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SMALL STREAMS: Contribution to populations of trout and sea trout

One in a series of Knowledge Transfer Workshops, organised by the IBIS project with the Atlantic Salmon Trust

Report of the workshop held at Carlingford, Co. Louth, Ireland 27-28 November 2012

also online (with materials): http://ibis-eu-know.weebly.com/nov-2012-small-streams--carlingford.html

INTRODUCTION

1 The workshop, which was jointly organised by IBIS and the Atlantic Salmon Trust, explored the importance of small streams for salmonids. It originated in a recommendation made by the AST Sea Trout Workshop that more attention should be given to the significance of small streams for sea trout production; while the focus was on trout, both resident and migratory, the role of small streams in the production of salmon was also covered. The workshop was attended by a large cross section of interest groups including fishery managers, fishery scientists, fisheries trusts, angling groups and environmentalists. It is intended that the outcomes of the workshop will feed into the further workshop being organised by the Institute of Fisheries Management on behalf of the Environment Agency, which will consider the importance of small streams for all species of fish.

2 The workshop took the form of a number of presentations on the first day, with time for questions and discussion; the second day was devoted to a discussion of key issues and research needs. In the course of the discussion sessions participants also provided data on a range of issues.

3 This report does not attempt to provide a detailed record of all the presentations and discussion. Rather, it tries to pull together the main issues that emerged during the workshop.

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KEY OUTCOMES

4 The workshop agreed on a number of recommendations for action, principally further research. These are summarised at the end of this report. It reached the following main conclusions:

- There is a case for focusing effort on very small streams (<1.5metres wide). While the workshop was not able to come up with a single definition of what constituted a small stream, it agreed that very small streams were particularly vulnerable, constituted a high proportion of the total stream and river length in many catchments and in most cases little data on them was available;
- more research is needed into the role and importance of small coastal streams in contributing to sea trout numbers at sea;
- the contribution of small fishless streams to the ecology and fish populations of their wider catchment needs to be established;
- while trout should in principle be regarded as a migratory species, there is a need to improve our understanding of migration patterns and to establish the relative proportions of resident and migratory fish within individual populations**;**
- the linkages between primary and secondary (macroinvertebrates) and fish production in small streams needs to be quantified.
- apart from their importance for fish, the contribution of small streams to overall catchment biodiversity (especially macroinvertebrates) is considered to be high and warrants further research.
- small streams are particularly vulnerable to anthropogenic activities and require close monitoring
- ways of raising the awareness of the importance of small streams among land managers, conservationists and the general public needs to be explored**;**
- a better understanding of the ecosystem services benefits provided by small streams will help develop a more convincing case for devoting resources to their conservation ;
- developing effective ways of using and retaining volunteers (citizen science) will be critical if progress is to be made in improving the monitoring and restoration of small streams.

THE ROLE OF SMALL STREAMS

Definition of a small stream

5 The workshop heard that there were a number of possible ways of defining a small stream – stream order, width, flow, depth – but it was generally agreed that the simplest, and most easily measured, was width. The average widths of first and second order streams (at 1:50,000 scale) are about 3 and 6 metres respectively, and as trout tended to be the dominant salmonid in streams of less than 6 metres it was suggested that this might be a workable upper limit. On the other hand, it was pointed out that a good deal of information existed about most second order and larger first order streams, and these tended to be reasonably well protected, while streams of less than 1.5 metres wide were less well understood and more vulnerable. First order (<3m wide) streams constitute a very significant proportion (50-60%) of the total length of typical rivers, although a much smaller proportion (10-20%) of the wetted area. Their self-defining feature, small

physical size, makes small channels susceptible to physical change and other environmental pressures. For example input or removal of large woody debris has *a priori* more effect in narrow channels. Moreover, the high ratio of bank length to water volume makes small streams more vulnerable to harmful impacts from land use, or pollution point sources. Similarly, bankside vegetation has a correspondingly higher influence on food input and shade in small compared with wide channels.

6 The workshop concluded that no single definition of what constituted a small stream was all inclusive. Instead, focus was needed on the role that small streams, and in particular very small streams, play in the ecology of a catchment and on their vulnerability to physical and water quality pressures.

