



**The Quarterly
Magazine of
Fisheries
Management**

FISH

Fish, Flows and Climate Resilience



- Fish, Flows and Climate Resilience
- UN Report on Nature's Dangerous Decline
- How Changing Flows Are Affecting Trout Recruitment in Navarra, Spain
- NASCO 2019
- Wylze Grayling Study
- *Anguillicola crassus* in Glass Eels
- Low Flows and Wildlife
- + more



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Fish 134

Inside this edition

- 4 View from the Chair
- 8 Fish, Flows and Climate Resilience
- 14 How Changing Flows Are Affecting Trout Recruitment in Navarra, Spain
- 18 Wylle Grayling Study
- 22 Low Flows and Wildlife
- 24 UN Report on Nature's Dangerous Decline
- 30 NASCO 2019
- 36 *Anguillicola crassus* in Glass Eels
- 40 The Paul Coulson BLOG
- 44 IFM News
- 47 Breaking News
- 50 Book Review
- 52 Members and their fish

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The theme for this edition of *FISH is Fish, Flows and Climate Resilience*, which was the theme for the IFM's 9th Specialist Conference in York in 2019.



Harriet Orr, climate change research lead for the Environment Agency, provides our first article based on her keynote address on climate resilience. "We know our future climate will be different. It will be at least 2°C warmer, or 4°C warmer if we cannot curb greenhouse gas emissions globally. This means we will need to do things differently to manage sustainable fisheries."

Dr Carlos Alonso of the Universidad Politécnica de Madrid, then looks at how changing flows, linked to climate change, are affecting trout recruitment in Navarra, Spain. Dr Stephen Gregory of the Game and Wildlife Conservation Trust, follows this by highlighting the importance of maintaining and/or restoring natural flows and riparian areas to provide the required flows for salmonids, while limiting temperature increases through drawing on long-term data from the River Wylle. Valerie Holt then discusses the impact of low flows on wildlife and argues for more action.

Moving to wider issues, I draw out some of the key findings from the recently published UN report on Nature's Dangerous Decline.

Dr Nigel Milner reports on the 36th NASCO (North Atlantic Salmon Conservation Organisation) Annual Meeting. Ian Wellby, head of IFM Training, concludes our main articles by discussing the implications of the recent diagnosis of an infection of *Anguillicola crassus* in glass eels.

Finally, I review one of Drew Jamieson's recent books, *Trout from Scottish Reservoirs, A Valuable Recreational Resource*, which is a little gem.

If you would like to contribute to FISH please get in touch.

Lawrence Talks - FISH editor
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View from the Chair

View from the saddle

In the last FISH I mentioned I was about to undertake a 1,000km cycling expedition over 10 days from Bilbao to Barcelona in Spain via the Pyrenees. It was a great adventure with just four others who have become great friends. The scenery and environment were stunning and varied, taking us on quiet roads through rolling countryside, hills, mountains, past lakes, coasts and through river gorges. It was a steady pace and, apart from some long and high Pyrenean mountain climbs, was never too challenging. The greatest pleasure and satisfaction was to have covered a large distance under my own power, and at a pace to have been at one with nature and my own thoughts. I returned refreshed in body and mind.

Politics and environmental legislation

So, we have a new Prime minister, not unexpectedly, in Boris. And with him comes a new Cabinet. I'm sure we all have different views, hopes and fears, particularly the outcome of the Brexit process and what it will mean for trade, legislation and our futures. We have a new Environment Secretary in Theresa Villiers, who is largely unknown and untested to us, but George Eustice who we are familiar with has returned as Fisheries Minister. Whilst Michael Gove, arguably the most effective Environment Secretary for a generation, has left that post, as 'Cabinet Enforcer' in his new role as Chancellor of the Duchy of Lancaster, he will hopefully ensure that his legacy in the 25 Year Environment Plan continues. Just before leaving he made a keynote

speech, asking *'If not now, when?'* He gave a detailed account of Defra's work and vision for the environment, addressing the biggest challenges of our age. He asked if not now, to tackle climate change and reverse nature's decline, then when? These were welcome words from the outgoing Secretary of State, and I hope the forthcoming new administration continues this direction of travel in tackling the challenge and scale of our environmental crisis. If you'd like to read the speech in full, go to: <https://www.wcl.org.uk/michael-gove-asks-if-not-now-when.asp>.

