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/2R

REBUTTAL PROOF OF EVIDENCE

OF

IAN DAVIDSON

SENIOR TECHNICAL ADVISOR SALMONIDS

on behalf of
NATURAL RESOURCES WALES

JANUARY 2019

This page has been left intentionally blank.

1 Introduction

1.1 Further to my Proof of Evidence submitted on 21 November 2018 (**NRW/2**), and having considered the Objectors' evidence submitted on 18 December 2018, I, Ian Davidson, present this rebuttal evidence.

1.2 My rebuttal is limited to those matters which require the submission of additional written evidence and will not repeat evidence already before the inquiry.

1.3 My rebuttal evidence addresses the following key issues:

1.3.1 Derivation and use of Conservation Limits (**"CLs"**)[1]

1.3.2 Data sources for stock assessment

1.4 I also address the request for further information made by Mr John in his supplementary proof dated 31 December 2018[2].

[1] NRW/1D, p 3.
[2] PGJ/1a.

This page has been left intentionally blank.

2 Derivation and use of Conservation Limits

2.1 There are two main matters raised by Objectors in respect of the derivation and use of Conservation Limits, which will each be considered in turn:

(a) First, it is argued that the CLs, Management Objectives and associated Management Targets[3] have been wrongly applied by NRW in assessing the status of individual river stocks and/or are unfit for purpose.[4]

(b) Secondly, Objectors contend that poorly fitting (Ricker) stock and recruitment relationships have been used to derive CLs for both salmon and sea trout, ignoring numerous intervening factors operating in the life cycle which influence fish numbers (e.g. environmental quality, predation, etc.).[5]

Objection contention 1: The Conservation Limits, Management Objectives and associated Management Targets have been wrongly applied by NRW in assessing the status of individual river stocks and/or are unfit for purpose[6]

2.2 Some of the Objector evidence[7] labours under a misunderstanding as to the terminology associated with CLs and their application to stock assessment. This matter is largely addressed in primary evidence.[8] I make the following additional points in response to specific contentions here.

2.3 First, Objectors express concern about the adjustment of the Replacement Line[98] and how and why that affects the CL value. Adjustment of the Replacement Line occurred in 2003 to reflect lower levels of sea survival than were originally assumed when setting CLs. The outcome of this revision was a reduction in CL values across all rivers. Some of the Objector evidence reveals a mistrust of this process and misunderstanding of its consequences.[10]

---

[3] NRW/1D, p 6.
[4] CPWF/2, paras 25 and 76; AN/1A, para 144; AN/1E, para 2; AT/1 paras 20 and 21.
[5] BM/1, Section 2.2.
[6] CPWF/2, paras 25 and 76; AN/1A, para 144; AN/1E, para 2; AT/1 paras 20 and 21.
[7] CPWF/2, paras 25 and 76; AN/1A, para 144; AN/1E, para 2; AT/1 paras 20 and 21.
[8] NRW/2 paras 3.44. to 3.54 and NRW/4, Section 4.
[9] The Replacement Line is a straight-line relationship which defines the survival rate between fish leaving the river as smolts and retuning as adults. In combination with the stock-recruitment curve describing the egg to smolt stage, it effectively completes a model of the full lifecycle. See para 3.46 of my primary evidence NRW/2, and ACC/29.
[10] CPWF/2, paras 26 to 30.

2.4 Fig 1 and the associated Table in the submission from CPWF,[11] present an unusual way of viewing the impact of falling sea survival on stock levels. In practice, the stock-recruitment curve defines a fixed carrying capacity for each river system (i.e. its smolt producing capacity) based on the physical nature of that system and the available area of spawning/rearing habitat. The consequence of falling sea survival will be fewer adults returning for a given smolt output and the population settling at a lower level of production. Fig 1[9], however, implies that adult numbers can be maintained by boosting smolt output (including beyond the carrying capacity of the system), although the means by which this would occur are not made clear.

2.5 As CPWF have observed, it is true to say that further adjustment of the Replacement Line to reflect more recent (and poorer) sea survival would result in a reduction in the CL. This is because the CL is set to maximise the catch of fish returning to home waters, and is not, as such, a reference point to conserve stocks. The inclusion of the Management Objective (and associated Management Target) does, however, afford additional protection to stocks (a buffer above the CL). CLs and Management Targets, at their current level, are considered to provide adequate protection to stocks (close to but not at maximum smolt production). Consequently, (and contrary to the conclusion drawn by CPWF[9]) further downgrading of CLs in response to falling sea survival <u>is not</u> being considered by NRW or the Environment Agency ("EA") as this would have the undesirable effect of weakening stock protection to unacceptable levels.

