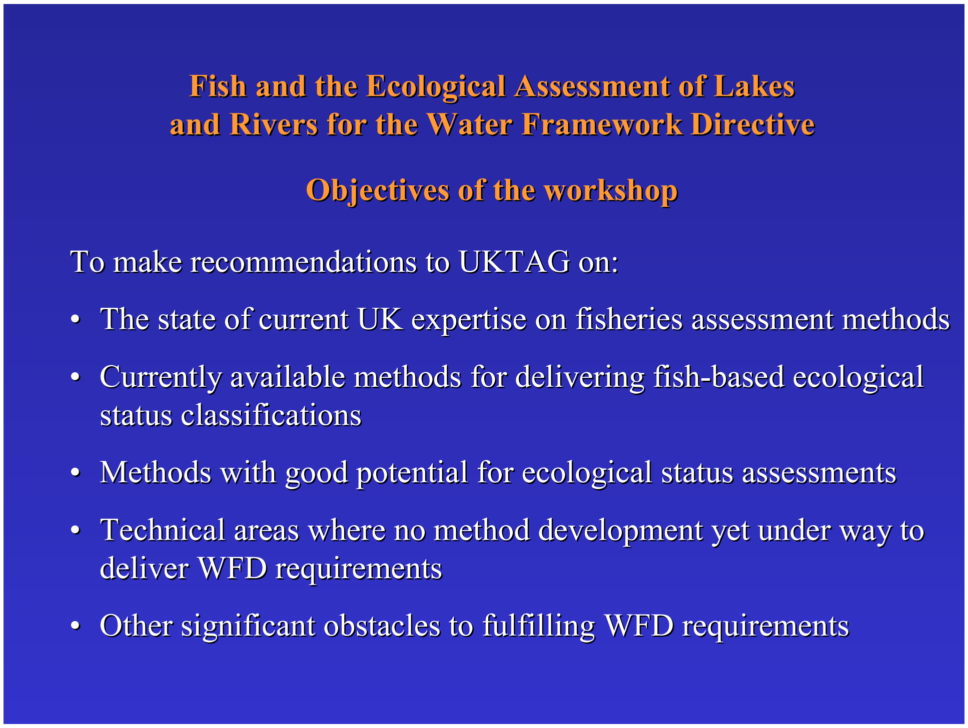

Figure 2.

Callum Sinclair then provided a concise overview of the WFD, the implementation process and significant milestones. The timetable for implementation is summarised in figure 3. Wide consultation has already taken place, but consideration of technical details relevant to Annex II and V continues.

The directive obliges member states to classify surface waterbodies and groundwater (including dependent wetlands). Thereafter they will have to maintain high status waters and implement programmes of measures to restore those identified as degraded, at least to ‘good’ status.

As part of the process of characterisation of waters, pressures due to human activity (eg abstraction, pollution, habitat degradation) will be identified.

Monitoring programmes will operate at different levels for <u>surveillance</u> (to support and validate impact assessments and to assess long term trends), <u>operational</u> (to assess the status of waterbodies at risk and to assess changes due to programmes of measures) and investigative purposes.

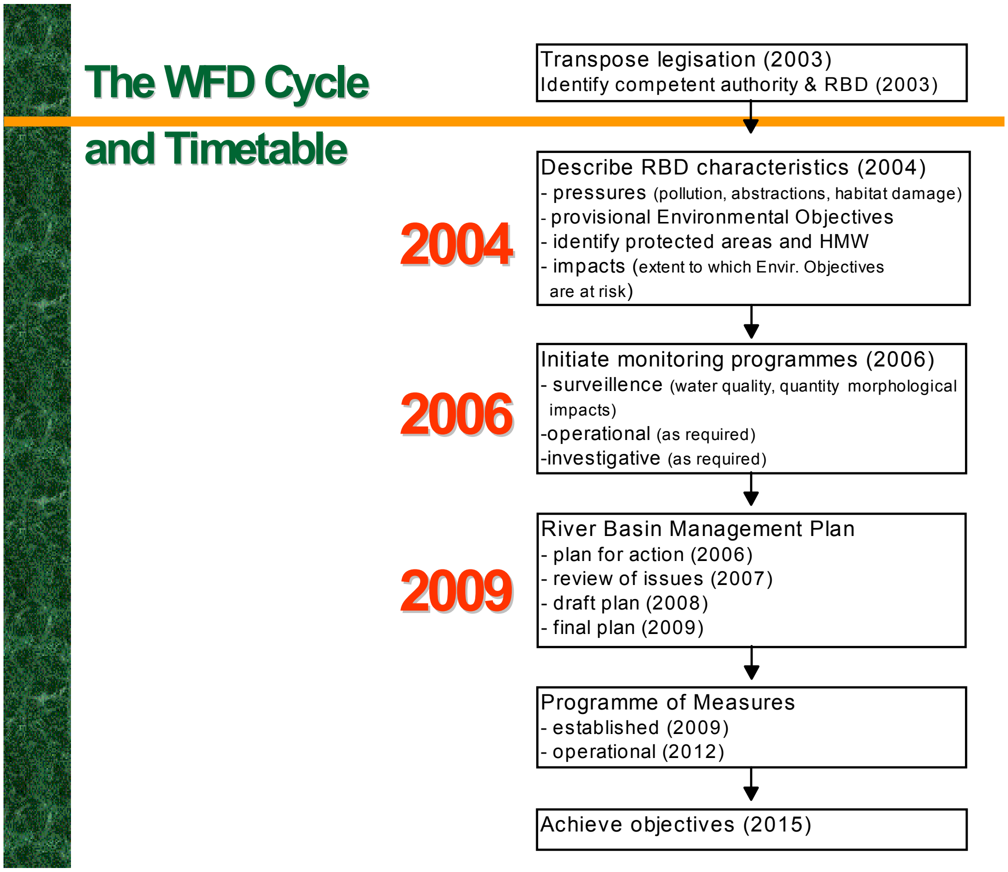

Figure 3.