The previous Business Secretary, Greg Clark, made a statement in March to apply 'non-regression' legislation, so that at least current environmental legislation will be implemented through the Environment Bill. The draft Bill outlined proposals to establish a world-leading body to hold the Government to account for environmental outcomes after the UK leaves the EU. The draft Bill also requires the Government to publish a statutory policy statement on the interpretation and application of nine environmental principles, including the four contained in EU treaties.

Michael Gove published the Government's first progress report against the 25 Year Environment Plan in May. It is available at <https://www.gov.uk/government/publications/25-year-environment-plan-progress-reports> and I commend you to spare half an hour to read it.

Marine Strategy

IFM has added its voice to NGOs which are part of the Wildlife and Countryside Link (WCL) to comment on the Government's Marine Strategy. The conclusions and key messages from this collaboration are:

- UK Seas are in a poor state, with only 4 out of 15 indicators meeting Good Environmental Status (GES), according to this assessment.
- The ambition of targets, baselines and actions in the Marine Strategy is weak, and there are no deadlines attached to operational targets. This does not align with the UK Government's ambition to be a global leader in marine conservation.
- There has been a lack of progress since 2012 with no prospect of meeting the 2020 target of GES for most indicators.

- We do not agree with a number of the assessments of status (i.e. for pelagic habitats, commercial fisheries, contaminants, contaminants in seafood and underwater noise).
- There is a lack of data to enable an effective assessment to be reached in a number of cases (e.g. on seals and contaminants, and there is a general lack of data for the Celtic Seas Region). In these cases the assessment is often termed as *'uncertain'* when more accurately it should be termed *'unknown'*.
- For some indicators (e.g. commercial fish) the assessment is based on out-of-date data, which gives an inaccurate picture of current status.

Being part of the Wildlife and Countryside Link does give IFM and other environmental NGOs a stronger voice in partnership to have greater influence on Government policies and other developments. My thanks to Steve Colclough and our Marine Specialist Section team, which leads on providing IFM's views on Marine matters to WCL and other fora.

50th anniversary conference

A reminder that our Annual Conference is in Nottingham, 8 – 10 October where we'll be celebrating the IFM's 50th anniversary. We'll reflect there how far IFM and Fisheries Management has come in the past 50 years and try to predict what the future might have in store. I hope to see you there.

To book your place go to <https://ifm.org.uk/events/event/copy-of-ifm-49th-annual-conference-thriving-or-surviving-creating-resilient-fisheries/>.

As ever, your views on anything IFM or fisheries management are appreciated and you are welcome to contact me direct at chairman@ifm.org.uk.

With best wishes.

David Bunt | IFM Chairman



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Fish, Flows and Climate Resilience

Environment Agency build a temporary salmon fish pass on the River Teme at Ludlow in 2016

Dr Harriet Orr, climate change research lead for the Environment Agency, provides a keynote address on climate resilience.

We know our future climate will be different. It will be at least 2°C warmer, or 4°C warmer if we cannot curb greenhouse gas emissions globally, and do this quickly. This means we will need to do things differently to manage sustainable fisheries.

There are information sources that can help us to understand how the climate and the environment is changing and that indicate what might happen in future. These data present a partial and often uncertain picture which can get in the way of both large scale strategic and more practical action being prepared. We need to try and understand something about the timescales and spatial extent of potential impacts and equally at what scale interventions need to be made to make a difference to the fisheries we want to protect and maintain.

Concepts like resilience have the potential to unify action but we probably need to be much clearer about what resilience means and how we can measure it to know if we're heading in the right direction, and also to be realistic. As the Environment Agency Chief Executive said in a recent speech, "While you can recover from a flood, there is no recovery from a rising sea: it takes land, communities, infrastructure and everything else away forever" (<https://www.gov.uk/government/speeches/climate-change-turning-emergency-into-opportunity>). Some changes cannot be resisted and we cannot build resilience to everything. So we need to be able to target our efforts effectively.

There are good examples of using available data, information and scientific approaches to inform our action and we could make more of these

to help us target our efforts. The big challenge is to identify the things we can do to make the biggest difference. We also need to work together to tackle the sources of pressure and encourage action amongst those who can make a difference.

Climate change impacts on fish

It would be great to have a clear view of what climate change will do to the distribution and abundance of different fish species and whilst we have progressed some way past climate envelope mapping for fish species (this is where we identify the optimal space for a species to exist – through looking at climate scenarios we can see how this changes) there are uncertainties particularly at very local scales.

