Summary of Issues Arising from the UKTAG Lake Fish Classification Consultation Responses

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Lake Fish Classification	
Recommended standard be approved:	Yes
Changes following consultation:	None

Lake Fish Classification public consultation responses

Detailed responses were received from 4 organisation, and questions about the method's application from a further one. The majority of respondents supported adoption, but one organisation raised questions about proceeding with this new method at this time. UKTAG considered these comments carefully and responses are provided in Annex 1.

Most comments were directed at the derivation of the method, but some questions were asked about implications for the subsequent development of improvement measures. This consultation is restricted to the derivation of the method, and the approach to measure development is set out below.

Key Issues Raised

Is the Method WFD Compliant? We believe the method is WFD compliant as it is reference based and the status classes it describes vary across a pressure gradient which is attributable to anthropogenic impacts in UK lakes. It allocates waterbodies into 4 status classes with Poor and Bad being combined as we believe no Bad status lakes were sampled in the development programme. The High, Good and Moderate status classes are defined in accordance with the normative definitions that are described in the Water Framework Directive.

The WFD identifies age-class structure as a parameter to describe lake fish community condition. However, our e-DNA method does not currently provide data for this metric, and we believe this is acceptable for the following reasons. Age class structure assessments requires the use of gill nets which are a destructive sampling method, and they only provide a biased view of age-class structure and a partial representation of species composition. In contrast e-DNA sampling provides a more comprehensive view of the species living in a lake and we believe that any short comings that arise from not describing age class structure are more than compensated for by the improved data on species composition and relative abundance that we get from e-DNA. Additionally, a number of methods that have been successfully inter-calibrated also exclude age class structure on the basis that they also have questions about the reliability of the data required for this metric provided by the currently available sampling methods

Following withdrawal from the EU UK is no longer part of the Common Implementation Strategy Group ECOSTAT which facilitates inter-calibration so it is currently no longer possible to actively compare the method with other Member States.

Correlation with Existing Methods for Other Biological Elements- Rather than being an issue we believe that this demonstrates that the method performs well in describing the pressure that it was developed to respond to. Where several methods are available that respond to the same pressure a significant degree of correlation would be expected, and other than for surveillance purposes it is not necessary to use all methods in all sites. Given the public interest in fish as important part of the fauna in GB lakes we believe a method that describes their condition is a welcome addition to the suite of methods available to describe lake status. The use of environmental DNA also provides a welcome adoption of this new technology.

Low GB Lake Fish Diversity and Distinct Bio-geographic Assemblages- Both of these issues are recognised as challenges when using lake fish communities as environmental indicators. However, we believe that the modelling used to predict the occurrence and absence of common species in reference lakes overcomes these issues. The alternative is to define local reference communities based on expert judgement and previous attempts at developing lake fish methods have struggled with this. This is recognised as an issue and we will review performance of the method in the early years of its application.

Related to this a specific question was raised about the about restricting the method's use to Scotland and upland areas of England & Wales; however, on balance we are content with the method's performance and recommend its use at Surveillance lakes across Great Britain.

Diagnosing Multiple Pressures Which Shape Fish Communities- We fully accept that no single assessment method has the ability to describe the full range of pressures which affect the aquatic environment. To account for this a range of methods are applied which have been optimised to describe range of pressures which affect UK lakes. We believe this multi-faceted approach provides a comprehensive view of the pressures affecting individual lakes.

Evidence Led Measure Development The UK environment agencies compile evidence of environmental pressures using a range of UKTAG approved methods and wider investigations. These methods on their own do not lead to the formulation of measures, instead appropriate measures are developed through groups who are familiar with the pressures which affect catchments, and are subsequently consulted on in River Basin Plans. This typically involves making judgments based on the strength of evidence, with expensive measures requiring high levels of certainty.

