A review into NRW's salmon stocking and fish hatcheries owned and operated by Natural Resources Wales

Chris Uttley 7th February 2014

Introduction and background

1 Natural Resources Wales has inherited four fish hatchery units from one of its predecessor bodies, the Environment Agency. Two of those hatchery units are currently not operational (Mawddach, which is temporarily mothballed pending this review, and Clywedog which was mothballed 12 months ago) and two are operational (Cynrig and Maerdy). The two operational hatcheries are primarily used for the production of salmon to be stocked into various rivers throughout Wales, including the cross border rivers of the Dee and the Wye.

2 Natural Resources Wales Executive Team have requested a review into the continued operation and existence of these hatcheries. There are a number of reasons why the review has been commissioned. It has been partly triggered by the Freshwater Fisheries, Agenda for Change Programme, which is seeking to re-examine and refresh all inland fishery practice and management inherited from the EAW, to ensure that it is consistent with the new purpose and duties of NRW. This includes the practice of fish stocking, which then has significant implications for the operation of the remaining hatcheries. The review has also been partly undertaken as a result of the need to take stock of the benefits of operating hatcheries before deciding on whether further significant investment needed to maintain the infrastructure of the hatchery sites should be made available.

3 The scope of the review therefore includes an examination of the legal drivers that are used to underpin the activity and a review of the impacts and cost effectiveness of salmon stocking on the rivers in Wales. It also looks at the cost of operating and maintaining the hatchery units in Wales and, at a very broad level, compares the costs of sourcing fish from external providers with that of producing them in-house.

Executive Summary

Legal Context to Salmon Stocking

4 NRW's salmon stocking activities are informed by our duties and responsibilities under a range of legislation, including the Salmon and Freshwater Fisheries Act 1975 , The Environment Act 1995 and legislation providing for the creation of reservoirs, barrage's and impoundments. Most salmon stocking in Wales is termed "mitigation" stocking and is justified as required by a number of legal drivers. The legal advice commissioned for this review has found that NRW does indeed have legal obligations to undertake works to mitigate for the impacts of various schemes to create reservoirs, impoundments and barriers. Subject to ongoing consideration by NRW legal services, it appears that none of these amount to a non-discretionary obligation to stock salmon, rather, the predecessors of NRW have interpreted and formed agreements with third parties that stocking salmon is the mechanism by which mitigation should be achieved. There appears to be sufficient flexibility in the various Acts, Orders and agreements to allow NRW to choose alternative means of achieving mitigation if it wishes to do so, with the consent of other signatories. In conclusion, there are relatively few legal impediments to making changes to salmon stocking programmes, provided NRW and others with similar obligations put in place alternative mitigation where relevant.

Impact and Effectiveness of salmon stocking

5 The current scientific literature regarding both the effectiveness and impacts of stocking salmon provides evidence that stocking salmon from hatchery reared fish can potentially have several negative impacts. There is increasing and compelling peer-reviewed evidence that:-

hatchery reared fish have lower survival to adulthood than wild fish of the same age,
hatchery fish that survive to adulthood have lower fitness than wild fish,
the presence of hatchery reared fish in wild populations reduces wild population fitness.

6 There is little available evidence to demonstrate that stocking is effective at improving wild population productivity, and in some cases it has been demonstrated to cause harm at a population level. Whilst we should be cautious about drawing conclusions from other stocking programmes, it is also highly relevant that some major long term salmon stocking programmes in the UK and other countries have recently been or are being brought to an end.

Implications for rivers designated under Habitats Directive

7 The scientific evidence for potential impacts could have significant consequences for salmon stocking on rivers designated as Special Areas of Conservation under the Habitats Directive, including the Rivers Dee, Wye, Teifi, Tywi, and Cleddau. This is relevant for two reasons. Firstly, the higher level of protection from impact afforded to those salmon populations protected under this legislation requires near certainty regarding lack of adverse effect, which given the evidence for potential impacts on wild productivity, is difficult to conclude. Secondly, the implications for transferring responsibility or ownership of stocking to third parties, or regulating third-party schemes, given that the requirement to avoid adverse effect applies equally to stocking carried out by others.

Salmon stocking and consistency with the Ecosystem Approach and IUCN Guidance.

8 Restoration stocking after extinction is a valid method of reintroducing a population to available habitat, and is consistent with an Ecosystem Approach. This approach has been used successfully on rivers in Wales, including the Taff. However, the review concludes that mitigation and enhancement salmon stocking are inconsistent with the Ecosystem Approach. Continued introduction of new individuals to a river without addressing the causes of salmon population decline delivers relatively fewer Ecosystem Services when compared to alternative restoration measures such as improving the quality and availability of spawning and juvenile habitat and further water quality improvements. Given the evidence regarding potential impacts to wild population productivity and the fact that factors causing population decline still need to be identified and addressed, it also appears to be inconsistent with the IUCN (International Union for the Conservation of Nature) Guidelines on species re-introductions and translocations.

Finance and cost-effectiveness

9 Only a small proportion of the budget for the operation of all hatcheries in Wales is dedicated towards work un-related to the culture of salmon and the review therefore assumes that the costs associated with the hatcheries are synonymous with stocking salmon. Cynrig hatchery would also benefit from significant investment to improve infrastructure and sustainability of its water supply.

10 Of the total amount spent on hatcheries in the last financial year, approximately 12% was income derived from external sources (Cardiff Harbour Authority under the terms of a legal agreement) specifically for the raising and stocking of salmon. A further 26% is attributable to money raised by NRW from water abstraction licence charges, but there appears to be no legal driver requiring it to be used for this specific purpose. From information available, there is no indication that it is significantly more cost-effective to source salmon for stocking from external suppliers compared to in-house

production.

11 When taking into account the benefits to ecosystem services, the apparent poor results in terms of adult numbers and additional population risk associated with those that do return, it appears to be more cost effective to concentrate NRW's resources on improving and increasing the amount and quality of habitat suitable for spawning and juvenile salmon production in Welsh rivers, than to use it for salmon stocking.

Conclusions

12 From the evidence available, the review concludes that on-going mitigation and enhancement salmon stocking deliver relatively poor outcomes for NRW and salmon populations, particularly given the lack of evidence for effectiveness and the evidence for potential impacts to wild salmon population fitness and productivity. These conclusions regarding the effectiveness and potential impacts of salmon stocking are equally applicable to any stocking undertaken by third parties. In addition, stocking delivers fewer additional ecosystem services when compared with other measures we could take and advocate others to take. The review concludes that NRW should focus it's efforts and resources on habitat restoration, particularly removing obstacles to migration and improvements to the quality and extent of spawning and juvenile habitat. Future restoration stocking should not be ruled out should it be required.