We have observed some marine species moving north and there is likely to be increased stress on fish species such as trout and salmon, increased infections, bacteria and parasites and shifts in fishing seasons. We know that rising temperatures and ocean acidification are changing fish distributions, their productivity and abundance. Changing temperatures in both marine and freshwater habitats are likely to affect growth rates and fish size as the distribution and abundance of plankton and food is affected.

The full relationship between fisheries and climate change is difficult to explore due to the context of each fishery and the many pathways that climate change affects, which makes modelling very challenging. We struggle to know what aspects of temperature will be the most important and whether we have any ability to influence them.

We can rarely quantify how much climate change affects fisheries separately from other pressures, which makes it hard to know whether focussed efforts to reduce other pressures are cost effective, e.g. warmer estuaries may be a barrier to fish migration – what effect could regulation of thermal discharges have on this? Does it really matter if some days are bad days if other days are good days for migration? Should a risk-based approach be taken? Should we focus on what we know; for example, numerous studies have demonstrated that habitat loss and eutrophication have been major causes of species decline in lowland England over the past 300 years?

A study of boreal plants in southern Britain found that climate change is now having an effect comparable to that of habitat loss on the extent of boreal vascular plants in southern Britain (<https://academic.oup.com/biolinnean/article/115/3/5>).

What climate change data and information are out there?

Climate Change Report Cards have been produced by NERC (Natural Environment Research Council), which indicate, for example, that cold-water fish communities are changing, with the Arctic charr becoming scarcer as waters warm and it competes less well with the more thermally tolerant brown trout.

Observed changes in the UK include: that all the warmest years on record have occurred since 1900, the number of days of lying snow has decreased over the last 50 years and sea level rise is already affecting UK estuaries.

In 2015/16, the exceptionally mild and wet winter has been linked to a significant crash in juvenile salmon abundance, which was evident from the Environment Agency and Natural Resources Wales fish monitoring programmes. Densities of juvenile salmon (particularly 0+ fry) were well below average in many English and Welsh rivers in 2016. The widespread nature of these observations suggests common factors operating at a broad scale, although various factors are believed to have contributed. These include: low spawner numbers, high winter flows in the winter of 2015/16 and unusually high winter temperatures.

For river coarse fish stocks a strategic review of data and information is currently underway to ascertain whether there are long-term trends in populations of coarse fish species, (perhaps driven by weather patterns or climate change) and whether these differ between different river types.

Hot summers are expected to become more common. In the recent past (1981-2000) the chance of seeing a summer as hot as 2018 was low (<10%). The chance has already increased due to climate change and is now between 10-20%. With future warming, hot summers by mid-century could become even more common



Environment Agency build a temporary salmon fish pass on the River Teme at Ludlow in 2016



Rive Coiltie at Urquhart Bay near Loch Ness, Scotland June 2006



can be used to identify areas that may benefit from management action such as native tree planting to reduce excess warming and keep maximum temperatures lower. This information can be combined with an understanding of the processes controlling the effectiveness of riparian shading to make decisions on the precise locations for planting.

In the USA they have developed interactive water temperature maps: <https://www.fs.fed.us/rm/boise/AWAE/projects/NorWeST.html>
We don't yet have these kinds of data available in England and Wales.

How can we prepare or adapt?

Climate change is happening and meaningful action against climate change is urgently needed at a local and global level. So far political commitment has been weak and action too little and too slow.

Greta Thunberg, the Swedish school girl, has done much to raise awareness of climate change and she has shifted political dialogue into a recognition, at least in words, that we are in a climate emergency.

Last year's Intergovernmental Panel on Climate Change (IPCC) report <https://www.ipcc.ch/sr15/> states that limiting global warming to 1.5°C requires rapid, far-reaching and unprecedented changes in all aspects of society. With clear benefits to people and natural ecosystems, limiting global warming to 1.5°C could go hand in hand with ensuring a more sustainable and equitable society.

In the words of the Environment Agency's Chief Executive, James Bevan, climate change is the biggest threat we face and we need to stop the activities that cause it, enhance our resilience and get everyone involved and talking about it.

In conclusion, it's clear that the future is going to be different and so we need to act differently. We need to work out what will make the biggest difference. We need to work together. We need to work with those who can make a difference.