Use of Small Streams by Salmonids

7 Small streams are principally used by salmonids for spawning and as nursery areas. Salmon prefer streams with a width of more than 2.5 metres; the minimum size utilised by trout, on the other hand, appears to be 0.8 metres, with streams of only 1 metre wide used by large sea trout for spawning. Juvenile trout tend to show a preference for habitat that lies close to banks, which by definition is a higher proportion of stream area in narrower channels. Electro-fishing surveys within the Tweed catchment have shown that streams averaging 2 metres and under are dominated by trout fry, while in channels averaging 2 metres and over salmon fry predominate. In very small streams 0+ trout fry move downstream early; this is essential in ephemeral streams such as winterbournes. On the island of Gothland 0+ trout fry move into brackish water, and elsewhere they may make use of pools and lake littoral zones. Evidence from Burrishoole shows that juvenile fish, particularly in older age classes, move progressively downstream from spawning areas throughout the year. Nevertheless, quite small streams may also contain small resident trout . **The workshop agreed that more research is needed on the movement of immature salmon and trout, within and out of small streams.**

Coastal Streams

8 The role of coastal streams, i.e. small streams that directly enter the sea or an estuary, is not well understood. There are a large number of these, and it is probable that significant populations of sea trout lead an essentially marine life, only entering coastal streams briefly to spawn. Estimates of smolt production for the streams entering Strangford Lough demonstrate the potential contribution made by coastal streams to sea trout production. As mentioned above, there is evidence of 0+fry moving into brackish water; this has also been reported on Orkney and on the Sussex Ouse. It was suggested that salinity was important here, and that while fry could tolerate brackish water they could not survive in sea water. The economic importance of coastal sea trout rod fisheries is growing, and it is possible that a substantial proportion of the sea trout targeted in these fisheries was produced in such streams. **The workshop agreed that more research is needed on the role and importance of coastal streams in contributing to sea trout numbers at sea.**

Fishless Streams and Invertebrate productivity in small streams

9 Even where very small streams are not populated by fish, they play an important role in a catchment and contribute significantly to overall biodiversity**.** They not only provide a direct source of invertebrates for fish, via downstream drift, but constitute potential refuges for invertebrates in cases of pollution downstream.

10 In her presentation Mary Kelly-Quinn summarised what is known of invertebrate productivity in small streams in Ireland. Although a considerable amount of macroinvertebrate sampling had been undertaken, this had generally been in the context of assessing land-use impacts; only one study had specifically focused on headwaters. Overall, small streams exhibited high heterogeneity in terms of their species complement, with typically over half of the macroinvertebrate species occurring in less than 5% of sites and less than 10 taxa common to all sites. Moreover, small streams made an important contribution to biodiversity, with significant number of species found only in headwaters. Only limited data on macroinvertebrate abundance were available, but it was clear that while abundance increased with distance from the stream source, heterogeneity declined. This might mean that fish in small streams had access to a wider food base. **The Workshop agreed that research was needed to improve our knowledge of the macroinvertebrate communities and productivity of small streams, and of the contribution made by aquatic and terrestrial macroinvertebrates from headwater streams to salmonid diets. The use of stable isotope analysis for the latter should be explored.**

Trout populations in small streams

11 The workshop agreed that in principle trout should be regarded as a migratory species; it was therefore important to consider migration patterns within rivers, and from streams/rivers into still waters. However, within a population there is a clear tendency for males to be resident and females migratory, and this is particularly marked for populations with an anadromous component. In the Tweed catchment six out of seven burns sampled by trapping show very similar population structures, with a predominance of small resident males and larger sea trout females. The seventh burn, higher up the catchment, has a different population profile, with only one main size group of larger, mostly resident fish, with a much more even sex ratio. The Tweed Foundation is exploring other ways of determining the origin and maternity of trout fry, such as stable isotope analysis, and of determining the sex of adult fish outside the spawning season by non-lethal methods. **The Workshop agreed that there was a need to improve understanding of migration patterns, and to establish the relative proportions of resident and migratory fish within individual populations, as part of the study of life history choices in trout recommended by the Sea Trout Workshop[i], and for research into simple, and cost-effective ways of doing this.**

12 The workshop also concluded that we needed to improve our understanding of the complexity of interactions between fish communities in small streams, including interactions between separate populations of the same species. A relevant factor is the variation in spawning locations, in terms of access, competition between and within species and food availability. Data from the Burrishoole system illustrates the genetic complexity of the population structure within a relatively small catchment, with individual streams making different contributions to the overall composition of the catchment stocks, and with ratios between brown and sea trout varying within these separate populations**. The workshop agreed that more genetic analysis was needed to**

ascertain population structures of migratory and resident trout within catchments, including small streams.