Annex 1: Summary of comments from consultees and UKTAG responses

Question Number	Organisation	Question	Consultee feedback	Our Response
Question 1	Scottish Water	Do you support the proposals to introduce a new lake fish assessment method	Scottish Water welcomes these proposals since introduction of a lake fish assessment standard reflects a general move across ecological disciplines to make more use of eDNA as a way of obtaining reliable data from surveys whilst minimising the intrusiveness of the survey. We support the need for staged intercalibration and recommend that the method is confirmed to be Water Framework Directive (WFD) compliant prior to implementation to ensure that any changes are meaningful and effective in supporting improvements to ecological status.	Noted Following withdrawal from the EU UK is no longer part of the Common Implementation Strategy Group ECOSTAT which facilitates inter-calibration so it is currently no longer possible to actively compare the method with other Member States. Thus it will not be possible to complete a formal Inter-calibration. However, as the method correlates well with existing nutrient sensitive inter-calibrated procedures we believe this provides us with confidence to support its use.

	Natural England	Do you support the proposals to introduce a new lake fish assessment method	Natural England support the proposal to develop and introduce a new WFD lake fish assessment method and we welcome this consultation between all parties interested in the conservation of standing water habitats and their associated biota, including fish populations. Natural England is responsible for assessing the condition of standing waters designated as Sites of Special Scientific Interest (SSSI) and Special Areas of Conservation (SAC) under the Habitats Directive (WFD Protected Areas). While there are similarities between wider WFD objectives/monitoring and the requirements of designated sites, there are also differences due to the often higher levels of precaution applied to specially protected sites. For lake sites, Natural England's assessment has indicated a widespread failure to achieve Common Standards Monitoring targets. These failures are mirrored by WFD monitoring and the failure to attain GES within lake water bodies. Natural England has designated a series of SSSIs and SACs notified for their lake habitat, some of these are additionally notified for rare or threatened fish species such as vendace, whitefish, bullhead, lamprey species, Arctic charr and spined loach as additional features to emphasise the importance of sites to those species. The habitat feature includes both the abiotic (hydrology, hydrochemistry,	By necessity the development programme for this work focused on the needs of the WFD, and we fully recognise the benefits that would arise from its evolution to address conservation agency sampling needs.

			geomorphology) and biotic (characteristic biological assemblages) elements.	
			The objectives for the habitat, and management practices used to deliver them, are based on natural function. Many SSSI and SAC lakes are in unfavourable condition due to impacts on the natural function of the lake habitat. This loss of natural function may be due to impacts such as:	
			• degraded shorelines and littoral zones (and therefore physical habitat provision); • poor water quality resulting from land management activities; • inappropriate land management in both the riparian zone and wider catchment; • impacted hydrology (abstraction, impoundments, flow diversion and un-natural water level variation); • over-exploitation of particular species; • Invasive species and fish stocking at artificially high biomasses.	
			These pressures are replicated in the wider standing water network across England, including WFD lake water bodies and priority lake habitats, often with greater severity since these lakes do not benefit from the added protection and focus afforded by SSSI and SAC notification. Despite measures that have been, and are being, put in place, these pressures will continue to impact on	

			lake habitats and species already under pressure due to potential climate change effects.	
			In many cases within the lake environment, fish may act as keystone species which, if affected by human pressures and/or interventions, may have a disproportionate impact on other aquatic habitats and species and the functioning of the site as a whole. This highlights the need for an effective lake fish monitoring tool.	
			In addition, Natural England is responsible for reporting to JNCC on the implementation of the Habitats Directive in England (under Article 17 of the directive). As part of this reporting procedure the conservation status of Annex I Lake Habitats and Species of European Interest listed under Annex II and/or V must be assessed and this includes vendace, whitefish, bullhead, lamprey species, Arctic charr and spined loach.	
			Natural England fully appreciates that the WFD fish assessment tool has been developed for a specific purpose (the determination of eutrophication pressures on WFD lakes) and should only be used as such, however, in accordance with Natural England's statutory duties, our response to this consultation applies to designated sites (Protected Areas as defined by the WFD), their associated habitat and species features and the use of a lake fish assessment tool to inform the management of these areas. It is our intention that the issues we highlight and	

			general principles discussed may be extrapolated to the overall functioning of the WFD fish assessment tool within all lake environments across the wider standing water resource.	
	Southern Water	Do you support the proposals to introduce a new lake fish assessment method	On balance – no. Not yet. On the basis of the supporting information I have seen and the information during the excellent webinar on 22nd Jan I think further work is needed on this proposed method. I am currently unsure of the merits of introducing this new assessment method (the lake fish assessment method) at the moment on top of the existing methods for assessing compliance of lakes with the WFD. The method evaluation reports how the results of the new assessment method compare with those from the existing assessment methods. An overall good comparison between the new and existing methods is presented in the document. As a result I am unsure why a new assessment method is required in addition to the existing ones.	When the development programme for this work was initiated the UK was required to develop a lake fish method for WFD reporting. This imperative has changed, but UKTAG believes there are merits in having a method that describes the condition of lake fish communities.