(~50%). <https://www.metoffice.gov.uk/binaries/content/assets/metofficegovuk/pdf/research/ukcp/ukcp18-infographic-headline-findings-land.pdf>

Summers are expected to become drier, particularly in southeast England; winters are projected to become wetter, particularly in northern UK. Sea level will rise by between 0.4m and 1m by 2100, and by up to 4m by 2300. The Future Flows Project <https://www.ceh.ac.uk/our-science/projects/future-flows-and-groundwater-levels> and <https://www.ceh.ac.uk/services/future-flows-maps-and-datasets> includes information on phosphorus, daily river flows and monthly groundwater levels for 282 river sites and 24 boreholes.

The daily maximum river temperature model for Scotland allows current and future river temperatures and sensitivity to climate change to be predicted from; the day of the year (DoY), air temperature on that day, location in the country (region/hydrometric area), location on the river network and the characteristics of the river (elevation, bankside woodland and channel orientation). The predictions



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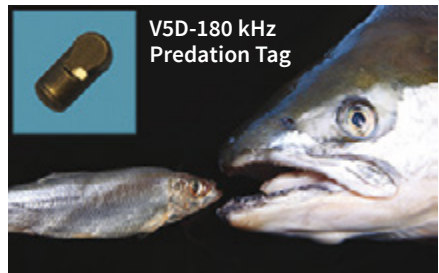


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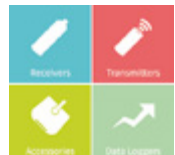


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How Changing Flows Are Affecting Trout Recruitment in Navarra, Spain

River Eska a salmonid stream in the Mediterranean region

Dr Carlos Gonzalez, Javier Gortázar, Pedro Leunda, Nekane Vizcay and José Ardaiz investigate how high flows may be affecting trout recruitment in Navarra, Spain.

Background

The southeastern end of the Bay of Biscay is dominated by westerly winds that bring moisture from the Atlantic, producing a high amount of rainfall during the year. Temperatures are cool in winter and mild in summer, which supports salmonid populations, including some of the southernmost salmon rivers in Europe. However, a slight, yet constant, decreasing trend of trout densities has been observed during the last few decades. The patterns of density variation among streams are geographically structured. This suggests that the observed trends might be influenced by climatic factors. In fact, recent studies have shown that climate change has been altering the pattern of flow regimes, including changes in the intensity and timing of winter peak flows.

Due to a strong effect of fry survival on juvenile densities, the inter-annual recruitment variation signal is transmitted along the age groups of a cohort. Therefore, recruitment success is the main endogenous driver of population density temporal variation in these trout populations. But in this region recruitment is known to be mainly driven by hydrological events during the incubation, hatching and emerging periods. It could therefore be that changes in winter peak flows may be contributing to the observed decrease in recruitment.

Navarra and the southern Bay of Biscay

Located in the south eastern shore of the Bay of Biscay, Navarra is an autonomus region that shares three biogeographical regions of Europe: Atlantic, Alpine and Mediterranean. Rainfall is greatest in the northern slope of the junction of the Basque coastal mountain range and the western Pyrenees. In the southern slope of these mountains, Föhn effect precludes rainfall,

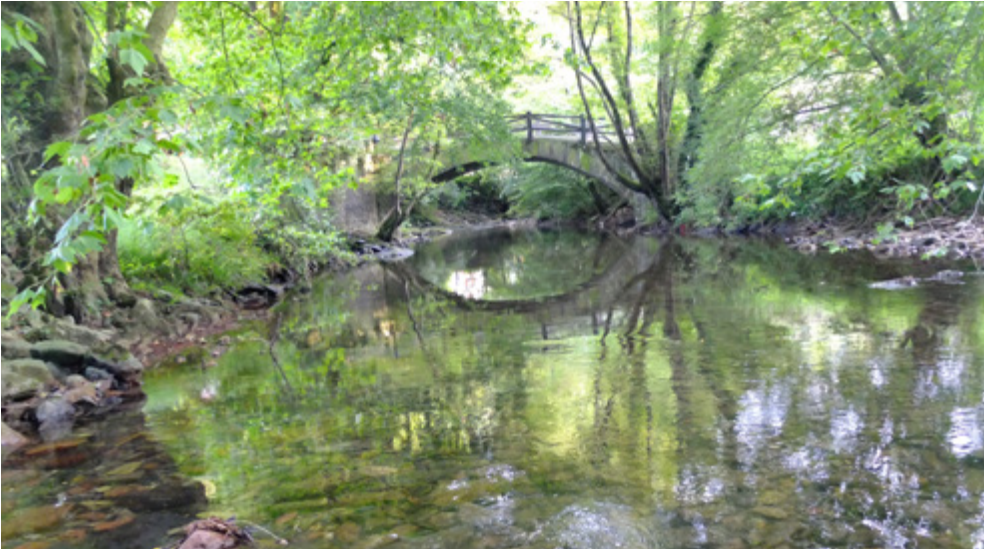


Electrofishing the Ustároz stream a tributary of Eska river at Mintxate in the Pyrenees

and gives a Mediterranean component to the hydrological regimes of the rivers, which here flow to the Ebro River and the Mediterranean sea. In the east, the Pyrenees are affected by an alpine climate with cold winters and nival flow regimes.