2.6 Secondly, further concerns are raised about variations in the Management Target expressed as a percentage of the CL,[12] and particularly its use in identifying egg deficit/shortfalls in ranking the vulnerability of river stocks.[13]

2.7 These deficit/shortfalls provide an additional indicator of stock performance, but are ranked third after (1) 'risk' status and (2) the 10-year trend in egg deposition estimates, both of which result from the formal compliance test (these indicators are referred to as 'stock health indicators' by CPWF[14]). The purpose of this three-

[11] CPWF/2, paras 26 to 30.
[12] CPWF/2, paras 25 and 76; AN/1A, para 144; AN/1E, para 2; AT/1 paras 20 and 21.
[13] NRW/2, Tables 2 and 3 on pp 29-30.
[14] CPWF/2 paras 73 to 76.

tier ranking process is to identify the most vulnerable stocks and the likely need for additional fisheries regulation.

2.8 The level of the Management Target relative to the CL reflects the degree of variation in egg deposition estimates over the latest 10-year period. Put simply, the more stocks vary from year-to-year, the less certainty there can be that the CL is being met. This means that where stocks have a high level of variation, the Management Target has to be higher as a percentage of the CL, in order to ensure that those stocks meet their Management Objective (of exceeding the CL for four years out of five). Conversely, where stocks are less variable, the Management Target is lower as a percentage of the CL.

Objector contention 2: Poorly fitting (Ricker) stock and recruitment relationships used to derive CLs for both salmon and sea trout, ignoring numerous intervening factors operating in the life cycle which influence fish numbers (e.g. environmental quality, predation, etc.)[15]

2.9 Objectors have criticised the use of Ricker curves. The Ricker curve is used by NRW and the EA to model the freshwater 'density-dependent' phase of the life-cycle of migratory fish (density dependent because the size of the population is constrained by the physical limits of river it occupies), and is one of a number of theoretical stock and recruitment relationships applied in fisheries assessment. The Ricker curve is a dome shaped curve where – in the case of its use on salmon by NRW – the number of smolts (referred to as "recruits") increases as the number of eggs ("stock") increases, until the population reaches the maximum number that the river can sustain. After that point, additional stock causes the number of recruits to reduce (for a number of reasons, such as increased competition for food and other resources), and so the curve trends downwards. The top of the curve therefore defines the point of maximum recruitment and the spawners required to achieve that point. A number of studies on salmonids have found that the Ricker curve provides a good description of observed population data.

2.10 NRW would not disagree that numerous intervening factors between stock (eggs) and recruitment (e.g. smolts or whitling) could explain some of the deviation of discrete points from a fitted Ricker (or other) stock-recruitment (SR)

[15] BM/1, Section 2.2.

relationship, but NRW have not attempted to explore the specific reasons for such deviations in modelling the Ricker stock and recruitment relationships. Rather NRW's focus (in common with other jurisdictions) has been to use these modelled relationships, determined essentially by a process of best fit (explained below), to define biological reference points (e.g. CLs).

2.11 NRW do not, however, ignore the likely importance of these various factors to salmon and sea trout stocks, either (i) in trying to better understand, in more detail, the effect of particular factors at particular life stages (the follow-up investigations to the recruitment failure in 2016 is an example of this, as is the application of other fisheries assessment tools, for example, assessments of water body status under the Water Framework Directive to identify environmental constraints on fish populations)[16] or (ii) in addressing these factors as part of NRWs wider approach to environmental management.[17]

2.12 For sea trout in particular, Ricker stock recruitment curves have been fitted to these data sets simply to derive a reference point that has an underlying biological basis, and allows for a more defensible assessment procedure than the previous rod catch-per-unit-effort based approach. It also has much in common with the assessment procedures applied to salmon.[18]

2.13 Fitting such stock recruitment curves is not an approach novel to NRW (or the EA). Similar approaches have been applied in deriving biological reference points (CLs)) for salmon stocks on Irish rivers (see White *et al.* 2016)[19].