			Although a generally good comparison is noted - at 6 of the 105 lakes examined in the comparison of the new method v the existing methods - a downgrading of the WFD classification is suggested when the new method is applied. As a result of the "one out all out" classification used in the WFD these six water bodies would be downgraded. We need to understand better why a deterioration was suggested under the new method for these six. I am unsure that using fish species are a good indicator of water quality especially in isolated lakes where it may not be possible for those fish representing better quality waters to be added naturally other than by man. In this scenario a "high" quality lake could theoretically be classified with a lower grade if this methodology was applied if the "right sort of fish" are not present.	Biological responses to environmental pressures will always have a degree of variability, so a perfect alignment is unlikely. Where different elements produce different results this is a trigger for further investigation at the water body level.
	NFU	Do you support the proposals to introduce a new lake fish assessment method	Yes, notwithstanding the points outlined above, we believe there is significant merit in using the eDNA method of data collation for fish populations compared to historical survey methods, such as gill netting.	Noted
Question 2	Scottish Water	Are you content with the technical basis and evidence base for the proposed standards, and with the resulting proposed classification scheme?	With the recognition there is potential for deterioration in classification at some waterbodies in Scotland based on these proposals, it is unclear why the method would be adopted prior to confirmation that it is WFD compliant. It is unclear whether ecological quality ratios would include only species found in the region being surveyed, e.g. we note that certain species noted in the consultation document are not present in Scotland.	Whilst full inter-calibration with other lake fish methods isn't possible at the moment, the comparison work we've undertaken leads us to believe that the assessments from this method will align well with other similar methods. Also refer to other comments on compliance and geographical application elsewhere in this response.

	Natural England		Natural England welcome the development of an eDNA based fish assessment tool for WFD assessment as, although not specifically designed for the purpose, it may allow the monitoring of protected fish species, such as vendace, whitefish, bullhead, lamprey species, Arctic charr and spined loach without the need to resort to gill netting or other destructive gear. It may also better inform the management of protected standing water habitats and their associated fish communities across England. eDNA metabarcoding techniques have been demonstrated to offer high quality presence/absence data in a variety of lake types with abundance/quantitative assessments currently being refined. Although there is still a significant level of uncertainty around some areas of the monitoring protocols, it must be considered that these techniques already offer marked improvements in resolution, compared with gears currently being deployed. Due to the very recent development of these genetic/biochemical methods, it appears highly likely that they will continue to be refined and areas of uncertainty reduced as the techniques evolve further. It is acknowledged that the tool is based on a significant data set gathered from 101 water bodies across England, Wales and Scotland and these data cover a range of lakes with differing trophic states and morphologies. However, Natural England wish to highlight that these data are skewed towards the	Currently the community data provided by e-DNA sampling programmes fails to deliver the information that is required to make complete assessments of species that are of conservation interest. We will continue to work with conservation agencies across the UK to explore areas of common interest in e-DNA/DNA monitoring. To support this we are happy to make the data sets that were used for this work available for future development projects. We recognise the scope to extend the geographical extent of the method's reference data set, and this will be kept under review in the early years of the method's application. However, on balance we are happy to recommend application of the method across the GB. All decisions on improvement measures are made on a "weight of evidence" basis, and the environment agencies will take account of these geographical issues when in the methods application. We are aware of the project being undertaken between Natural England and the University of Hull and understand the outcome of this work to feed into the standardisation work that is being undertaken in parallel with the metric