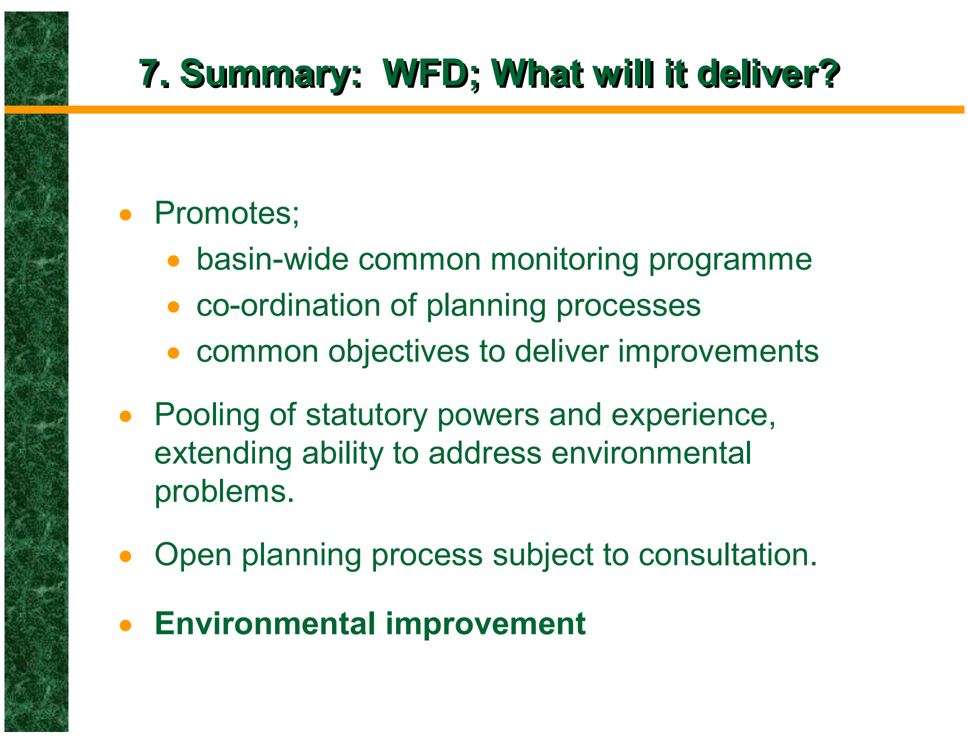

Figure 4.

Attaining the objectives of the river basin plan will depend upon various control mechanisms, but be informed by the results of monitoring. It is this latter activity that provides the context for the present workshop.

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Peter Pollard then considered the technical requirements of the directive, with particular reference to fish.

The role of monitoring in the river basin planning cycle is summarised in figure 5.

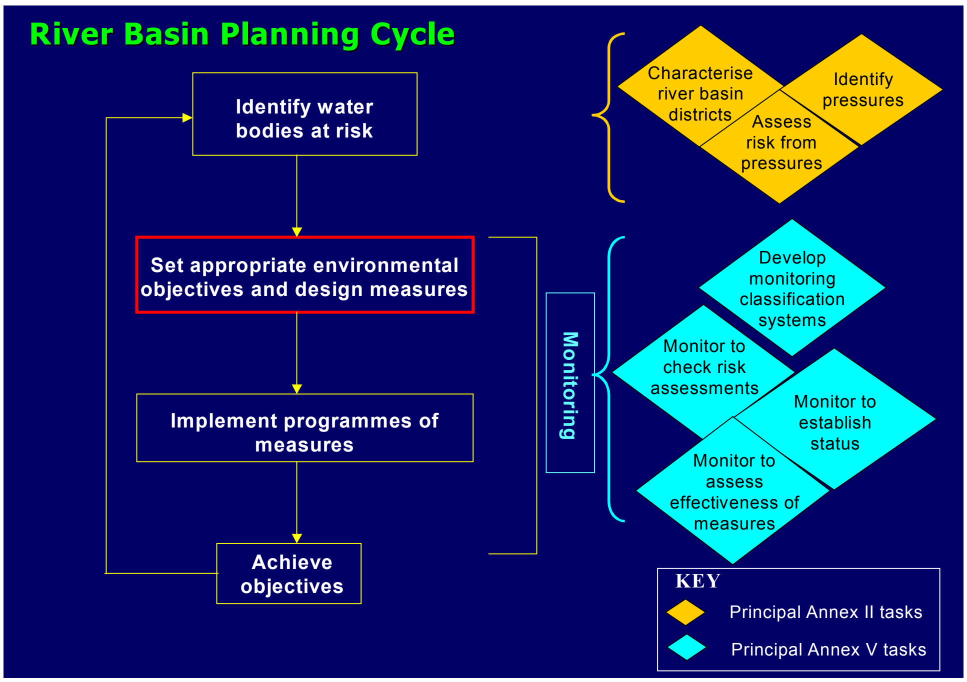

Figure 5.