The Recommendations made as a result of this review are:

NRW should bring all our own on-going mitigation, population re-inforcement and enhancement salmon stocking in Wales to an end, This includes all third party stocking on rivers designated under the Habitats Directive for their wild salmon populations. A further component of this includes the development of a realistic and practical timetable for bringing all other third party salmon stocking in Wales to an end, and a start to the process of working and consulting with stakeholders and co-signatories to relevant agreements to put in place suitable alternative mitigation measures instead of stocking. Future restoration stocking should not be ruled out if needed, however there is currently no identified need for this in Wales.

In addition, given the benefits to salmon and the wider environment from a range of habitat restoration measures, NRW should work with all interested parties to further develop and focus effort on this approach, in particular on removing barriers to migration and increasing the quality and extent of spawning and juvenile habitat available in our rivers. There is a significant opportunity to develop an approach to mitigation and enhancement that will provide multiple benefits to the Welsh environment and to all those that have a stake in ensuring salmon numbers are increasing or stable.

In light of the recommendation above, NRW should reduce its hatchery capacity. Taking into account the patterns of hatchery ownership and the capacity and track record for working on other freshwater issues, it is recommended that operations at the Mawddach and Maerdy hatcheries are

brought to an end as soon as practicable and any lease-hold arrangements at Clywedog should be brought to an end.
Cynrig hatchery is available on a long term lease that has many years still to run. NRW would almost certainly be required to restore the site to its existing condition before re-sale or return of the lease. In addition, the hatchery clearly has the capacity and the expertise to undertake valuable and practical field based research and development. It is therefore recommended that NRW should consolidate any residual salmon culture (whilst changes to agreements are negotiated and concluded) at Cynrig and carry out further work to assess the feasibility of adapting the site for additional freshwater and fisheries research capacity. In parallel, NRW should investigate the potential for partnerships with Welsh academic institutions or other research bodies for developing and funding work at Cynrig.

Detailed Review Findings

Current hatchery capacity and ownership

13 At the time of this review, only two of the four hatchery units are fully operational, those being Maerdy, near Corwen in North Wales and Cynrig, near Brecon. The Mawddach hatchery near Dolgellau has been temporarily mothballed, pending the outcome of this review, and production of the fish for stocking the Afon Mawddach is being transferred to the Maerdy Hatchery.

14 Fish culture operations at the Clywedog hatchery have been brought to an end as the stocking supported by this unit (on the Rivers Teme and Tanat, tributaries of the River Severn) has ceased.

15 NRW lease the land for two units; Cynrig hatchery near Brecon is on land leased by NRW from a nearby land holder under a long term lease arrangement, and the freehold of the Clywedog hatchery is owned by Severn Trent Water. NRW own the freehold of the land and the buildings at the Maerdy and Mawddach hatcheries.

Salmon stocking supported by NRW Hatcheries and third parties in Wales

16 The list below describes the main salmon stocking programmes and the reason for each programme's existence. It also identifies the hatchery responsible for producing the fish.

<u>Reservoir mitigation programmes</u>
Dee – Celyn (NRW). (Maerdy)
Wye – Elan (NRW). (Cynrig)
Tywi – Brianne (DCWW/NRW) (Private provider of stock).
Cleddau - Llysyfran (DCWW/NRW) (Private provider of stock)

Barrage & Hydropower mitigation
Taff – Cardiff Bay Barrage (NRW, externally funded) (Cynrig)
Seiont (agreement between Welsh Water Authority and CEGB, relating to Dinorwic power scheme) (Maerdy)
Rheidol (agreement between NRA and successors to Powergen relating to HEP impact) (Private provider of stock)

Pollution mitigation
Mawddach – (Maerdy)

Other activity
Freshwater Pearl Mussel culture (Maerdy & Cynrig)
White clawed crayfish (Cynrig)
Char & Gwyniad (Maerdy)
Water Voles (Cynrig)

17 NRW and its predecessors have been undertaking salmon stocking operations in Wales for many years. The Wye has been stocked intermittently since the early 20th century. More recently, since the 1960s, our predecessors continued stocking activity in the belief that hatcheries could produce a greater number of adult fish than would occur if the parents were left to spawn naturally. Stocking was therefore adopted to mitigate for lost habitat due to reservoirs and barrage impoundments built in the second half of the 20th century, but it was also used more widely by external fisheries groups seeking to increase the abundance of adult fish available to recreational fisheries. Hatcheries generally function on the basis that taking adults from the wild, and caring for eggs and fry in a hatchery, leads to increased overall survival compared to that expected in the wild. The expectation is therefore an increased number of adults than would have arisen naturally. Understanding of potential population-scale harm through adverse genetic effects and the ability to test the effectiveness through genetic fingerprinting has developed since these programmes commenced, and notably within the past 5 to 10 years.

18. There are currently no rivers in Wales where salmon populations are supported solely by stocking and where, conversely, salmon stocks would decline to un-viability in the absence of stocking effort. There are 23 principal salmon rivers (including the cross-border Wye, Severn and Dee) and Salmon are classed as at risk in 11 rivers. Trends indicate this will reduce to 8 in 2017. There are 42 principal salmon rivers in England, and the number at risk is currently 11. This has reduced from 23 in 2004 and is predicted to reduce further to 4 by 2017. Only 1 salmon hatchery is operated by the EA (Kielder) and only two other restoration schemes are supported, in addition to the stocking of the Tyne.

Legal drivers for salmon stocking by NRW

19 Most salmon stocking activity undertaken by NRW and its predecessor, EA, has taken place and still takes place in the context of mitigation schemes for impacts caused by reservoirs or other impoundments that inhibit migration of adult salmon (e.g. Cardiff Bay Barrage, stocking of the Taff) or remove spawning habitat from use (e.g. Llyn Celyn). A small amount is as a result of mitigation for impacts from hydro electric schemes (e.g. Afon Seiont) and pollution incidents (e.g. Mawddach.)