13 Data were presented showing relationships between wetted area and rod catches of salmon and sea trout in Scottish salmon districts**.** These showed a good correlation so far as salmon were concerned, which suggested that fish were making full use of available habitat and that rod catch is was a reasonable indicator of abundance. There was no such relationship for sea trout, either because sea trout were distributed more sporadically or because the data did not record resident trout. It was also pointed out that catch records for sea trout were less reliable than for salmon.

CLIMATE CHANGE AND SMALL STREAMS

14 Ciaran Broderick gave a presentation outlining the results of the RESCALE (Review and Simulate Climate and Catchment Responses at Burrishoole) project, which explored the potential ecological, biological and physical impacts of climate change on the Burrishoole catchment, utilizing the detailed environmental data available for the catchment. Data for the catchment had been compared with projections derived from different models, downscaled to a catchment level. The data had shown an increase in average seasonal temperatures, in the frequency of high temperatures and of heavy rainfall events. The combined projections suggested an increase in mean temperature over the period 2070-2099 of 1.7 ˚C, 1.8 ˚C, 1.7 ˚C and 2.2 ˚C (relative to the period 1961-1990) for winter, spring, summer and autumn respectively; moreover, the observed temperature data up to 2008 exceeded all the projections. The projections also suggested an increasing tendency towards a more seasonal rainfall regime, with this trend becoming more pronounced as the century progressed; and winter rainfall was projected to increase by 13% from the 2050s onwards, accompanied by a decrease of 10% in summer rainfall amounts. This was likely to lead to significant changes in flow regimes. Overall, seasonality in our climate would become increasingly pronounced.

15 In discussion it was noted that small streams were particularly vulnerable to the impacts of climate change. Increased water temperatures are likely to pose particular problems. There is evidence that these are affecting egg growth, with reduced times to hatching (although this could be being offset by later spawning). Relatively limited increases in temperature have been shown to affect juvenile growth and survival, and there is also evidence that higher temperatures reduce survival rates among ranched salmon. There is a need for data on the effect of higher temperatures on energetics and on marine survival. Overall, trout have a narrower range of optimal temperatures than salmon, and it is possible that increased in-stream temperatures will serve as a driver for increases in levels of anadromy.

16 Climate change is also likely to lead to more extreme conditions, with more floods and droughts; the impact of these will be accentuated by the limited resilience of small streams .It was noted that work was needed on how algae, plants, invertebrates and fish would survive and on their ability to adapt; interfaces between small and larger streams and small streams and loughs would be critical as refuge areas. Climate change would also increase the risks posed by invasive species, disease and parasites.

17 **The workshop concluded that it was important to record and map the impact of climate change on small streams, including cumulative impacts, using appropriate indicators, and that there was a clear need for national repositories of climate change information**. It was pointed out that in Ireland a great deal of relevant information was held in the National Biodiversity Data Centre (http://www.biodiversityireland.ie/). It was also necessary to bear in mind that there is evidence for the existence of microclimates within catchments, so extrapolation of data from particular sites needed to be done with caution.

MONITORING SMALL STREAMS

The Small Streams Risk Score (SSRS) System

18 Martin McGarrigle gave a presentation on the use of the SSRS system to monitor small streams. Under the Water Framework Directive water bodies are to be assessed to establish their ecological status, using a range of indicators. This required extensive monitoring, to establish ecological status and, where status is less than good, to ascertain reasons for failure. However, the great majority of small streams fell outside this process, although, since levels of diffuse pollution were proportional to length of river bank, ignoring small streams posed serious risks of downstream water bodies failing to meet WFD requirements. To address this problem the SSRS system had been developed; this used macroinvertebrate numbers and species to identify stretches of small streams 'at risk' of
failing to achieve the good status goals of the WFD and diffuse pollution sources.

19 The SSRS was designed to enable field operatives to monitor sites with minimal training, since they needed only to identify a limited number of key indicator species. Once a site had been assessed it is put into one of three classes. The results give a clear indication of a problem. The SSRS was used to assess risk, not status, and if a potential problem was identified chemical sampling was needed to confirm the results and identify the source of the pollution. Over 200 Inland Fisheries Ireland field staff has been trained in the use of SSRS techniques and through their work they had to date collected significant additional data on the status of small streams in Ireland.

20 It was noted that the Flylife Partnership's Anglers Monitoring Initiative used very similar methods in Great Britain. It is not known to what extent similar systems existed in other Member States, most of which lack good historical records of invertebrate species and abundance.