[16] NRW/2 3.26 to 3.43.
[17] See the primary evidence of Peter Gough (NRW/1), Ruth Jenkins (NRW/5) and Robert Vaughn (NRW/6).
[18] NRW/2 paras 4.1 to 4.17.
[19] NRW/2Rc

3 Data sources for stock assessment

3.1 A number of Objectors criticise NRW's data sources and their interpretation for stock assessment purposes, including the following:

(a) First, it is claimed that modelled angling exploitation rates, used (on rivers without traps or counters) to raise catches to estimates of run size for CL compliance, do not take adequate account of annual changes in fishing effort or other factors (e.g. flow) likely to influence fishing success.[20] Objectors note that fishing effort (on rivers like the Dee and Mawddach) has declined in recent years and link this to a likely fall in exploitation rate. They also contend that run timing, namely the percentage of the run entering after the end of the angling season, is not properly accounted for in estimating numbers of returning fish.

(b) Secondly, catch based assessments were considered by some to be too unreliable and uncertain, and indicated that more counters could and should be deployed. Others were critical of the use of existing trap/counter data – mainly on the Dee, and principally relating to extrapolation of data/observations to other rivers and the general inferences made about stock status and composition. Some called for greater use of juvenile survey data or were critical of the way juvenile survey data had been used in NRW's Technical Case.[21]

(c) Finally, NRW was criticised for not using other techniques to evaluate the status of stocks and causes of decline, namely (i) redd counting; (ii) smolt tagging to investigate marine migration routes and sources of loss and (iii) DNA.[22]

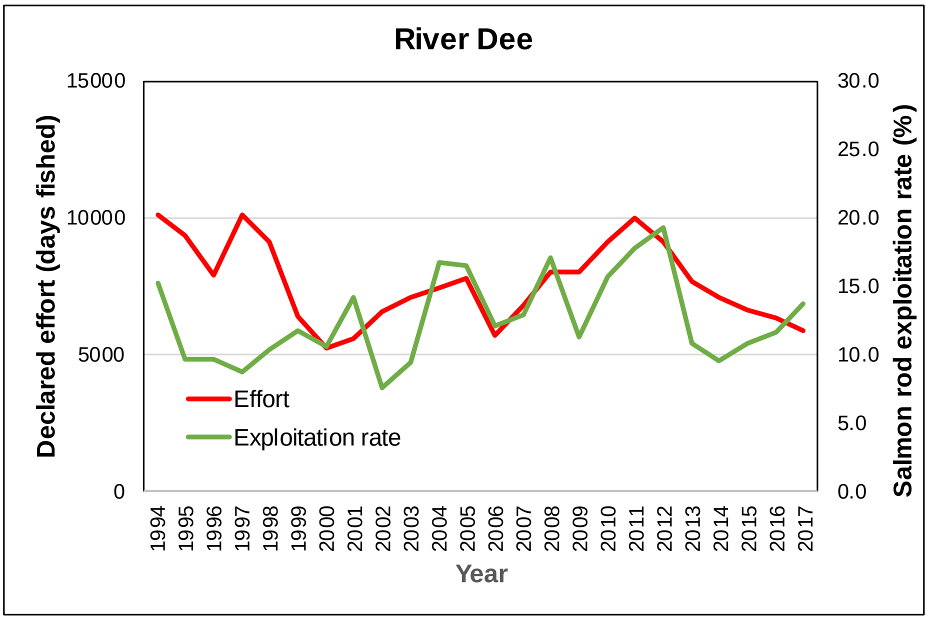
3.2 In general, these matters are addressed in my primary evidence.[23] I make further points to address these issues in turn below.

[20] CPWF/2 paras 41 to 46 and 49.
[21] ACC/1 para 16; AR1 paras 14,15, 21 and 37; CPWF/2 paras 51, 52 and 79; PJG/2 questions 1 to 9.
[22] PAAS/1 para 4iii;AR/1 para 63; NH/1A para 30.
[23] NRW/2.

Objector contention 3: Modelled angling exploitation rates, do not take adequate account of annual changes in fishing effort or other factors (e.g. flow) likely to influence fishing success.

3.3 CPWF refer to evidence of declining fishing effort on the Welsh Dee in recent years (2007-2016) and link this to a similar decline in angling exploitation rate.[24] However, over the full time-series of data available (Fig 1) it is evident that the relationship between these two variables is more complex than CPWF suggest.