20 A fundamental part of the review has been an examination and testing of the legal basis for salmon stocking undertaken by NRW, since the culture of salmon is the main activity undertaken by our hatcheries. Salmon stocking has been undertaken in the context of our fisheries duties contained within the Salmon and Freshwater Fisheries Act 1975 the Environment Act 1995, and a wide range of additional instruments relating to the building of reservoirs, barrages and impoundments

21 After reviewing each of the instruments, and agreements that are cited by previous reviews to justify salmon stocking by NRW, the conclusion is that there are indeed legal obligations acting upon NRW to undertake actions to mitigate for the impacts of historic environmentally damaging schemes. However none of the various legal instruments amount to a non-discretionary obligation to stock salmon, rather, the predecessors of NRW have interpreted and formed agreements with third parties that stocking salmon is the mechanism by which mitigation should be achieved. There is therefore some flexibility in the relevant obligations to allow NRW to put in place alternative means of mitigation if it should choose to do so.

22 Indeed, in some cases, the legislation or agreement specifically makes provision for alternative mitigation actions eg Agreement between Welsh Water Authority and Central Electricity Generating Board 1985 relating to Dinorwic power scheme. In other cases there is flexibility within the obligation to undertake a variety of mitigation actions, in agreement with other parties (e.g. the Cardiff Bay Barrage Agreement 2008 is to mitigate for a specified time by agreed means, and is subject to review at any time). In another case, (e.g. The West Glamorgan Water Board (Llyn Brianne) Order 1968 (Tywi)) the way in which the original provisions of the Order have been implemented has been changed in the light of new scientific understanding and there is no reason to believe that further changes could not be made in the light of even newer scientific understanding). Some stocking is undertaken as a result of an agreement reached after a pollution incident (Afon Mawddach). Stocking on the Wye is carried out without any specific legal driver other than the general requirement to mitigate for the impacts of water resources schemes (Elan Valley). Stocking on the Seiont could be replaced with alternative mitigation if NRW took the view that this would be in the interest of the fishery.

Environmental context to Salmon stocking

Effectiveness of salmon stocking in Wales

23 The measure of effectiveness of salmon stocking in Wales will depend on the purpose for which stocking was carried out, including achieving increased abundance of salmon, increasing rod catches of salmon or improving and safeguarding wild population fitness. All three are valid measurements depending upon the circumstances involved. Since the majority of salmon stocking in Wales occurs on rivers designated under the Habitats Directive, (some of these specifically for their populations of wild salmon,) and since the best guarantee of improved rod catches in the long term appears to be improved wild population fitness, for the purpose of the review, effectiveness is determined against the benchmark of improving and safeguarding wild population fitness.

24 Irrespective of how we define effectiveness, there has been little monitoring of the effectiveness of stocking programmes in the UK and particularly in England and Wales. There is very little evidence available to help determine whether our programmes deliver

their objective of increasing adult abundance to mitigate for the impacts that initiated the stocking.

25 There are two relevant Welsh case studies that quantify the outcomes of hatchery stocking undertaken. The first is the Taff (a restoration programme) and the second is the Dee (a mitigation stocking programme).

River Taff

26 Stocking of marked hatchery smolts as part of the Cardiff Bay Barrage monitoring programme indicated that, prior to impoundment by the Barrage, hatchery smolts contributed 8.5% - 23.7% of the monitored run of one sea-winter salmon, and 0 – 23.4% of the two sea-winter run. During construction the contribution of hatchery fish to annual runs were sometimes higher, peaking at 47%. Expanding this for trapping efficiency indicates a maximum rate of return of approximately 2%. In common with the results of the Tyne stocking review (Milner et al 2004), it is concluded that early Taff stocking accelerated stock restoration following recovery from extinction during the industrial revolution. The contribution that hatchery reared fish make to the overall population is diminishing as the population increase, as one would expect following significant investments to provide access to the majority of the catchment for spawning fish. Recent estimates demonstrate that fish derived from natural spawning in the newly opened and improved Taff catchment now dominates production with hatchery fish yielding about 6% of the annual run of fish.

River Dee

27 The Dee is the most important index river (a river for which detailed data about salmon runs are collected) in England and Wales and long-term return rates of wild and hatchery fish are reported. In common to other such comparisons, wild salmon smolt returns are shown to exceed those of hatchery-derived smolts by a factor of as much as 19:1, whilst average returns from hatchery parr are approximately 0.14%.

Effectiveness of other Salmon stocking programmes

28 Whilst we should be cautious about drawing conclusions on effectiveness from examples of stocking elsewhere, a number of examples from other parts of the UK and internationally are also relevant here. Direct comparison is difficult as there may be differences in hatchery operations in the examples described below that are not apparent at the time of this review.

29 Low returns of hatchery fish as adults in some Scottish rivers such as the Spey and Don have triggered modifications to established programmes and in some cases, their complete closure. For instance, in a wide ranging genetic study, the River Spey Fishery Board found that of the rod caught salmon analysed in any one year (average 218) the contribution to the rod catch varied from 0 to 1.8%. Assuming an angler exploitation rate of 15% it appears that the hatchery did little more than generate a similar number of returning fish as had been taken from the river for broodstock. The significance of the review on this river is that the hatchery rearing costs are entirely funded by private interests with the aim of maximising angling revenue from increased returns of adults. The Board initiated a review into the salmon stocking policy and practice in 2011 as a result of low returns of

adults related to hatchery brood stock compared to the high cost of the hatchery. Salmon stocking has not completely ended, but the Spey Board have recently published the results of their genetic based hatchery study (Coulson et al, 2013l)), and the results (**Table 1 – formed from two separate tables in the original report**) demonstrate the returns from the hatchery were well below the anticipated 10% increase in catches published when the of the stocking strategy was devised (Spey 2004)

Table 1 - Summarises the number of brood stock used in Spey Hatchery, the number of fish sampled and the numbers and % of adult returns subsequently attributed to them.

Year	Brood Stock Male	Brood Stock female	Sample size	Assigned one parent	Assigned both parents	% sample attributed to hatchery
2004	241	284	/	/	/	/
2005	240	189	/	/	/	/
2006	234	261	/	/	/	/
2007	252	234	/	/	/	/
2008	156	164	299	2	1	0.3%
2009	108	118	257	2	1	0.4%
2010 (Spey dam)	150	172	113	0	0	0%
2011	Na	Na	217	1	4	1.8%
2012	na	Na	204	0	3	1.5%

30 A report into the recovery of salmon on the River Tyne (Milner et al 2004) concluded that the recovery of salmon populations was largely facilitated by improvements in habitat (better estuarine water quality that allowed migration), but was aided in the early stages by hatchery releases from the Kielder hatchery.