The tasks associated with monitoring are described in Annex V of the directive, and require, among other things, the development of appropriate monitoring tools.

The classification process can be summarised by figure 6, and emphasises the primary role of biological information for all classes of water body, as well as the more exacting suite of criteria for those of high status:

The quality elements refer to other biological groups besides fish. In order to assess the ecological status of a fish population, its abundance, composition and age structure must be considered. The principle of the classification process will be to compare these quality elements of the population with reference conditions appropriate to the water body, and thereby derive an Environmental Quality Ratio. This numerical value will allow classification on a five-point scale.

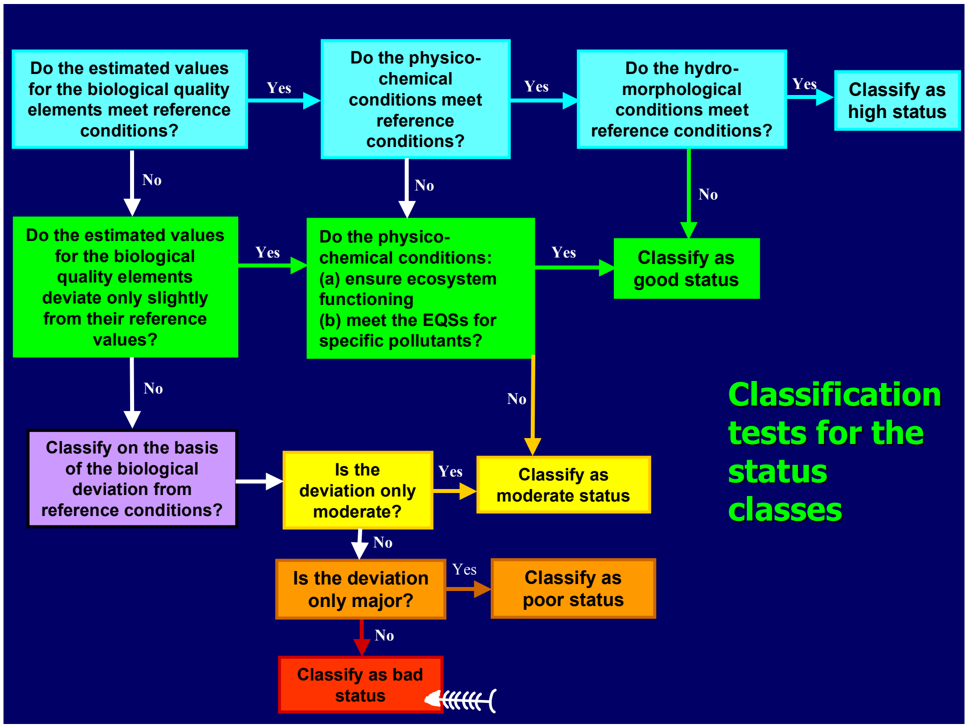

Figure 6.

In considering the significance of changes in abundance, it is expected that weight will be given to those that threaten the viability of the population by reducing its reproductive capacity or that jeopardise the well being of other dependant aquatic organisms.

In 2006, surveillance monitoring will be used to review/validate the risk assessments made in 2005. It will also establish the classification status of waterbodies.

The classification system will be default based, so it will be appropriate to measure the deviation evident for the quality element that is worst affected by the environmental pressures identified for that waterbody.

Some key questions to be considered regarding the use of fish as a biological quality element in monitoring programmes are:

- *To which anthropogenic pressures (i.e. due to human activity) are fish especially vulnerable?*
- *How is the impact made manifest?*
- *Which indicators should be used?*
- *What is the risk of miscalculation?*

Answers may depend not only on the intrinsic vulnerability of fish, but also on our ability to produce reliable measurements.

A specific problem for the use of fish population information is that 'good status' will not be jeopardised by angling or other exploitative fishing pressure.

Ultimately we require a reliable reference based method to assess the status of fish populations by 2007. This will be used for the surveillance programme and for operational programmes, where a higher level of confidence may be needed.

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In discussion, Peter confirmed that although environmental assessment methods using, for example, invertebrates, are already available, the directive requires the inclusion of a suite of biological elements, including fish. Circumstances may determine, however, the most appropriate quality element to use.

Willie Duncan noted that methods of using information about fish populations would be needed by 2003 to contribute to the risk assessment/characterisation process.

Peter also confirmed that the UK is working closely with other member states, for example to establish reference conditions for water bodies and to set boundaries for the classification schemes. A typology for surface waters is being developed, with each type having predetermined multiple reference conditions, appropriate to the different quality elements.

It was noted that although the process of implementation follows a logical sequence, long lead-in times make it necessary to work on a number of issues now, some of which might be more easily tackled at a later date. Tasks are progressing in parallel.

Peter Maitland drew attention to the natural variation in species abundance and composition that occurs, which might confound assessments and deserves consideration.

Ian Cowx referred to European projects that are relevant. STAR seeks to standardise river classification systems and is relevant to intercalibration efforts, at least in headwater systems. FAME is concerned with fish monitoring and establishing associated reference conditions. It is due for completion in 2005. A website based in Vienna has more details. Roger agreed that such projects are of interest, but SEPA has resolved not to wait for their output, but to press on with the implementation programme.