			higher altitude, lower productivity end of the range, with lowland, high alkalinity water bodies being under-represented, particularly within the reference data set.	development that is the basis of this consultation.
			This potential bias is most likely to impact on English fish population assessments, when compared with those of Wales and Scotland. Natural England fully appreciate that this bias is an artefact generated by the lack of high quality, lowland lakes occurring in England, however, this should highlight the importance of urgent investment in lake restoration programmes across the UK, with a particular emphasis on English, lowland lakes which currently represent some of the most degraded, but least addressed, habitats included within the WFD and Protected area programmes.	
			The ability of eDNA to detect 40 fish taxa within UK lakes is a testament to the sensitivity of the new method. Although the WFD tool reduces the metric to a small number of widely distributed fish species, the additional information on other fish species is of vital importance for both the condition assessment process and the management of protected areas. This additional information should be recorded and held in an easily accessible format to aid the work of SNCB's, in addition to the needs of WFD assessment. We respectfully ask that these species records be made available at the earliest opportunity. In addition, due to the rapid progress being made with eDNA techniques, raw data should	

be in an open access format to facilitate further research.

Use of the fish assessment tool at the sites listed has produced a reassuringly close correlation between fish and other biological classifications. The tool seems well suited to identify eutrophication pressures in many lowland high alkalinity lakes, such as those in the meres and broads. However, due to a lack of such lakes in good condition, only one at GES is incorporated in the test data set. Consequently confidence must be lower in how well the tool would identify such lakes in good condition. This is partly due to a lack of data, but also due to how percids are treated by the tool and the natural lack of positive indicator species in these sites. This may be a particular issue for lowland England where the species found differ from those in Wales and Scotland. The extent to which this is an issue is unclear and it must be acknowledged that the fish tool correctly identified the single lowland high alkalinity lake as being good or above. It has also correctly classified many lowland lakes in less than good condition.

When selecting 'reference sites' and assessing fish communities across the UK, the sensitivity of fish populations to detect eutrophication pressures is acknowledged as the assessment tool appears to reflect these changes. However, Natural England have concerns around natural biogeographic distribution of fish communities and the impacts of anthropogenic stocking which

| | | | may result in the artificial range expansion of many fish species across England.

There is the possibility of these factors influencing outputs for some water bodies where species considered locally non-native are present due to stocking or species which the tool considers should be present due to physico-chemical/morphometric conditions are not present due to natural biogeographic isolation.

In general terms, It is felt that reference fish populations are relatively poorly understood in many lakes, particularly lowland/high alkalinity examples.
More specifically, due to the importance apportioned by the tool to salmonid/coregonid and brown trout populations in EQR calculations this may increase the probability that the tool could poorly describe and classify lowland waterbodies where these fish may not be expected to be present or only at low abundance.

Despite the many fish species detected, it is surprising that only salmonids, trout, percids, roach, bream and carp are found to be useful components of the tool. It is also surprising that a negative relationship was found between percids and nutrient concentration. The scientific literature has previously suggested a unimodal response of perch to nutrient concentration, with a peak at moderate nutrient concentrations. This has also been supported by observations in the | |

Norfolk Broads where perch are scarce in highly eutrophic turbid conditions, but are more likely to be present, and in greater numbers, as lakes recover with clearer water and more macrophytes. In contrast, the negative relationship between cyprinids and nutrient concentration is often reported in the scientific literature and they are commonly dominant when lakes are in poor condition due to eutrophication.

Some of these issues may be addressed by further work to define reference fish populations within lowland lakes and to better elucidate the importance of perch / trout dominated communities and their interactions with other fish species. To help resolve this evidence gap, Natural England are currently developing, and seeking funding for, a PhD to investigate the interactions of freshwater fish species within English lakes. However, it is acknowledged that it is difficult to improve this aspect of the tool due to the lack of lowland high alkalinity sites at good ecological status in England that could be sampled.

Although potentially out of scope for this consultation, it is worth noting that opportunities may exist for refining the sampling regimes used for fish eDNA data collection. Natural England are currently undertaking a project with Hull University to interrogate the 101 lake data set to determine the levels of certainty / uncertainty

| | | | with differing levels of sample effort. On initial inspection, there appears to be the opportunity to significantly reduce individual sample effort at a site without significantly compromising fish species detection or quantitative assessment. This reduction in individual sample effort may enable a greater number of lake sites to be monitored within the overall sample programme, thus increasing geographic coverage with no increase in resource.