31 An Atlantic Salmon restoration stocking programme on the Conneticut River in the United States of America is also being effectively wound up due to extremely low rates of return. Since about 1980, a partnership of organisations, including the Government Fish and Wildlife service have stocked up to 1.4 million salmon fry at a cost of $2M per annum. Despite significant investment, numbers of returning adult fish were as low as a few dozen in some years. Whilst private interests will continue with limited stocking, central government funding and support is being withdrawn. The failure of the restoration is attributable to a wide number of factors, including failure to ensure all impacts to habitats were removed during the stocking programme.

32 A recent Baltic wide seminar (Palme et al 2012) into salmon stocking, initiated by a request from the European Commission for an end to hatchery reared salmon stocking throughout the Baltic, heard evidence on the genetic impacts of stocking and from a wide range of academic and Government institutions. One of its conclusions was that salmon introductions into rivers with viable populations should be brought to an end, to protect the productivity of the existing wild population. This position appears analogous to the Welsh situation in that whilst rivers may have suffered declines in salmon, all appear to have currently viable populations, including rivers subject to recent restoration stocking such as

the Taff. Estimates (based on current population data) indicate that numbers of salmon rivers at risk in Wales will reduce from the current eleven to eight in 2017.

33 Finally, a very recent study undertaken (Young 2013), analysed the catch returns from 62 rivers in England and Wales. After controlling for environmental factors affecting adult abundance, the author concludes that the 42 rivers with stocking had non-significantly lower mean catch statistics than the 20 rivers where no stocking had taken place. For stocked rivers, there was no evidence for a generally positive relationship between annual stocking efforts and catch statistics. He suggests that the results indicate that potential impacts on wild salmon populations from stocking are not balanced by detectable benefits to rod fisheries.

34 As stated already, it is difficult to draw conclusions from generic reports and studies on other river systems, due to the wide variations in how hatcheries operate and site specific circumstances. It is worth noting however that all hatchery operations include the removal of brood stock, i.e. wild fish that would otherwise have continued to spawn and added wild progeny to the stock. It is therefore always important to consider net benefits from hatchery operations.

35 Effectiveness could also be related to many other factors in the environment, including factors not influenced by changes brought about by the hatchery process.

36 This review concludes that there is a lack of convincing evidence that stocking of salmon is the most effective way of safeguarding or maintaining wild populations or of increasing annual rod catches and that in some cases, such as on the River Spey, returns of hatchery derived adult fish appear to be little better than direct replacements for broodstock used in the hatchery.

Impacts of salmon stocking

37 There is a significant body of peer reviewed recent literature & studies that suggest a range of potential genetic and ecological impacts from stocking salmon, for example, Aracki & Schmid 2010, Chilcote et al 2011, Aracki 2007, Christie 2011, NMFS Hatchery Reform 2009

38 A range of findings include:

Although hatchery fish may perform relatively poorly after stocking, some survive to return to the river and spawn, either with other hatchery fish or wild fish, and therefore pass their genes to the next generation.
There is evidence that the contribution of hatchery fish harms the fitness of the population through contribution of offspring with traits that were favoured by hatchery selection pressures. Progression of these traits, and the genes underlying them, to subsequent generations therefore presents a risk of reduction in overall population fitness. One element of this is the capacity of the population to adapt to future environmental pressures such as climate warming.
The reduction in mortality of juvenile salmon in a hatchery can lead, even after higher post-release mortality, to higher adult-to-adult survival than wild spawning adults. For wild populations, this can result in potential over-representation of genes and traits artificially preserved in a hatchery and it is this that can affect stock fitness. A recent review of the

global literature found no evidence for hatcheries restoring or improving the productivity of existing wild populations. It further concluded that for populations not at immediate risk of extinction, stocking will reduce rather than increase population growth rate. This means that that despite short term benefits to salmon abundance that can be achieved from intensive hatchery based stocking, long term impacts to population fitness may cancel out these benefits resulting in longer term reductions in productivity. Again, this appears analogous to the Welsh situation.

39 There are also papers in the scientific literature that demonstrate that in some cases, stocking can result in less significant negative population effects (Araki & Schmid 2010, Fraser 2008, Brannon 2005). This therefore creates some uncertainty around quantifying or predicting the degree of potential impact in a specific instance of stocking. Presence and degree of impact could be influenced by a range of factors, including environmental and hatchery effects and stocking management decisions. Whilst this uncertainty in the literature needs to be reflected in the review, it is also this uncertainty that means it is difficult to plan to mitigate any potential harm through changes to hatchery practice, since we do not know for certain how these impacts arise. A bibliography of literature is provided at Appendix 2.

Salmon stocking and rivers designated as Special Areas of Conservation under the Habitats Directive.

40 A further important consideration for this review is how to treat the potential environmental impacts of salmon stocking on population fitness in the context of rivers designated under the Habitats Directive. Several of the rivers on which major salmon stocking programmes exist or indeed where future expansion is being discussed are designated under this legislation, including the River Dee, River Wye, Afon Teifi, Afon Tywi, Afon Eden (A tributary of the Mawddach) and Afonydd Cleddau. Some are designated specifically for their wild salmon populations whilst in others salmon are not a primary reason for designation.

41 The legislation implementing this directive requires any plans and projects not directly connected with the management of the SAC to be subjected to an Appropriate Assessment and all of the mitigation and enhancement salmon stocking on SACs in Wales fits into this category. Even if it could be concluded that salmon stocking was directly related to the management of the SAC, the weight of scientific evidence on the potential harmful impacts of this practice means that NRW would not adopt it as a means of managing an SAC even though there would be no need to test this through an appropriate assessment.

42 When an appropriate assessment is required the test is set at a high level. Plans and projects must demonstrate, beyond reasonable scientific doubt, that there will be no adverse effect of the integrity of the site. NRW also has general duties under the legislation that would apply to all salmon on designated sites. Each SAC has a suite of Conservation Objectives and a published management plan. These plans were originally drafted by CCW. Some of these plans make statements about salmon stocking, for example the River Wye Core Management Plan states:

"*The management objectives for SAC salmon populations are to attain naturally self-sustaining populations. Salmon stocking should not routinely be used as a management*

measure. Salmon stocking represents a loss of naturalness and, if successful, obscures the underlying causes of poor performance (potentially allowing these risks to perpetuate). It carries various ecological risks, including the loss of natural spawning from broodstock, competition between stocked and naturally produced individuals, disease introduction and genetic alterations to the population. Therefore, there is a presumption that salmon stocking in the Wye SAC will be phased out over time"

43 Appendix 1 describes recent European and UK case law judgements that inform the level of certainty required before an activity can be consented or permitted. Given the recent scientific literature that stocking salmon reared in hatcheries can potentially have impacts on the long term population fitness of wild salmon populations, and a lack of clear evidence that negative impacts can always be avoided, this review concludes that it can not be demonstrated beyond reasonable doubt that stocking salmon will have no adverse effect on the integrity of any site designated for a wild salmon population. An appropriate assessment would be required before further stocking can be consented and any appropriate assessment is likely to rely upon the same scientific literature and expert opinion that has been made available for this review.