The definition of 'water body' prompted some discussion, since this will influence the scale of the monitoring task. Each water body is expected to fall within a single type of river or lake. Boundaries may be at major confluences or changes in status. It was acknowledged that a number of such uncertainties over definition of terms and methods would make planning the implementation of the directive difficult.

One key principle underlying the directive is that systems will be managed in an integrated and strategic manner, recognising the interdependence of water bodies and their ecological processes.

Session 2 Background: using fish in ecological assessment

Roger Owen introduced the first 'breakout session', which provided participants with an opportunity to consider a number of questions in the context of rivers and of lakes. The main outcome of the discussions is summarised as follows:

- **Which pressures in rivers and lakes can be assessed using fish?**

The main pressures recognized in the WFD impinge upon water quantity, water quality and hydromorphology. Within these broad categories, most were considered to be amenable to assessment using fish, but a different suite of metrics might be required in different situations. Fish can be used as broad scale indicators (of obstacles in rivers, for example). Some species may have particular limitations on their utility: migratory species may not best reflect conditions in a river stretch that they only temporarily occupy, for example.

With regard to *water quality*, the following pressures were identified by the lakes group:

- *Eutrophication*. Effects would be seen in both upland (species poor) and lowland (species rich) in terms of species composition, growth rates and, though perhaps less so, age structure and maximum size.
- *Acidification.* Altered species composition and increased growth rate of remaining species.
- *Pesticides* (synthetic and non-synthetic pollutants). Fish may be more sensitive indicators of pollution than chemical monitoring. Metrics likely to be particularly sensitive include aspects of life cycle such as age to maturity and fecundity, which might need to be supported by some sort of tissue analysis.
- *Hormones.* Possible impacts, but these are not well studied and would need method development for use in investigative monitoring.
- *Suspended solids.* Recruitment and age structure might be affected, but this would need supplementary investigative studies (e.g. gill histology).
- *Temperature*. Growth rate may be affected, this is not considered to be particularly sensitive, and may only be detectable if the impact is on a large scale.

A background paper prepared by Rick North and Alan Starkie summarises the pressures to which fish fauna are subject (Table 1):

Table 1: List of Pressures for Risk Assessment – relative to Fish Fauna in lakes

Pressure	Mode of Action	Impact on Fish Fauna	Indicator Fish Metric	Related Abiotic Metric
Human population within catchment	Water quality, eg: • Ammonia • BOD • Nutrients (N, P) • Oestrogenic substances Abstraction for potable water	• Elevated mortality • loss of sensitive species • change in age structure • reduced recruitment • Loss of littoral habitat	• Species composition (presence/absence of sensitive species) • Age structure • Abundance	• Residents/unit area of catchment • Volume of WRW effluent discharged to water body • Quality of WRW effluent discharged to water body
Land use in catchment: 1) Forestation	• Accelerated acidification of surface waters in susceptible areas	• Progressive loss of sensitive/all species	• Species composition • Abundance • Age structure	• WQ (eg, Alkalinity, pH, hardness, Al, Organic carbon) • % of catchment area afforested
2) Agriculture	• Livestock pollution • Use of chemicals, eg pesticides (sheep-dip) • Arable fertilisers, herbicides • Abstraction for irrigation	• Elevated mortality • Loss of sensitive species • Change of species composition • Reduced recruitment	• Abundance • Species composition • Age structure	• WQ (eg Nutrients & suspended solids) • % catchment area used for arable agriculture • N° head of livestock/unit area of catchment.
3) Industry	• Water Quality – inc toxic pollution and suspended solids • Abstraction eg for cooling	• Elevated mortality • Loss of sensitive species	• Abundance • Species composition	• N° consented discharges • Volume consented discharges
Fishery management	• Manipulation of fish stocks • Angling pressure	• Introduction of non-native species • Elevation of biomass to unsustainable levels • Selective removal of predatory/non target species • Fishing (Angling) mortality	• Species composition • Abundance	• Stocking consent history • Angling participation (Effort)

Water quantity – Changes in water level in both rivers and lakes due to abstractions could affect habitat availability and spawning areas. Hence, species composition and abundance might be affected. Hydrological change would affect productivity and hence fish growth.

Hydromorphology – Physical disruption to the habitat might affect recruitment. Sedimentation and dredging would both affect morphometry and fish: by reduced spawning success in particular.

- **Are methods currently available to provide quality status classifications?**

Appropriate established metrics are likely to be presence/absence, numbers and age structure or some combined index of this. Although there have been a number of academic papers on the subject, flowing from indices such as the Index of Biological Integrity, there is no well-developed method that would enable one to classify lakes in terms of their fish fauna. There are, however, statistically sound methods – particularly in Scandinavia (Sweden, Finland) for assessing fish metrics.

A fish based assessment method is under development as part of European project (FAME). This will have adaptations for different ecoregions and employ sampling using standard methods. The IBI provides a basis for method development, and has a history of use in rivers. It was noted, however, that many sites in the UK FAME input are impacted, and some geographical areas are not covered (Scotland, Eire and Northern Ireland. There is some concern over the way that reference sites are being established. The member states driving the project generally have either high or low biodiversity and there is some uncertainty over how UK rivers would fit into the range of river types.