In summary, due to the effective working of the tool, its use should be progressed, in its current format. As lowland high alkalinity sites in England improve in quality or data is gained on unimpacted fish assemblages from paleo research, it would be beneficial to check the tool's performance on a wider range of lowland high alkalinity sites which represent good or higher ecological status. | |
| | Southern Water | Are you content with the technical basis and evidence base for the proposed standards, and with the resulting proposed classification scheme? | I do not dispute the robustness of the eDNA method and the information that has been provided about the benefits and the applicability of this method when compared to traditional gill netting methods. It seems obviously like a great leap forward. I am not sure however about the new WFD assessment method based on this work (see above for my comments on this).
I know the methodology was applied correctly taking each site on an individual basis. However when mapped in Figure 4 of the accompanying document there is an unfortunate – broad - | Noted, we recognise the issues with the reference data set that this method was developed from, but believe it will discriminate lightly or un-impacted lakes in England & Wales. |

			geographical trend that lakes in Scotland and highland areas in England and Wales (the Lake District, Snowdonia etc.) have a "high" or "good" classification using the new fish eDNA method while those in other areas – broadly lowland England have "poor"/ "bad" classifications.	
			This is unfortunate and we need to understand better how this trend arises – and for example plot the results of other WFD assessment methods applied to lakes in a similar way. I know the methodology has been applied in a fair and even way – but maybe the classification of what is a "high" or "good" quality lake based on the fish eDNA assessment needs to be reviewed? I have not seen the detail of this work but it would be useful to know how these lowland English lakes fair when they assessed using the other WFD assessment methods. Is this a bias in the new eDNA assessment method or are these lakes broadly "poor" and "bad" using other WFD assessment methods.	Evidence from the classifications published previously by the relevant agencies shows a higher proportion of lakes failing to achieve good ecological status in England than in Scotland and Wales, and this is directly related to the higher level of nutrient and other pressures affecting lowland areas in particular.
	NFU	Are you content with the technical basis and evidence base for the proposed standards, and with the resulting proposed classification scheme?	We think the method of assessment, as described, within the consultation document, does not give due consideration to other factors/pressures that can strongly influence current fish populations; thereby inferring observed fish populations are solely determined by current nutrient inputs and baseline lake conditions. UKTAG may have considered and dismissed other inputs but for clarity and transparency it would be helpful to include such a discussion within this consultation.	Noted, the formulation of improvement measures are derived from a range of evidence sources, and when expensive restoration is required the environment agencies require a high level of certainty prior to action being taken.

| | | | With respect to River Basin Management Plans, the agencies use monitoring and assessment targeted at risks and focused on the causes of these risks (Paragraph 1.32). We do not believe this method currently assesses all the pressures and may incorrectly draw conclusions based on the current understanding of nutrient sources, in doing so ignore some fundamental (historical) reasons for current fish populations. This could unduly and unfairly implicate current agricultural practices as having greater influence on fish population than they do.

We believe other factors should be considered prior to class determination; for example, the historical presence or absence of fish taxa, leisure activities undertaken within the lake, historical point source discharge to lake such as sewerage into Llangorse Lake and canal discharge into Aqualate Mere.

The WFD 'one-out-all-out' rule is a blunt tool that provides a 'pessimistic bias', which could result in implementation of costly measures to improve the lake status without much chance of success. WFD classifications and River Basin Management Plans provide little useful information to stakeholders to allow them to identify and/or address the specific causes of poor status of local waterbodies and watercourses. | |
| | AECOM- Pete Cowley | | 1. Current fish eDNA sampling that we have used through one of the industry eDNA providers has consisted of sub-sampling around the margins of a water body, and then pooling the sub- | Yes, a sampling protocol that requires a number of samples to be gathered and analysed individually has been prepared for this method. |

			samples into a single sample to result in a single sample being sent to the laboratory for analysis. This would not fit with the methodology Willie described, as presumably individual sub-samples would be required to indicate the Occupancy factor. Will there be a bespoke eDNA sampling methodology for WFD compliance? 2. In relation to the above, will there be an accreditation for eDNA providers to ensure WFD compliance, in line with the required sampling and analysis protocol?	Standardisation for e-DNA/DNA sampling and analysis is in its infancy. Whilst there won't be any compulsion on which procedures to follow in general usage it makes considerable sense to utilise the recommended sampling and analysis methods when using this metric, and it will be a requirement when undertaking environmental assessment for WFD reporting work on behalf of the UK environment agencies.