44 This aspect of the review also has consequences for the future operation of hatcheries and salmon stocking carried out by third parties into rivers designated for their wild salmon populations, since the conclusion applies equally to any third party applying for consent to stock.

Conclusions regarding impact and effectiveness of salmon stocking

45 There has been considerable debate regarding both the effectiveness and impacts of stocking hatchery reared salmon into the wild. There is a wide ranging scientific literature based upon studies carried out in America and parts of Europe on a number of salmon species and in a number of specific locations. In addition to the peer reviewed literature, there are a range of reports and other grey literature. Whilst it is difficult to compare and draw conclusions from scientific studies carried out in other countries, and their relevance to hatchery operations in Wales, it is possible to draw a number of broad conclusions about both the effectiveness and potential impacts of releasing hatchery reared salmon into the wild.

46 There is increasing and compelling peer-reviewed evidence that:-

a) Hatchery reared fish have lower survival to adulthood than
wild fish of the same age,
b) Hatchery fish that survive to adulthood have lower fitness than wild fish,
c) The presence of hatchery reared fish in wild populations can reduce wild population fitness.

47 There is very little evidence that post-restoration, stocking is an effective way of improving wild population productivity. Whilst acknowledging differences in hatchery and stocking practice, it is significant that many salmon stocking programmes in the UK are being significantly reduced or brought to an end completely. The review concludes that there is a lack of convincing evidence that stocking of salmon is the most effective way of safeguarding or maintaining wild populations or of increasing annual rod catches.

48 In some cases stocking has also been demonstrated to cause harm at a population level. This evidence has accumulated in Europe mainly over the past 5 to 10 years or so, although evidence for species of Pacific salmon – some with similar life history strategies to those of Atlantic salmon – has been quite regularly reported over the past 20 years or more. There are also papers in the scientific literature that demonstrate less significant negative population effects in some cases, and therefore create some uncertainty around the conclusion above. However, as the majority of salmon stocking in Wales takes places on rivers designated under the Habitats Directive, it is extremely difficult to conclude beyond reasonable doubt that there will be no adverse effect on those wild salmon, as required by that legislation.

49 From the evidence available, the review concludes that whilst there is an element of uncertainty and case specificity around impacts of salmon stocking, there is sufficient evidence of potential impact available to influence policy change in this area, particularly given the burden of proof regarding lack of impact required under the habitats directive and the growing level of expertise and knowledge about less potentially harmful methods of mitigating for and remediating environmental damage.

Salmon Stocking – Wider policy context

50 A part of this review is a consideration of the consistency of the salmon stocking programme with two general areas of policy. Firstly, it has assessed the consistency of the activity with an Ecosystem Approach. The Welsh government has requested NRW to ensure it takes account of the Ecosystem Approach and Ecosystem Services in carrying out all its work. Secondly, the review has also assessed whether the stocking of salmon is consistent with internationally accepted guidelines on species translocations and re-introductions produced by the International Union for the Conservation of Nature.

Ecosystem Approach and salmon stocking

51 It is difficult to examine a single focussed activity such as stocking salmon against a broad concept such as the Ecosystem approach. The activity is clearly set within a wider context, which is the maintenance and improvement of salmon populations on certain rivers as mitigation for the impacts caused to salmon by previous impoundments and barriers. It also needs to be viewed within the context of the most up to date scientific literature surrounding the activity and also take into account different aspects of the activity. For instance, stocking can be used to restore populations after extinction events. In this case, despite there being some longer term risks associated with stocking, it is clearly consistent with an Ecosystem approach to facilitate the return of a salmon population if suitable habitat is available.

52 However, if we accept the broad scientific conclusions regarding the potential longer term impacts of salmon stocking on wild population fitness and therefore future numbers of fish, we can conclude that enhancement stocking (to provide a short term population increase for recreational purposes) is not consistent with an Ecosystem approach.

53 Mitigation stocking is the attempted replacement of a specific number of fish in response to a planned and well understood impact. Whilst the aims of mitigation stocking

are laudable, recent evidence regarding potential impacts on wild populations and the relative effectiveness of this activity means that NRW is now re-examining the desirability of this activity.

54 Mitigation salmon stocking could be considered as the classic single sector response to a problem, in that although there are clearly multiple issues acting to reduce the population of salmon, rather than tackling the issues (which may be difficult or considered impossible e.g. reservoirs) causing the reduced population, we have intervened at the end of the process in a direct way and substituted the functionality of the environment with an alternative system (a hatchery).

55 Salmon are in their own right a high value ecosystem service. Their existence in a river provides a number of provisioning and cultural services. They are also used to provide information about a whole range of other regulating services, because of their dependence upon a high quality environment. Society extrapolates from the existence of salmon to draw conclusions about the quality of a range of other services provided e.g. water quality, lack of pollutants, nutrient recycling and landscape. Salmon is quite rightly considered to be an indicator species because of the services it provides and in turn relies upon, and because they are so easily recognised and understood by society.

56 Assessing whether mitigation stocking of salmon, as a response to decreasing populations or as mitigation, is consistent with an Ecosystem approach is best done by comparing it to alternative methods of increasing salmon numbers, including reducing adult mortality and improving the quality and amount of spawning and juvenile habitat.

57 The simplest comparison we can make is by comparing salmon stocking with improvements to habitat quality. A single additional salmon achieved by stocking alone brings no additional benefits in terms of improvements to water quality, physical habitat quality or removal of obstructions. A single additional salmon achieved as a result of improvements to water quality and physical habitat, brings with it additional regulating services such as erosion control, reduced pollution and potentially increased biodiversity. These additional ecosystem services are achieved through the mechanism of the environmental improvements required to increase numbers of salmon. The additional services will benefit the full range of species in the river and enhance and improve processes such as nutrient management and habitat connectivity, assist in the adaptation to climate change, reduce drinking water treatment costs etc. This is before taking into account the potential impacts of stocking and the risk that we may even reduce the services provided by the salmon themselves if population fitness is reduced.