21 In discussion it was noted that it was important to that ensure macroinvertebrate taxa were sampled in both winter and summer; sampling in early summer, for example, before emergence, could produce artificially low figures, and some sources of pollution, such as septic tanks, had a greater impact in summer, with populations recovering over winter. Results needed to be mapped and recorded, with records easily accessible. Continuous, long term records were particularly valuable. These could identify changes to taxa and to a stream's productivity, although caution was needed in interpreting results in view of natural variability.

Mapping Small Streams

22 Biological records need to be linked to accurate geographic information. Wetted area, either directly measured or derived from channel length, upstream catchment area and Shreve river index, is currently used to define the extent of fish habitat in a catchment. It was noted, however, that modern GIS technology provided a powerful tool, and made it possible to record and display a wide range of additional habitat data. Moreover, the land through which a stream flowed, in terms of geology, vegetation and farming practices, had a major influence on in-stream habitats. Multi-layered GIS based maps could also be used to display the ecosystems services that could be delivered by small streams. It was noted that the Sea Trout Workshop had recommended the development of a GIS based inventory of sea trout rivers[ii], and this was being taken forward via the Celtic Sea Trout Project. **The workshop recommended that this should be extended to cover small streams in order to quantify their contribution to catchments and display location in relation to potential pressures.**

MANAGEMENT OF SMALL STREAMS

Threats to Small Streams

23 Small streams face particular management challenges:

- Because of their tendency to have a steep gradient, small streams may face particular issues of access and connectivity.
- They naturally experience a very wide range of flows and may even dry out seasonally or in drought conditions;
- Small streams naturally experience a very wide range of temperature extremes;
- Because of this vulnerability to extremes of flow and temperature, small streams are very sensitive to land drainage, forestry planting and bank cover removal;
- Their small size makes them very vulnerable to single events (tree falls, for example), overshading, accidental damage and neglect;
- Naturally low pH and limited buffering capacity make small streams particularly vulnerable to acidification.
- Because of the intimate association between small streams and their watersheds, they are vulnerable to extensive activities such as mining, heather burning and fertilisation.

24 Many of these problems can be avoided by greater awareness of the importance of small streams, not just for salmonids but for biodiversity more generally. Moreover, small streams provide ecologically valuable networks linking different habitats within a catchment. These are of benefit not only to fish and invertebrates, but also to other species. There is considerable scope for involving other interest groups – for example, those concerned with birds – in the protection and conservation of small streams. **The Workshop agreed that ways of raising the awareness of the importance of small streams among land managers, conservationists and the general public needed to be explored.**

Restoring Small Streams

25 While it is important to avoid further damage to small streams, on its own this will not be enough. It was pointed out that within the British Isles small streams existed within a managed environment, and they themselves needed management. Schemes to create buffer strips, plant trees etc. were widespread, but there was limited information on their effectiveness, and schemes rarely provided for ongoing maintenance. It was, for example, important to have a balance between light and shade, with variations in vegetation and tree cover and to avoid creating over-shaded tunnels. The Wild Trout Trust provides detailed advice on habitat management for trout - http://www.wildtrout.org/content/wtt-publications. Shading is also important as a means of keeping water cool; the Environment Agency's Keeping Rivers Cool project provides guidance on this. **The Workshop agreed that consideration should be given to the need to develop specific guidance on management and restoration of small streams.**

Flows and barriers

26 Many small streams naturally have highly variable flow regimes, which limit access in low flow conditions. This makes them particularly vulnerable to barriers such as culverts, bridge footings and vehicle crossing points. While the impact of a single culvert might be low, the cumulative impact on a single catchment, where the majority of watercourses are small streams, is considerable. On the positive side, such barriers can often be dealt with reasonably cheaply and easily (although cumulative costs might be high). In larger streams hydropower schemes and weirs restrict fish passage. The workshop was informed of a case study in the Bush catchment in Northern Ireland, where the construction of a barrier preventing access upstream by migratory trout had led to significant reductions in numbers of 0+trout.

27 It was noted that genetic differences between trout populations in catchments were likely to be linked to connectivity, with, in particular, genetically distinct populations above natural barriers. For this reason there should be a presumption against removing natural barriers, and caution exercised over removing long standing artificial ones.