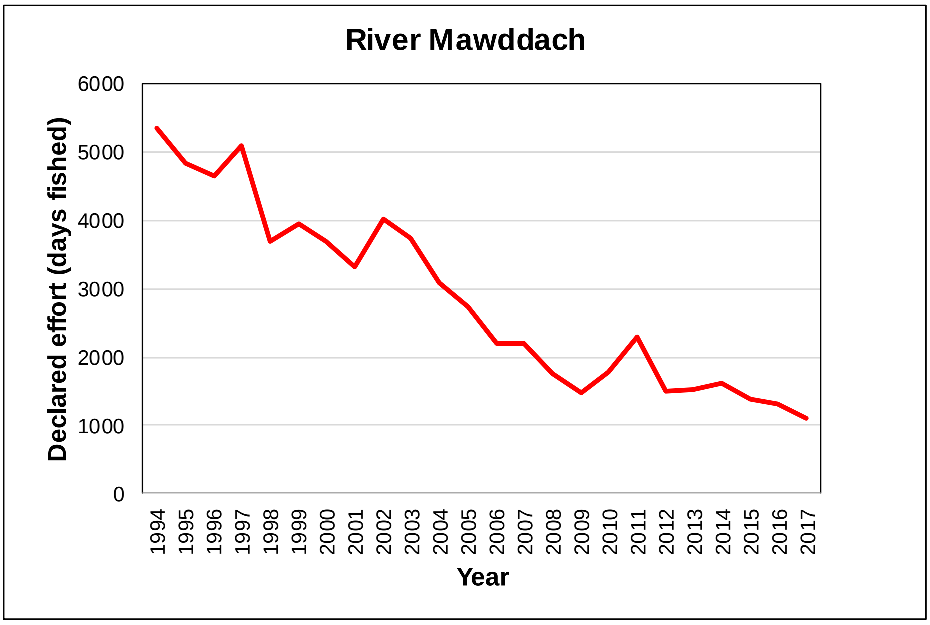
Fig 1 Annual variation in declared angling effort (days fished) and salmon rod exploitation rate (fish of all sea ages) on the Welsh Dee, 1994-2017



3.4 NRW don't disagree with CPWF[15] that there has been a marked decline in declared angling effort on the Mawddach (including the Wnion) since these data were first collected in 1994, although fishing effort appears to have been relatively stable since 2009 (Fig 2).

Fig 2 Annual variation in declared angling effort (days fished) on the River Mawddach (including Wnion), 1994-2017

[24] CPWF/2 paras 41 to 46 and 49.



3.5 Equally, NRW do not disagree that weather conditions, particularly through the influence on river flow and temperature, can affect fish migration and angling success. As indicated by CPWF poor angling catches in low flow conditions, may not just occur because fish are less 'catchable' but because fewer fish have migrated into the river and hence are available for capture.

3.6 Furthermore, the failure of fish to enter rivers in low flow conditions may not just be an issue of delayed migration until more amenable flow conditions arise, but delay in these circumstances may result in increased mortality in estuarial/coastal waters and hence give rise to fewer fish eventually returning to spawn in dry years (e.g. Solomon and Sambrook, 2004[25]). For this reason, and especially at a time when salmon stocks appear to be at exceptionally low levels generally,[26] the extremely dry conditions experienced in the summer of 2018 give particular cause for concern re. their potential impact on returning stocks.

3.7 Regarding the matter of out-of-season salmon runs:[27] On the Dee, numbers of salmon entering the river at Chester after the end of the angling season (mid-October) average less than 10% of the total run. Similar figures are evident on the Teifi, where counter reports for Glanteifi for the years 2010-2014 and 2017 indicate that around 77% and 91% of salmon counts (collected April-November)

[25] NRW/2Rd
[26] NRW/2 3.16.2.
[27] CPWF/2 paras 41 to 46 and 49.

were recorded pre-October and pre-November, respectively. Given the marked decline in grilse numbers in recent years, and particularly late summer fish, the proportion of salmon entering rivers after the end of the angling season is likely to diminish. 'Extant' exploitation rates (i.e. expressed as the total catch divided by the annual run) are used to derive run estimates from rod catches and so factor-in the out-season run component.

3.8 A review of the models used hitherto to derive angling exploitation rates on rivers without traps or counters is currently underway. This is being conducted jointly by NRW, EA and Cefas, and is supported by a statistical modeller working with the Game and Wildlife Conservation Trust. The review aims to develop a single model to apply to all rivers - building on and refining existing procedures with the aim of utilising a version of this model in the 2018 assessment.