58 In purely practical terms, and comparing salmon stocking with similar scenarios in terrestrial environments, we would not devote resources to re-introducing species of invertebrates, birds or mammals without first ensuring that we had done as much as possible to restore their habitat, so that they can become a fully self sustaining population. Indeed there have been significant failures from attempting to do this. It is the case that no, or few terrestrial species in a similar state of population decline are used to underpin a recreational activity such as angling, but the conclusion of this review is that whilst salmon stocking following an extinction event in an effort to restore a functional population is consistent with an Ecosystem Approach (providing the reason for the extirpation had been dealt with), both enhancement and ongoing mitigation stocking appear to be inconsistent with the Ecosystem approach.

Consistency with International Union for the Conservation of Nature (IUCN) – Guidelines for Reintroductions and other Conservation translocations, 2012.

59 These guidelines, recently updated, form the internationally accepted principles by which the re-introductions of locally extinct or threatened species would be undertaken. The review has considered the applicability of the guidelines to salmon stocking, and on the basis of the definition below, it concludes that salmon stocking undertaken by NRW in Wales is in theory covered by the definitions used. It also concludes that the current salmon mitigation stocking programme would need some modification to become consistent with the guidelines.

60 "Conservation translocations consist of (i) reinforcement and reintroduction *within* a species' indigenous range, and (ii) conservation introductions, comprising assisted colonisation and ecological replacement, *outside* indigenous range. While salmon stocking from hatchery fish back to the same river is not technically a translocation, mitigation stocking in particular appears to fit the definition of a population reinforcement.

61 **Population Restoration** includes Reinforcement (***Reinforcement*** *is the intentional movement and release of an organism into an existing population of conspecifics.)* Reinforcement aims to enhance population viability, for instance by increasing population size, by increasing genetic diversity, or by increasing the representation of specific demographic groups or stages.

62 One of the first principles used in deciding whether reinforcement should occur is confidence that the reason for the severe population decline has been correctly identified and removed. Consideration should be given to threats through all seasons and at appropriate geographic scales for the species life history.

63 The guidelines state that although reintroduction and "*translocation is an effective conservation tool, its use either on its own or in conjunction with other conservation solutions needs rigorous justification. Feasibility assessment should include a balance of the conservation benefits against the costs and risks of both the translocation and alternative conservation actions.*

64 *Any proposed re-introduction or translocation should have a comprehensive risk assessment with a level of effort appropriate to the situation. Where risk is high and/or uncertainty remains about risks and their impacts, a translocation should not proceed."*

65 Whilst no specific risk assessment for salmon stocking has been carried out, based upon the conclusion of the potential environmental impacts and concerns raised in the scientific literature about the impacts of stocking on the longer term population fitness, the review concludes that the risks from salmon introductions appear reasonably high and therefore, to be consistent with IUCN guidelines, the activity should be subjected to a detailed risk assessment.

66 In addition, based upon the principle that re-introductions should only occur when causes and threats to population extinction and decline have been removed, (as discussed in the section on the Ecosystem Approach), the review concludes that salmon stocking is

taking place against a back drop of long term habitat decline and destruction (creation of reservoirs barriers, and impoundments), which are now being partially addressed, but which are still exerting significant downward pressure on salmon populations. This is in addition to relatively “unknown” pressures at sea.

Conclusion regarding consistency with general policy and principles

67 The review concludes that, whilst there are legitimate differences between the case of salmon stocking and other conservation re-introductions and reinforcements, (because salmon are an important commercial resource,) the majority of NRW’s mitigation salmon stocking is inconsistent with the Ecosystem approach to salmon management and does not take full account of the IUCN guidelines on species re-introductions and reinforcements.

68 The key question appears to be whether stocking is the most effective action that can be undertaken in the context of the likely ongoing effects of the original impacts, coupled with unresolved and on-going impacts from other sources e.g. sedimentation, diffuse pollution, at sea capture, plus the likely impacts of climate change. This review concludes that on-going stocking of new individuals into an existing population is not the most effective action and achieves relatively few benefits in return for the significant investment made.

Finance and cost effectiveness

69 The latest final end of year accounts available (FY 2012/13) for Welsh hatcheries show that the total expenditure related to their operation the that year was £409k. Of that, only 7% of the operational costs are used to underpin additional biodiversity work. The review therefore assumes that the full annual financial cost associated with running the hatcheries is the minimum annual spend for NRW on salmon stocking. In addition to the direct operational expenditure involved in running the hatcheries, in FY 12/13, approximately £108k was spent tackling a major maintenance backlog of work at the hatcheries, bringing the total for 2012/13 to £517,539. This additional £108k is not related to any income received directly and could be considered a one-off or periodic expenditure.

70 12% of the total spent last year is income received for the specific purpose of mitigating impacts related to Cardiff Bay Barrage . A further 26% is funding received from NRW’s Water Resources work. 4% of the total cost for last year is income achieved from the sale of hatchery fish to the Mawddach Trust for stocking in that river. Therefore, 42% of the expenditure on salmon rearing and stocking is related to income received into NRW, but only that received for Cardiff Bay mitigation is income ring fenced to this particular activity..

71 Cynrig Hatchery also has various infrastructure problems that need a permanent solution, these include issues with leakage from the mill leat which brings water to the site and undermines concrete structures. Other investment would make the operation of the facility more sustainable, including changes to the abstraction and water re-cycling, to reduce water usage at the site.

72 There will be additional costs associated with salmon stocking that are not identified here, and these include staff costs e.g. fisheries staff assisting with actual stocking, processing of Salmon and Freshwater Fisheries Act section 30 stocking consents and stakeholder work associated with stocking inquiries and negotiation.

Comparison of stocking costs with private service providers.

73 Using some current sample figures provided to the review it has been possible to compare the costs of in-house production with the cost of sourcing fish for stocking from commercial suppliers. From the figures provided, there is no significant cost saving to be gained from buying fish commercially, compared to the costs of producing fish in–house. Based upon numbers of fish produced and indicative costs, Salmon parr sourced commercially are approx' 4% cheaper than those produced by NRW hatcheries. This is not a significant cost saving, especially when taking into account the uncertainty around these figures and additional costs associated with quality control that are less directly controllable if production is not carried out by NRW.

Cost effectiveness of stocking when compared with other measures of increasing salmon populations.