Measures used in FAME include fish community and population structure, but the intention is to use the most appropriate metric for the water body in question. Models will give reference values against which estimates can be classified.

FAME is due to reach the report stage in December 2004 – rather late in the WFD characterisation schedule.

- **Are methods for assessing fish metrics statistically reliable?**

For small standing waters species composition and age structure may be assessed; abundance estimates would also be practicable if sufficient effort was put in.
For large lakes, the same applies, but it would require significantly more effort and would have greater degrees of uncertainty, even in determining what species were present.

For rivers, FAME will address this issue. Existing methods are considered to be constrained by data collection methods and the coverage possible.

- **Are there common methods in use now across the EU?**

There are well-developed methods such as catch per unit effort (CPUE), for estimating abundance. Also, European Standards Committee (CEN) are developing standards for electrofishing and gill netting. FAME is also considering methods for rivers. Some differences in preferred approach can be expected, however: relating to lethal and non-lethal methods, for example.

An important distinction must be made between data collection methods (which are broadly similar across the EU) and data analysis (where differences are apparent).

- **Which methods are under development that will allow WFD compliant classification?**

No suggestions were made by the group considering lakes, but FAME and the STAR project were cited for rivers.

- **Do we have the required expertise in the UK? Can we access the required expertise (in the UK, EU or ex-EU)?**

Yes, was the firm opinion of both the lakes and rivers groups; but we must continue to keep close contact with others in Europe. It was noted that there is a cost element in assessing the information.

- **Do we already have data to allow us to carry out the initial risk assessment of failing WFD objectives?**

Some small projects have begun to address this requirement for standing waters, such as the REFCOND project for WFD assessment of reference conditions, and the collation of information on fish communities (by Peter Maitland). There are some patchy data, but datasets are generally incomplete, and collected using different methods (and not in a standardized way).

For rivers it is thought that the data does exist, but not in a useable database. Much data is raw and non-standard. Also, some variables of interest for WFD purposes (river width, altitude etc) have not always been captured. It was noted that the Scottish Fisheries Coordination Centre (SFCC) collects data to a common standard.

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In the plenary discussion following the breakout sessions reported above, the general feeling was that currently available methods could provide the necessary data on the metrics in question. Doubts were apparent over the assessment procedures, however. The FAME project was the focus of much discussion, with some participants expressing doubts of the type mentioned above. There was a widespread feeling that method development needed for WFD implementation in Scotland and Northern Ireland should proceed in parallel with the FAME project, and that a watching brief should be maintained. Links between the UKTAG groups and the FAME and STAR projects can be maintained through Alan Starkie and Ian Cowx.

The basis of the FAME approach is to use the IBI to select the sites in optimum condition, which can then be reviewed for expert decision as to whether they are suitable as reference sites. The IBI is being amended somewhat to take more account of population based metrics, to take better account of impoverished fish populations.

It was suggested that there is unlikely to be significant difference between the methods used for surveillance and operational monitoring. Variation in intensity and frequency of method application is to be expected, however.

Session 3 Selecting fish population parameters

Malcolm Beveridge introduced the second breakout session, referring to a background paper prepared by Rick North and Alan Starkie. This sought to summarise the metrics thought to be appropriate for assessing fish fauna of water bodies for the WFD. These would yield information on species composition, abundance and age structure, and are set out in Table 2.

Table 2: Metrics for the assessment of ecological quality of fish fauna. Shaded metrics are the absolute minimum required to satisfy the Directive.

Metric	Primary data/material collected	Information derived
Species	Identity of species captured.	Presence/absence of all fish including rare, non native and migratory species.
Abundance of species (Count of fish of each species.)	Numbers of fish of each species.	**Species composition -** % by number of each species present. Index of **abundance** (CPUE or population estimate) Piscivore/non-piscivore ratio.
Age of individual fish/age structure of fish community.	Scales or other appropriate skeletal structures from individual fish.	Age/growth history of individual fish. **Age structure**, growth rates of species.
Size structure of fish populations.	Individual fish lengths.	Species length-frequency distribution, (surrogate for **age strucure** if ageing not possible). Biomass estimates via length/weight regressions.
Weights of fish.	Individual/species weights.	Improved biomass estimates, **Species composition** by weight. Condition Factor for species.
Health status of fish.	Incidences of disease, parasites, damage.	Index of population health, predator pressure.

Data to yield all of the information described in Table 1 could be collected on each sampling occasion at a particular site. Data that does not provide information directly relevant to the major requirements of composition, abundance or age-structure would be useful as an index of impact and its collection would have little cost implication.

Participants were asked to consider the suitability of metrics for use in different types of water body of different scales, their usefulness and practicality. Knowledge gaps should also be identified. The groups' conclusions are summarised in Table3.

Table 3. Metrics for fish populations and their relevance to the WFD.