3.9 This refined model will draw on recent developments by NRW in this area; namely the exploitation rate model used to derive sea trout returns/spawner numbers from rod catch data. The sea trout model responds to annual changes in species-specific fishing effort and includes a variable to account for in-season flow conditions.[28] The model can be readily adapted for salmon but (pending the above review) hasn't yet been formally applied to this species.

Objector Contention 4 Concern about the reliability of rod catch-based assessments and the use/under-use of alternative data from traps/counters

3.10 Objectors have expressed concern about the reliability of the stock assessments, and in particular, the use of rod catch-based assessments, and the use (or lack thereof) of data from traps/counters and juvenile electrofishing surveys.[29] This is largely addressed in my main proof of evidence.[30] NRW's additional response to those concerns is threefold.

3.11 First, with regard to the use of counters, there are no simple solutions to estimating the total return of adult salmon and/or sea trout to our rivers, despite claims to the contrary.[31] Obtaining direct estimates from counters or traps is a resource intensive and costly activity both in terms of establishing infrastructure and running facilities. Hence there are few rivers across England or Wales, or

[28] APP/4, Annex 5.
[29] CPWF/2, paras 69 and 70.
[30] NRW/2, section 3.
[31] ACC/1 para 16.

the wider North Atlantic area that run such facilities. The data collected at these few sites are used to inform assessments on rivers without counts and where, invariably (e.g. in all UK jurisdictions), there is a great deal of reliance on the use of catch data as indicators of stock abundance.[32]

3.12 Secondly, it is argued that extrapolation of data from the Welsh Dee to other rivers is generally unreliable because of the nature of the river: principally its location, size, reservoir construction and flow regulation.[33] This is referred to generally in my main proof of evidence.[34] The following further points are made in addition:

(a) There is little information on the areas of stream made inaccessible to spawning salmon as a result of reservoir construction on the Dee (APEM 1998[35]), but it is likely to amount to less than 5% of the C. 6 million m2 wetted area of river currently considered accessible to salmon.

(b) Any adverse impact of cold water release is likely to be confined to the C. 10km of the River Tryweryn downstream of Celyn reservoir. The effect of this on salmon hatching and swim-up times was examined by APEM[36] who concluded any impact was negligible. Changes in management of the draw-off point since this report will have further reduced any adverse temperature effects.

(c) There are no issues with the oxygen content of water released from these reservoir sites.

(d) The stated impacts on fly life and salmon/trout survival are unfounded.

(e) The spawning tributaries of the Dee system are not significantly compromised by reservoir construction.

3.13 My primary evidence indicates the Dee is similar to other ‘counted’ salmon rivers in Wales and England in terms of recent patterns and trends in the abundance

---

[32] NRW/2.
[33] AR/1, paras 14-15.
[34] NRW/2.
[35] NRW/2Re. Chapter 6, page 55.
[36] NRW/2Re. Section 5.1.7, page 40.

and composition of adult stocks.[37] Hence the Dee should not be considered entirely atypical of other Welsh salmon rivers, and the input of Dee data to assessment procedures on other rivers should not be dismissed as invalid.

3.14 It is important to note that the direct contribution of the Dee programme to wider assessment procedures is, in reality, relatively limited. This includes application of a sea-age weight key, used on other rivers to estimate proportions of 1SW and MSW salmon in the return (contrary to some claims, this age-weight key is updated annually to reflect changes in size and sea age composition over time[38]).

3.15 Monitored rivers other than the Dee also make similar contributions to the assessment process where local information is absent. Objector evidence considers the application of Dee data to the assessment procedures on the Usk appropriate, particularly given the broadly similar nature of the two rivers.[39]

Objector contention 5: NRW have failed to use other techniques to evaluate the status of stocks and causes of decline,

3.16 Objectors have criticised NRW's stock assessment on the basis that it has not used (or under-used) three techniques, namely (i) redd counting; (ii) smolt tagging and (iii) DNA, considered in turn below.

(i) Redd counting

3.17 Some Objectors have expressed a lack of trust in the current stock assessments in the absence of redd counts or true records of fish ascending our rivers.[40] A redd is the spawning location of a salmon or sea trout and is identified from disturbance of the river gravels. Redd counting was largely dropped as a means of monitoring spawning activity in England and Wales in the 1980s. There are a number of reasons for this, including:

(a) The technique requires coverage of large stretches of river, ideally repeatedly over the spawning season (C. 2-3 months);

---

[37] NRW/2, paras 3.16-3.25.
[38] CPWF/2, paras 39 and 40.
[39] GM/1, paras 3.12 and 3.13.
[40] PAAS/1, para 4iii.