74 The review has been unable to find any independently assessed empirical data that compares the cost effectiveness of stocking salmon with improving spawning habitat or reducing mortality by improving catch and release of adults. However, as described already, the adult return rates from stocking appear highly variable and subject to hatchery and site specific variables, and the review has already concluded that there is little evidence for successful re-inforcement of existing viable salmon populations. There are also additional risks to long term population fitness from mitigation stocking.

75 Reducing mortality by catch and release or removing or reducing commercial fishing effort provides an immediate guaranteed increase in the number of adults available for spawning. However catch and release can be an unpopular measure with some anglers and therefore fishery owners, although it is notable that full statutory catch-and-release is required on the rivers Wye and Taff – two rivers currently receiving mitigation stocking.

76 There is however a developing evidence base to demonstrate that habitat restoration is an effective way of increasing spawning and numbers of juvenile salmonids. A study (Beechie et al 2013) has been published in the USA this year..It collates a vast array of recent research and monitoring and concludes that site-specific and large-scale studies are now confirming the scientific basis for protecting and improving habitat to promote salmon survival and abundance. The evidence cited does not come from a single study, but rather from the increasing weight of the literature supported by a rapidly expanding body of research and data on hundreds of habitat actions throughout the Columbia Basin. It concludes that initial results have identified the most effective measures to be; fish passage improvements, in-stream wood and rock structures, livestock grazing controls, connection or construction of off-channel habitat and flow augmentation. In the UK, the Wild Trout Trust have also collated an evidence base (Wild Trout Trust 2012) to support habitat restoration as a valuable method for increasing abundance of both trout and salmon in small streams. Whilst the majority of this evidence was not collected or created in Wales, it demonstrates that there is now a peer reviewed evidence base regarding many of the measures we can take to increase the quality and amount of

juvenile and spawning habitat available. We also know that many of these measures carry relatively low risk of adverse impacts and can benefit other species in addition to the target ones.

77 This review therefore concludes that both alternative measures (reducing mortality and habitat restoration) could be more cost effective at safeguarding wild population fitness and productivity than stocking. Improving and increasing the amount and quality of suitable spawning and juvenile habitat will provide additional ecosystem services that do not have the risk of potential negative impacts to wild populations associated with them.

Discussion and Recommendations

78 This review concludes that there is now sufficient evidence available to influence policy change in this area of work. **It recommends that NRW should bring all our own on-going mitigation, population re-inforcement and enhancement salmon stocking in Wales to an end, This includes all third party stocking on rivers designated under the Habitats Directive for their wild salmon populations. A further component of this includes the development of a realistic and practical timetable for bringing all other third party salmon stocking in Wales to an end, and a start to the process of working and consulting with stakeholders and co-signatories to relevant agreements to put in place suitable alternative mitigation measures instead of stocking. Future restoration stocking should not be ruled out if needed, however there is currently no identified need for this in Wales.**

79 There is now an increasing body of evidence that demonstrates stocking of salmon, in the context of the Welsh environment, is not the most cost-effective way of protecting populations or mitigating for impacts when assessed against a number of criteria.

80 National and international experience serves to highlight the lack of evidence that stocking is an effective means of increasing abundance of wild populations and in some cases demonstrates the opposite. Many salmon stocking initiatives in the UK and other parts of Europe are being brought to an end or reduced to a residual minimal level on the basis of the available evidence. There is also a significant body of work that highlights the potential impacts of stocking, and the risks to wild populations from hatchery reared fish.

81 The review acknowledges that there is some uncertainty regarding the extent of impact on individual rivers, but since salmon stocking in Wales occurs largely on rivers designated under the Habitats Directive for wild salmon populations, the potential risks cannot be safely ignored, particularly when alternative measures are readily available. This also has implications for future hatchery operation and ownership and stocking by third parties.

82 In addition, besides potential negative impacts, the review concludes that most salmon stocking (excluding restoration in the event of extinction) is inconsistent with an Ecosystem Approach, as it fails to address the reasons for population decline and does not deliver additional ecosystem services when compared with alternative measures, particularly when compared to the potential benefits from improvements to the quality and amount of spawning and juvenile nursery habitat. There is a growing evidence base supporting the use of habitat restoration techniques for increasing salmon populations and

these bring with them potential multiple benefits for the wider ecosystem and other species.

83 Previously, the rationale for continued stocking has relied upon an interpretation of the legal framework as providing an unarguable obligation to stock salmon as mitigation for environmental impacts. However, as stated in the section on legal drivers, there is no direct legal driver that requires stocking of fish as the only means of achieving mitigation. There also appears to be flexibility in the legislation to allow NRW to use alternative means of mitigating for the impacts of developments.

84 There is little doubt however that NRW would be expected and, in some cases, required to undertake and fund alternative mitigation measures should we choose to bring mitigation stocking to an end.

85 It is not possible to state with certainty how much alternative means of achieving mitigation would cost, as this would be determined by the scale of the intervention, negotiations with land owners and partners, and a range of other factors.

86 **The Review recommends that given the benefits to salmon and the wider environment from a range of habitat restoration measures, NRW should work with all interested parties to further develop and focus effort on this approach. In particular, but not limited to, removing barriers to migration and increasing the quality and extent of spawning and juvenile habitat available in our rivers. There is a significant opportunity to develop an approach to mitigation and enhancement that will provide multiple benefits to the Welsh environment and to all those that have a stake in ensuring salmon numbers are increasing or stable.**

87 Clearly, the conclusions and recommendation on salmon stocking and use of future resources have significant implications on the future operation of hatcheries by NRW and also for stocking carried out by third parties. An aspect of this review is to determine whether private commercial suppliers of salmon could provide fish at a lower cost than NRWs hatcheries can supply them. Figures provided to the review show it is marginally cheaper to buy fish from a private supplier than produce them in-house, but the difference is insignificant, especially when taking into account the substantial additional risks which would be harder to control.

88 However, the conclusions regarding effectiveness, impact and consistency with wider policy also apply to stocking carried out by others and therefore simply sourcing fish from private suppliers or selling the NRW hatcheries as operational fish culture concerns are not viable options for NRW. Both of these options would not avoid the wider conclusions about impact, effectiveness or consistency with policy.

89 In coming to a view on future recommendations for the hatcheries, the review has taken into account the recommendation on salmon stocking, the ownership patterns of the hatcheries, staffing and capacity and expertise for undertaking additional or related work.