Data collected (currently or potentially)	Metric derived	Water Framework Directive requirements			
		Reference Conditions	Classification	Pressures/ Impacts	Comments
Species presence/composition	Richness/ Diversity	Yes, critically important **but** not in isolation.	Problems for a 5 class scheme, when few species are present.	Yes, in rivers, but in lakes there are reservations.	A well-defined,cost effective sampling strategy is needed. Specific metrics have different applicability. Habitat variation within a basin/water body may result in localised species absence. Longevity of a species influences its population response to pressures. Introduced species are problematic – exclude from assessment if possible.
Species abundance/community composition	Multiple, (See table 2.)	Yes. Consistency of sampling method is important.	Yes in rivers. In lakes this is difficult and therefore of low confidence. Possible early warning value.	Yes in rivers. In lakes some impacts may not be picked up (e.g. sea/brown trout in salmond rivers.)	IMPORTANT for multi-metric approach. Problems exist with migratory species Sampling problems in large water bodies. Methods may be biased, so need to be consistent. A suite of options is preferred. Natural variability and sampling error (both may be large) need to be understood. Possible to combine with age structure information or treat separately, but interpretation may be difficult. Useful where few species present. Longevity is again an issue.
Individual fish age/age structure of fish species	Proportions- to detect recruitment, longevity & survival	Yes, important to assess impacts & stage at which they	Contributory information. Species dependent (longevity and temperature)	Yes. Confounded by the effect of other variables on recruitment,	Age or size structure? Length frequency might be used to derive age. Poor discriminatory power for use in classification if used in isolation. Growth rates might be useful.

		occur. But may be impractical in lakes.	but important.	but may aid interpretation of other data.	
Population size/structure	Ditto	Ditto. May be very site specific for lakes	Ditto	Ditto	Derived from previous row. Note that the Austrians have divided their fish stocks into ‘small’, ‘medium’ and ‘large’ with some success.
Fish weights	Condition factor or similar	Possible from literature but not attempted.	Yes.	Yes – length-weight relationship is considered useful in lakes.	Low priority in rivers – collect for special investigations? Few existing data

Session 3 was intended to focus on fish metrics, but in practice it proved difficult to avoid consideration of data capture issues. Bias in sampling, for example, might influence the value of the metrics derived from the data. Timing of surveys may be important for species composition where migratory species occur.

The use of a multi-metric approach was considered favourably, and advocated for each WFD task. Most metrics were considered to be of value in at least some circumstances, and there was reluctance to set aside any of them. This was despite the acknowledged benefit of a simple regulatory approach.

The relationship of individual metrics to a classification scheme would need clarification, together with their relative weighting. Relative abundance and length frequency analysis were considered to be particularly useful for lakes. It was noted that age structure reflects both recruitment success and survival, and may be useful for detecting historic impacts in investigative work.

Different water body types are expected to require different metrics. A population based metric such as abundance might be important in species-poor headwaters, for example, whereas in lowland rivers, a community based parameter such as species composition might be more useful. It was noted that short-lived species are particularly susceptible to impacts, which may give rise to missing year classes.

Setting reference conditions is expected to be problematic, particularly in lakes. Inadequate data sets are expected be the main problem in many waters.

Introduced species posed particular problems and could be considered both to provide a metric (% of introduced species present) and to constitute a pressure. It was suggested that those introduced to a water body more than 100 years ago, and are still present, are sometimes regarded as ‘naturalised’. However, it is unclear how widely this convention is accepted. More recent introductions may exert an ecological pressure which is intractable and justifies ‘less stringent measures’. In such circumstances, even ‘good’ status may no longer be achievable.

Day 2 14th August

Session 4 Fish assessment methods

Willie Duncan introduced the final workshop session. Participants were asked to focus on sampling methods, rather than sampling strategy, and to assess their suitability for WFD purposes, their usefulness, practicality. Knowledge gaps and cost effectiveness were also of interest. The outcome of these sessions is summarised in tables 4 to 8.

The rivers group were keen to emphasise that the utility of any method would be extremely dependent upon the sampling strategy adopted, so that the product of their deliberations related solely to methods. The importance of using standard procedures was also emphasised, but it was noted that each technique could be adapted to best meet the data needs of the survey.

The resource requirements for determining fish metrics were considered independently by Rick North and Alan Starkie, whose estimates are summarised in table 4. They conclude that data on fish metrics would be collected by a method or methods most appropriate to the water body being sampled. Direct capture methods would yield data pertinent to all metrics. Other methods, such as hydro-acoustics, could not be used in isolation.

In discussion, there was particular concern expressed that destructive techniques might be disallowed or be politically unacceptable. This is difficult to avoid and may require 'education' or PR effort. This illustrated a wider concern – the need to involve the practitioners of fish monitoring in the deliberations of the policy developers. As further illustration of this problem, it was suggested that the developing CEN standard would call for the deployment of about 70 gill nets to survey Loch Lomond. Such things need to be fed back to Roger Sweeting for further consideration. Paul Logan and Roger Owen also have involvement in the CEN process.

It was noted that the WFD requires estimates of confidence of class, and confidence in the metric(s) used will feed into that.

There is evidence of considerable UK expertise, although it may not be being fully utilised. The lack of involvement of operational staff in the Environment Agency was a particular cause for concern.

Preparation of a Scottish Monitoring Strategy will be an important next step, but it will need to take account of practicalities. Issues raised during the workshop are relevant to this. The labour intensive nature of most fish survey work was emphasised. UKTAG have a responsibility to report on resource implications of methods under consideration.

In general, the situation in rivers appeared to be better, and in Scotland the SFCC and the Fisheries Research Service were identified as key contributors to the WFD process.

Table 4. Assessment of fish survey methods for WFD quality elements in rivers.