(b) redds are often difficult to spot and/or identify to species (i.e. of salmon or sea trout origin);

(c) there is uncertainty about the number of redds produced per spawning pair, and;

(d) identifying redds becomes impossible in high/turbid water conditions (after which any signs of a redd may be completely erased).

3.18 Given these limitations, and the labour intensive nature of a systematic redd counting programme, the method was dropped – relying instead on other monitoring methods (catches, juvenile electrofishing surveys and, on some rivers, the deployment of traps and counters) to assess stocks.

3.19 The most reliable estimates of adult return are obtained from traps or automated counters. The patterns and trends in these data sets (x3 sites in Wales) are examined in my primary evidence.[41]

(ii) Smolt tagging

3.20 It is claimed that mortality at sea, associated with salmon farms in the Inner Hebrides (and sea lice infestation), is likely to be a significant source of loss for salmon smolts leaving Welsh rivers, and that NRW should investigate this through smolt tagging studies.[42] Smolt tagging work is undertaken on the Welsh Dee, and a handful of other rivers in England and Wales, to evaluate the proportion of fish which survive to return as adults (providing a measure of 'marine survival' – see example[43]). These studies are not the same as the use of acoustic tags to track the migration routes of individual smolts at sea. The latter approach is expensive and technically challenging. Facilities are being proposed by other jurisdictions – namely an array of scanners between the north coast of Ireland and the west coast of Scotland - that could be used to detect the migration patterns of salmon smolts in this area. That could include, potentially, fish originating in Welsh rivers. There is no evidence to suggest that salmon smolts from west coast rivers in England and Wales are encountering salmon farms in the Inner Hebrides.

[41] NRW/2, paras 3.16 to 3.25.
[42] AR/1, para 63.
[43] ACC/28, Table 25 on p.56.

(iii) DNA

3.21 It is claimed that NRW should be using DNA techniques applied in the USA to the monitoring of migratory salmonids (‘steelheads’)[44]. This appears to be a reference to the use of DNA to monitor the presence and, potentially, the abundance of fish and other species from samples extracted from still or running water environments (environmental DNA or eDNA). Such methods are being actively explored by NRW and others, but further research is required to be able to utilise this technique to monitor, for example, the abundance of salmon in our rivers.

[44] NH/1A, para 30.

4 Mr John's request for further information

4.1 In his supplementary proof of 31 December 2018[45], Mr John requested various data sets used by NRW to be updated to 2018 and provided to the inquiry. NRW has not had time to do this yet, but will seek to do so by the start of this inquiry.

[45] PGJ/1a.

This page has been left intentionally blank.

5 Conclusions

5.1 The issues addressed in this submission largely relate to (i) misunderstanding and/or mistrust of NRW/EA procedures for deriving and applying Conservation Limits to assess and manage salmon and sea trout in Wales; and (ii) scepticism, mainly (but not entirely) about the quality of catch returns and the procedures used to generate run estimates from catch data as part of the assessment process.

5.2 Despite the criticism of these procedures (and the catch, count and other data sets that underpin them) there appears to be some level of agreement between the outcome of NRW's formal stock assessment process, and the informal view of fishermen (expressed in the evidence reviewed here) about the generally poor state of salmon and some sea trout stocks on Welsh rivers. Where there is less agreement is in determining what the fisheries management response should be to failing stocks.

5.3 Clearly there are a number of aspects of the stock assessment process that are contentious for fishermen. NRW view the current procedures as providing an objective means of assessing the status of individual river stocks of salmon and sea trout, and a sound basis for making decisions about stock protection. However, no stock assessment process is perfect and there is always room for improvement; to that end a programme of review and refinement is already underway with colleagues in the EA, Cefas and GWCT.

6 Statement of truth

6.1 I hereby declare that:

I. This proof of evidence includes all the facts which I regard as being relevant to the opinions that I have expressed and that the inquiry's attention has been drawn to any matter which would affect the validity of that opinion;

II. I believe the facts that I have stated in this proof of evidence are true and that the opinions I have expressed are correct; and

III. I understand my duty to the inquiry to help it with matters within my expertise and I have complied with that duty.

Ian Davidson

SENIOR TECHNICAL ADVISOR SALMONIDS

Natural Resources Wales

January 2019