Ecosystem services

28 Governments are increasingly using an ecosystem services approach to assess the value to society of particular aspect of the environment. A number of the goods derived from ecosystem services were relevant to small streams; restoring small streams and their associated wetlands would, for example, reduce flood risk, help improve water supply and quality, maintain aquatic biodiversity, benefit the natural environment throughout the catchment and improve fisheries. **The workshop concluded that a better understanding of the ecosystem services benefits provided by small streams would help develop a more convincing case for devoting resources to their conservation, and that work on this should be taken forward at the further workshop recommended by the Sea Trout Workshop**[iii]

CITIZEN SCIENCE/VOLUNTEERS

29 Given the scale of the task involved in monitoring small streams, the workshop recognized that it would be essential to make use of enthusiasts and volunteers (so called citizen science). The Flylife Partnership's Anglers Monitoring Initiative provides a good example of the use of volunteers, drawn largely from angling clubs, to monitor invertebrate communities, and this is an approach that could be extended to other forms of monitoring. Key issues will be defining clearly the tasks to be undertaking, providing training, recording data in a uniform and consistent way, monitoring results and providing ongoing support and, not least, ensuring the long term viability of schemes (which will depend on retaining the enthusiasm of volunteers). It will also be important to establish links with other interest groups, such as ornithologists, botanists and terrestrial entomologists, as well as interested members of the general public such as hill-walkers. The latter, for example, could report invasive plant species. **The workshop agreed that the greater use of citizen science to monitor small streams provided a promising way forward, and one that should be pursued**.

Note: The UK-Environmental Observation Framework (UK-EOF) (http://www.ukeof.org.uk/) was launched in 2008 in response to the long term issues that surround environmental monitoring, observations and surveillance. It has recently published a guide giving advice on how to develop, implement and evaluate citizen science projects to study the UK's environment, covering many of the issues identified by the workshop This states, inter alia, that 'the value of citizen science in helping to meet the need for environmental monitoring and to address the challenges outlined within the emerging governmental biodiversity and environment strategies is widely recognised.'

30 Restoring small streams is another task which will benefit from the involvement of volunteers. Bodies such as rivers trusts and the BTCV are already active in this area. This is closely linked to the issue of raising awareness of the importance of small streams. Farmers and other land managers can themselves make significant improvements to small streams, at minimal additional cost, if they know what to do. **The workshop agreed that the guidance recommended in paragraph 25 should be drafted with this in mind**.

SUMMARY OF RECOMMENDATIONS

Research

Research is needed:

1. on the movement of immature salmon and trout , within and out of small streams
2. on the role and importance of coastal streams in contributing to sea trout numbers at sea
3. to improve our knowledge of the macroinvertebrate communities and productivity of small streams, their significance in terms of overall catchment biodiversity and of the contribution made by aquatic macroinvertebrates from headwater streams to salmonid diets. The use of stable isotope analysis for the latter should be explored.

4. to improve understanding of trout migration patterns, and to establish the relative proportions of resident and migratory fish, within individual populations**,** as part of the study of life history choices in trout recommended by the Sea Trout Workshop, and for research into simple, and cost-effective ways of doing this.
5. to ascertain, using genetic analysis, population structures of migratory and resident trout within catchments, including small stream.

Monitoring and Management

1. It will be important to record and map the impacts of climate change on small streams, including cumulative impacts, using appropriate indicators and that there is a clear need for national repositories of climate change information.
2. Ways of raising the awareness of the importance of small streams among land managers, conservationists and the general public should to be explored.
3. The development of a GIS based inventory of sea trout rivers should be extended to cover small streams in order to quantify their contribution to catchments and display location in relation to potential pressures.
4. Consideration should be given to the development of specific guidance on the management and restoration of small streams; this should take account of the potential role that farmers and other land mangers could play.
5. A better understanding of the ecosystem services benefits provided by small streams would help develop a more convincing case for devoting resources to their conservation, and work on this should be taken forward at the further workshop recommended by the Sea Trout Workshop.
6. Greater use of citizen science to monitor small streams provides a promising way forward, and one that should be pursued.

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[i] A comprehensive programme, provisionally titled *Life History Optimisation in Trout in a Changing Environment,* should be developed**,** to explore the factors that influence the life history strategies that trout adopt*,* together with the ways that climate change might affect them

[ii] A GIS linked inventory of sea trout rivers should be developed, with supporting information on the size of the resource, and once the system is operational it should be taken up throughout the British Isles

[iii] The Workshop agreed that more should be done to establish **the social and economic importance of sea trout and sea trout fisheries.** In particular, more work is needed on the ecosystem services value of these fisheries. It recommended that a seminar or workshop, attended by the appropriate experts, should be organised to take this forward