Method	Species	Abundance	Individual age/ popn. age structure	utility
Gill netting	Yes	Yes	Yes	Technique not usually used in rivers. Not a routine method. At present has restricted use in England and Wales. Compensation scheme might be needed. Scottish Executive would probably not regard favourably. Not applicable for small rivers
Seine netting	Yes	Yes	Yes	More acceptable (as non-destructive) although with large populations of cyprinids there are associated mortalities. Labour intensive. Site specific but good for quantitative information. Selective and specialised – however if appropriate gear is used – a good technique. Gives a sense of the fish present.
Fyke netting?	Some use	Some use	Yes	Has application. Species selective but useful for benthic species (and spawning charr)
Electrofishing – preferred method – ranked 1	Yes	Yes	Yes	CEN standard that has been shelved as sampling strategies have yet to be finalised. Proven technique. Standard method to be used. Most commonly applied. Limitation is water depth / width.
Hydroacoustic survey	No	Yes	No	EA has standards for use. Relates to fish community, not populations. Requires validation. Air bubbles create difficulties. Site specific. Application for fish abundance in lowland rivers. May be useful to target and compliment other techniques. Diurnal changes in fish behaviour need consideration.
Angler census	Yes	No	Some use	Requires end user involvement. Site specific and not widely applicable. Selective but may have application if stringently controlled. Match angling in lowland rivers, species composition and size structure available. Stretches that are angled are those most

				suitable for this – not necessarily representative of fish communities.
Trapping	Yes	Yes for some spp.	Yes	Site specific but limited use for WFD
Fish counters / imaging	No	Some use	No	May have some application. Migratory species application – site specific
Visual counts?	Yes	Relative indicator	No	Limited but In some limited circumstances can get abundance/ presence.

The table of metrics provided as a basis for discussion included 'population size/structure' and 'fish weights'. These were not regarded as quality elements by the rivers group, and were discounted.

The lakes group chose to distinguish between the inshore sampling of small shallow lakes and the offshore sampling large deep lakes.

Table 5. Assessment of inshore fish survey methods for WFD quality elements in **small, shallow lakes**. (3 star rating is used to evaluate utility.)

Method	Metric					Utility
	Species	Abundance	Individual age/ pop age structure	Population size structure	Fish weights	
Gill netting	***	** CPUE	**	**	**	Excepting extreme inshore. Destructive: Nordic standard net.
Seine netting	***	** CPUE, areal estimates, CMR(catch per metre rowed)	**	**	**	Site limitations (physical obstructions). Discrete adult and young versions. Possible requirement for night time sampling.
Electrofishing	**	*	*	*	*	Complementary tool. Boat-mounted
Hydroacoustic	0	*	0	0	0	Developing technique (see

survey						rivers comments above)
Angler census	**	*+	**	**	**	Species and size bias. Potentially good for long time series.
Trapping	**	*	*	*	*	Complementary tool. Eels.
Trawling	*	*	*	*	*	Hand and other specialised trawls.

Table 6. Assessment of offshore fish survey methods for WFD quality elements in **large/deep lakes**. (3 star rating is used to evaluate utility.)

Method	Metric					
	Species	Abundance	Individual age/ popn age structure	Population size structure	Fish weights	
Gill netting	***	** CPUE	**	**	**	Destructive. Nordic standard net.
Seine netting	0+	0+	0	0	0	Purse under development. Possible requirement for night time sampling.
Electrofishing	0	0	0	0	0	
Hydroacoustic survey	*	***	*	**	*	Requires complementary methods. Good for total biomass
Angler census	*	*	*	*	*	Species and size bias. Potentially good for long time series.
Trapping	0	0	0	0	0	
Trawling	***	**	**	**	**	Significant access issues.

Session 4 also invited participants to apply a checklist to each method and consider whether the following criteria can be met in assessing ecological conditions in lakes and rivers.

Table 7. Assessment of selected fish survey methods for **rivers** against key criteria.

Methods for rivers:	Electric fishing	Hydroacoustic survey	Seine netting	Angler census
Can method '*x*' generate a metric that can predict values at reference conditions?	Yes	No	Yes	No – adds value but lacks precision
Is the method relevant to all water body types?	No – limited in large deep waters	No – largely applicable to deep slow waters.	No – only suitable in certain locations	No –only at selected sites
Will the method assist with the risk assessment of pressure-impact (good stress-biological response relationship)?	Yes	Will assist	Yes	Yes – may be helpful
Can it provide a robust statistical probability of class status (high level of confidence)?	?			
Is the method already well established and validated?	Yes	Yes	Yes	No
Are there national/international standards for the method?	Yes	No	No	No
Is the element/method compatible with the ones described in the Directive?	?			
Can it be considered a cost effective method?	Yes – most cost effective of methods considered	Yes – resource efficient,but expensive start-up.	Yes – cheap to set up but labour intensive	Yes

Table 8. Assessment of selected fish survey methods for **lakes** against key criteria.

