WATER RESOURCES ACT 1991

THE WALES ROD AND LINE (SALMON AND SEA TROUT) BYELAWS 2017

THE WALES NET FISHING (SALMON AND SEA TROUT) BYELAWS 2017

DOCUMENT NRW/3A

SUMMARY PROOF OF EVIDENCE

OF

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on behalf of

CENTRE FOR ENVIRONMENT FISHERIES AND AQUACULTURE SCIENCE (CEFAS)

and

NATURAL RESOURCES WALES

NOVEMBER 2018

1   Introduction

1.1   My name is Jonathan Barry. I have a BSc in statistics from Reading University, an MSc in statistics from Edinburgh University and a Ph.D. in statistics from Lancaster University. I am a statistician working for Cefas - the Centre for Environment, Fisheries and Aquaculture Science - and honorary lecturer in the Environment section of the Data Science Institute at Lancaster University.

1.2   I have carried out statistical consultancy for over 30 years, since 1986. I have currently published around 85 peer-reviewed papers in the academic literature. Most of my work is in the ecological and environmental sciences.

2   Scope of evidence

2.1   My evidence covers:

2.1.1   a description of the statistical aspects of the current approach to assessing the status of salmon stocks and the associated procedures for assessing compliance with management objectives; and

2.1.2   my response to the statistical critique of those procedures, which was commissioned by some of the stakeholder groups engaged in the formal consultation process on the byelaws, and prepared by O'Hagan and Fop of University College, Dublin.

2.2   The scope of my evidence therefore addresses the underlying methodology by which NRW have identified that there is a problem, and determined its nature and extent.

2.3   I conclude that the approach taken by NRW is fit for purpose.

3   Statistical basis of salmon stock assessment modelling

3.1   The use of Conservation Limits in England and Wales has developed in line with the requirement of ICES and NASCO to set criteria against which to give advice on stock status and the need to manage and conserve individual river stocks. The status of individual river stocks in Wales is evaluated annually against these criteria, using egg deposition estimates. Conservation Limits indicate the minimum desirable spawning stock levels below which stocks should not be allowed to fall.

The Conservation Limit is set at a stock size (defined in terms of eggs deposited) below which further reductions in spawner numbers are likely to result in significant reductions in the number of juvenile fish produced in the next generation.

3.2 In reviewing management options and regulations, NRW also uses an over-arching Management Objective that a river's stock should be meeting or exceeding its Conservation Limit in at least four years out of five (i.e. >80% of the time). A Management Target is set for each river, representing a spawning stock level for managers to aim at in order to meet this objective. The target is set using the standard deviation of egg deposition estimates for the last 10 years, and is set at a level such that the Conservation Limit forms the 20th percentile of a distribution, the average (or 50 percentile) of which equates to the Management Target. This means that if the river is reaching its Management Target, there should be an 80% chance of a given sample exceeding the Conservation Limit. Compliance with this objective is calculated annually for all the Principal Salmon Rivers in Wales for the latest assessment year and forecast for five years ahead.

3.3 These assessments for each Principal Salmon River are then incorporated into a national decision structure for guiding decisions on the need for fishery regulations. This assesses the probability of the river achieving the Management Objective in five years' time, indicates what change in exploitation rate is required, and helps to highlight the need for other management actions where appropriate.

Details of the annual compliance assessment –

3.4 The performance of salmon stocks in Wales is assessed using a compliance scheme designed to give an early warning that a river has fallen below its conservation limit. Using an approach introduced in 2004, Bayesian regression analyses are applied to egg deposition estimates from the last 10 years, a 20-percentile regression line is fit to the data and the probability that this regression line is above the conservation limit is calculated:

3.4.1 if there is < 5% probability that the regression line is above the conservation limit, the river fails to comply (i.e. is regarded 'at risk');

3.4.2 if the probability is > 95%, the river complies in that year (i.e. is 'not at risk');

3.4.3   between these probability values, we cannot be certain of the stock status and the river is 'probably at risk' (5% < p < 50%) or 'probably not at risk' (50% ≤ p < 95%)).

3.5   In line with the precautionary approach, it is assumed that there is an underlying linear trend in the logarithms in the egg numbers (effectively this means that the change in egg numbers from time 1 to time 2 is proportionate to the egg numbers at time 1), and that trends observed in the past will continue into the future. The regression line is therefore extrapolated to project the likely future performance of the stock relative to its Conservation Limit, and so assess the likely effect of recent management intervention and the need for additional measures.

3.6   It should be noted that egg deposition estimates for a river may be consistently above the Conservation Limit but status may still be uncertain. This can be the case where there is significant year-to-year variation in egg deposition estimates, which produces broad Bayesian Credible Intervals around the regression lines. It also arises because of the slope of the trend line and the increasing uncertainty associated with all regressions when extrapolated into the future.

3.7   As well as providing an assessment of the status of a river in relation to its Conservation Limit, the direction of the trend in the 10-year time-series of egg deposition estimates and its statistical significance may also serve as an important indicator of the need to take management action and of the degree of intervention required. Thus, a clear negative trend would give additional cause for concern.

3.8   Conservation Limits and Management Targets form only one part of the assessment of the status of a stock, and management decisions are never based simply on a compliance result alone. Because stocks are naturally variable, the magnitude and duration of compliance failures are also key considerations. A range of other factors are also taken into account; particularly, the structure of the stock and any evidence concerning the status of particular stock components, such as tributary populations or age groups, based for example on patterns of run timing and the production of juveniles in the river sub-catchments.

4   Discussions with University College, Dublin Academics

4.1   I was asked to review comments included in reports produced by Dr O'Hagan and Dr Fop that were appended to letters sent by stakeholder groups in response to the consultation process around the proposed new fishery control measures.

4.2   I produced an initial assessment of the O'Hagan and Fop reports in April 2018, to inform the production of a formal Cefas response, which was later included in Defra's May 2018 response to the Chairman of the Ribble Fisheries Consultative Association. I later produced a further short report in response to the circulation of additional comments on statistical issues from Dr O'Hagan and Dr Fop that had been produced in response to the Cefas report.

4.3   I do not agree with O'Hagan and Fop on many of the more minor points that they raised. However, more importantly, I am at odds with them on their opposition to assuming a linear reduction in (log) egg numbers in the future when one has been observed in the past.

4.4   The method used by the Environment Agency and NRW is based on a precautionary approach and assumes that what has happened in the past could happen in the future. I think that it is instructive to consider the options if a linear decline in (log) egg numbers is observed.

   1. Assume that a linear decline will happen in the future (the EA/NRW model approach). If you are correct, then taking remedial action will hopefully resolve the problem. If you are wrong, then your remedial actions were unnecessary.

       OR

   2. Assume that a linear decline will NOT happen in the future (which is essentially the time series approach proposed by the consultant statisticians). If you are wrong, then this could cause damage to the fishery because remedial action has not been taken. If you are correct, then you won't have taken remedial action unnecessarily.

4.5   Of the options above, I think that 1 is best because the adverse consequence (unnecessary remedial action) is far less serious than the adverse consequence in 2 (damage to the stock). This is clearly a value judgement, in line with the

precautionary approach, and one that needs to be considered by fisheries experts, rather than statisticians.

5   Conclusions

5.1   My view is that, for the time being, we should carry on with using the precautionary approach currently in use by the Environment Agency and NRW, which I continue to believe is fit for purpose.