90 Cynrig hatchery operates on a lease-hold basis, whilst the Maerdy and Mawddach hatcheries are fully owned by NRW. The freehold for the Clywedog hatchery is owned by Severn Trent Water, and is not a long term agreement. In addition, some staff based at

Mawddach, have left under Voluntary Exit terms, which has already required the temporary mothballing of operations here and the transfer of equipment to the Maerdy site..

91 Taking all this into account, **the recommendation is that fish culture operations at the Maerdy and Mawddach hatcheries should be brought to an end, and a management decision, informed by consultation with stakeholders, taken on the future of those sites. Income raised from their sale could potentially be put towards alternative mitigation measures in the relevant catchments.**

92 Cynrig hatchery has a track record of working on other species, including freshwater pearl mussel, white clawed crayfish and water vole. This is valuable and highly regarded work and there appears to be the potential and capacity to develop Cynrig into a dedicated freshwater and fisheries research facility, possibly in partnership with academic institutions or other research bodies. There is little financial or business benefit to be gained from closing a facility such as Cynrig and losing the expertise of the staff based there. Using Cynrig for research and work that did not include producing large quantities of salmon fry would have the added benefit of potentially reducing the amount of water required at the site and could help address issues around sustainability without significant investment. **The review recommends that NRW should begin further work and discussions with other bodies on the feasibility of adapting Cynrig into a dedicated freshwater and fisheries research facility**.

93 **The final recommendation is that NRW start the work of discussing and consulting both internally and externally as soon as possible. There will be a high level of interest in any final decisions that are taken as a result of this rev**

Appendix 1

Case law examples of 'levels of certainty' in relation to the application of the Habitats and Birds Directives.

When determining whether an activity has the potential to impact on the features of a European site, particularly in relation to the level of 'proof' required and the effective application of the precautionary principle, the Directives have been clarified and informed by a number of British and European Court rulings and judgements.

'Likely Significant Effect'. This is the first test that any proposal must undergo to determine whether there is the potential for a feature to be impacted. Its meaning was usefully defined in a European Court Case brought against the Netherlands known as the Waddenzee ruling (C-392/96 7th Sept 2004). This defined 'Likely' as the possibility of a significant effect occurring unless it can be excluded on the basis of objective information and a 'Significant Effect' as anything which could undermine the conservation objectives of the European site. It specifically states that " in case of doubt as to the absence of significant effects then [an appropriate] assessment must be carried out"

The ruling then went on to make it clear that to have a likely significant effect there must be creditable evidence to show that there is a real risk rather than a hypothetical risk but also that to demonstrate the absence of likely significant effects there must be objective information based on clear verifiable fact rather than subjective opinion.

Justice Sweetman speaking as Attorney General of Ireland (in support of an ECJ opinion C-258/11 11th April 2013) talking about a development in the west of Ireland, further clarified that "There is no need to establish such an [likely significant] effect; it is merely necessary to determine that there may be such an effect".

The importance of using an appropriately precautionary threshold was emphasised in a UK case (Bagmore wind farm case, Scottish Court of Sessions 92012 CSIH 93) where the courts made it clear that the purpose of the likely significant effect test was to determine which plans or projects were clearly safe to be carried out, if there was a risk more detailed assessment would be needed.

The 'Appropriate Assessment'. This is the formal assessment stage of any proposal and is aimed at determining whether the potential effects of a plan or project will have an adverse effect on the site. Again it is measured against the conservation objectives for the site. It considers all the cumulative impacts of other existing activities and site conditions and also looks at 'in combination' effects with other proposed plans and projects if required. Again the Waddenzee judgement makes it clear that the assessment must be made in the light of the best scientific knowledge in the field and consider not only obviously destructive effects but also degradation, disturbance and factors leading to potential decline. Proposals can only be authorised only once it is certain that "…it will not adversely affect the integrity of that site. That is the case where no reasonable scientific doubt remains as to the absence of such effects" (para 61). This is a fundamental definition of the precautionary approach ie, it is not sufficient that there is doubt over whether adverse effects could occur, there must be clear evidence that they won't.

This need to demonstrate lack of impacts was also emphasised in the European Commission v Portugal Castro Verde case (C239/04, 26th October 2006) where although there was no guarantee that once the proposed motorway was built that it would have adverse effects on the European site, there remained reasonable scientific doubt that such effects could manifest themselves.

The Integrity Test. In its most basic form, this test demonstrates whether the proposals would undermine the site's conservation objectives and in many ways is just an extension to the appropriate assessment. The integrity test does not have to demonstrate absolute certainty that no effects will occur, but that no reasonable scientific doubts remains to the absence of adverse effects. Where there is uncertainty, the competent authority must ensure that all the potential risks have been identified (as far as possible/reasonable) and a framework is put in place to prevent those risks from materialising. This is not the same as there being no risks, just that those risks are understood and there is confidence that they will not result in adverse effects. The following cases help to understand what this means.

Waddenzee again provides several fundamental clarifications with paragraph 56 stating that an authorisation may only be granted once the competent authority is convinced that it will not adversely affect site integrity and 59 stating this would be the case where no reasonable scientific doubt remains as to the absence of adverse effects. This determination has underpinned most subsequent European rulings including the Castro Verde case mentioned above (paragraphs 20 and 24) and Case C-209/02 Commission v Austria (paragraphs 26 and 27), and C-304/05 European Commission v Italy (paragraph 58 and 59). The latter one is important as the judgement goes on to state (paragraphs 69-71) that gaps and lack of precise findings are sufficient to undermine the level of certainty required to allow a proposal to proceed. Similarly in the Sweetman ruling mentioned above (The Galway Outer City Bypass Scheme), states "Authorisation [can only be given when] in the light of the best scientific knowledge in the field, [the competent authority] are certain that the plan or project will not have lasting adverse effects on the integrity of that site. That is so where no reasonable scientific doubt remains as to the absence of such effects."

There are a number of UK example which further clarify this particularly in relation to the degree of 'reasonableness' which should be applied. Two key ones are Hughes v Carmarthenshire County Council which set out that while it was not necessary that proposals led to an improvement on a site they must not lead to a deterioration and the Bagmoor wind case where the possible loss of one breeding pair of golden eagles as a result of the wind farm was considered sufficient to constitute an adverse effect on integrity, even though there was no guarantee this would take place. It was accepted that there was sufficient scientific doubt over whether the eagles would be displaced by the windfarm, and this would result in a failure of the conservation objectives for this site, that the risk was too great and the permission was refused.

Appendix 2

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