Methods for lakes:	Gill netting	Hydroacoustic survey	Seine netting	Angler census
Can method '*x*' generate a metric that can predict values at reference conditions?	Yes	No	Yes	No
Is the method relevant to all water body types?	Yes – but destructive	No	No	Yes – but biased
Will the method assist with the risk assessment of pressure-impact (good stress-biological response relationship)?	Yes	Yes	Yes	Yes
Can it provide a robust statistical probability of class status (high level of confidence)?	Yes	No – adds value	Yes	No
Is the method already well established and validated?	Yes	Yes – but still developing	Yes	Yes
Are there national/international standards for the method?	Yes	Yes – but still developing	No – under development	No
Is the element/method compatible with the ones described in the Directive?	Yes	No – adds value	Yes	Yes but potential bias
Can it be considered a cost effective method?	Yes	?	Yes	Yes

Table 9. Resource implications for sampling fish in lakes using various techniques

Method	Initial Gear cost per operational unit	Optimum team size*	Max daily performance**	Lab Process & report time – man days per field day	Example Total Man days for lakes of area:		
					<5ha	**10ha**	**50ha**
Nordic Gill net survey	£k 5-10 (Guess)	2	6-8 gill net gangs	2.5	4.5	4.5	9
Seine net (eg 150m)	£k 6-8	4-6	4-5 draws 6000 - 8000m^2	2.5	7.5	15	22.5
Electric fish margins	£k 8-10	3-4	2000m of shoreline	2	5	5	10
Hydro-acoustics	>£k 50	2-3	8-12 Ha	2	N/A	5	15
Angler census	<£k 2	1	20-30 interviews	1	2	4	12

* Subject to Health and Safety and Lone-Worker protocols ** Includes preliminary data recording in the field, eg species id, fish lengths, and scale collection.

The cost of surveying a given lake would depend upon its area, depth and the techniques selected. As an example, for a 10 Ha lake sampled by hydro-acoustics and seine netting, the resource implications would be:

Hydro-acoustic costs		5 man-days
Seine netting costs		<u>15 man-days</u>
	total	25 man-days

For comparison, the resources required to sample the same sized lake by the proposed Nordic Gill Net Survey technique would be 4.5 man-days.

Session 5 - Conclusions/recommendation

Brian Clelland and Roger Owen drew the workshop to a close by reviewing briefly some key features. Roger suggested that the following conclusions might be drawn.

Conclusions

1. Common methods for assessing fish are in use through the UK. These are not yet national standards but some are Agency standards.
2. A largely common understanding of the applicability and relative efficiency of methods exists but their actual use depends on the resources available.
3. Fish are sensitive to a variety of pressures and especially useful for certain pressures using the appropriate metric or indicator.
4. In relation to WFD: Determination of appropriate elements for ecological classification (spp composition, abundance and age structure) is possible with appropriately selected assessment methods, but usable data is currently very sparse.
5. The FAME project is designed to deliver a common approach to deriving a classification scheme for the fish quality element, including an element of intercalibration. However, it does not deliver this until 2004 and does not include data/sites from Scotland, Northern Ireland or the Republic of Ireland.
6. Reference conditions for fish quality element metrics depend on successfully identifying reference sites. In ecoregion 17, high quality sites have been selected as potential reference sites, based upon long-term monitoring, verification pending. Scotland is to identify the best available water bodies, subject to a REFCOND check of anthropogenic pressures and ecological criteria.
7. There are no established classification schemes using the ecological quality response approach for fish in the UK (although a current Peter Maitland project may contribute to this). Some classification schemes operate in other EU states (eg. Austria for alpine lakes).
8. Development of ecological classifications based on fish is achievable but metrics have to be derived by the most appropriate method or combination of methods for UK lakes and rivers.
9. Methods can be separated according to practicality, cost-effectiveness and specific utility for water body types.
10. Methods/metrics could be used for Risk assessment, Operational Monitoring and Investigatory Monitoring – with progressive levels of certainty. (This largely depends on the intensity of monitoring).
11. To achieve statistically robust classification might often require a combination of techniques to collect appropriate data.
12. It appears to be possible to assemble a list of methods grouped for suitability and utility for various WFD purposes. But they require standardization.
13. Current data is very sparse for WFD classification – this requires an overall UK strategy.

In closing the meeting it was agreed that a note of the proceedings would be circulated for comment, and that a final draft would be made available to the UK Task Teams.

Annex 1: List of participants.

Name	Organisation	e-mail
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Annex II Agenda for the workshop on fish and the Water Framework Directive.

Day 1	**13th August**	
1030	Delegates arrive; coffee	
	Meeting chair: Roger Owen SEPA	
	Meeting rapporteur Brian Clelland SEPA	
Session 1	Introduction	
1100	Introduction to Workshop (plenary)	Roger Owen
1115	The Water Framework Directive and fish	Callum Sinclair/Peter Pollard
1145	Discussion	
1230	*lunch*	
Session 2	Background: using fish in ecological assessments	
1315	Introduction (plenary)	Roger Owen
1330	Workshop sessions[1]	
1430	Presentations (plenary)	
1500	Conclusions	
1530	*tea/coffee*	
Session 3	Selecting fish population parameters	
1600	Introduction (plenary)	Malcolm Beveridge
1615	Workshop sessions[1]	
1715	Presentations (plenary)	
1745	Conclusions	
1915	*Taxis depart for Edinburgh*	
2000	*dinner – French Corner Bistro, Queensferry Street, Edinburgh*	
Day 2	**14th August**	
Session 4	Fish assessment methods	
0900	Introduction (plenary)	Willie Duncan
0915	Workshop sessions[1]	
1045	*tea/coffee*	
1115	Presentations (plenary)	
1145	Conclusions	
Session 5	Revision of conclusions/recommendations	
1215	Discussion (plenary)	
1315	*lunch*	
1415	**CLOSE**	

[1] lake; river