What we did

Twenty five yearly data sets on age class densities at 28 sites were used to test whether flood intensity and timing were affecting the recruitment in this area. The data are part of the long term data series that are being collected by the Fisheries Administration of the Government of Navarra (Sección de Restauracion de Ríos y Gestión Piscícola) since 1994. We also used daily mean flow data from the official gauging network. The hydrological regime was characterised by variables describing the daily flow at median conditions, and extreme (flood or droughts) events. The duration, timing, total count and temporal dispersion of peak flows were also calculated. We then finally divided every year into four periods, according to trout phenology: emergence, pre-summer growing, post-summer growing and the reproductive season. Flow variables were calculated for every period.



River Ezkurra a salmonid stream in the Atlantic region

What we found

We could explain up to 31% of the observed inter-annual variability of fry density by means of flow regime variables. We found that adult density during the previous year significantly affected annual recruitment, without any evidence of density-dependent regulatory effects. Also, as we expected, extreme low and high flow events during the emergence period reduced annual fry densities.

The highest flood events reduced recruitment more intensely when they took place earlier during the egg incubation period. A high dispersion of peak flows during the emergence period negatively affected fry density when it occurred earlier in this period, but positively affected it when they occurred late in the emergence period.

A significant increasing trend in winter peak flow intensity was observed, which is consistent with its effect on annual recruitment, and the observed trend in fry abundance. However, no significant trends in flood timing, count or dispersion were detected.

The timing of winter peak flows seems to be driving brown trout recruitment dynamics but not in isolation. A combined effect with the intensity of floods seems to be contributing as a driver of the observed decrease in recruitment.

Implications and consequences

The most important driver of recruitment is the intensity of peak flows during the egg and early fry stages. It is well known that eggs are severely affected by scouring. But, which is the mechanism producing such effect? Dragging and changes in net energy intake of fry are good candidates.

When the peak flows during the egg period are intense, the later in the season they occur the less negative effect they have on egg survival. When peak flows during this period are very low its effect, which is very slightly beneficial on recruitment, is weaker. Therefore, in conditions of climate change, if winter floods are going to be more intense and take place later, both effects could become counteracting.

The consequences of these offsetting effects are twofold: indeed, they might be buffering a potential negative trend, but also they might be masking the powerful negative effect of winter peak flows on trout recruitment. What driver would have a longer and more pervasive trend? Knowing this would lead us to be able to better forecast the fate of trout in Navarra and the southern Bay of Biscay.

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The off-set tines of the rake force weed to zig zag up through the rake and jam, weeds are up rooted and cropped at their base, the rake also gathers detritus and sludge. The winch hauls the loaded rake right up onto dry land, two men then simply tip it forwards to dump the weed then set it back on the float for the next haul. Mobile pond life has to opportunity to return to the pond un harmed.



Electrofishing the Wylye © GWCT

Wylye Grayling Study

Dr Stephen Gregory of the Game and Wildlife Conservation Trust (GWCT) highlights the value of long-term data sets for investigating the impact of environmental change.

European grayling are taxonomically and ecologically similar to salmon and trout and can be fished out of their seasons. Compared to these other salmonids, however, they are more sensitive to environmental change. So alongside their intrinsic value as a game fish, grayling also act as an early indicator of problems that may affect salmon and trout. The Game and Wildlife Conservation Trust (GWCT) now leads the collection, analysis and publication of the 30-year Wylye Grayling Study dataset: now the

longest grayling dataset in Europe and probably the world. Only with such long-term datasets can we begin to address fundamental questions about the ecology of salmonid populations, such as, how do rare events such as floods affect salmonids that spawn their eggs in gravel? Answers to these questions will inform management of salmonids and their habitats to promote their long-term persistence on the Wylye and other chalk streams in southern England and Europe.

Wylie Grayling Long-Term Study

Together with the Piscatorial Society, Natural Resources Wales, the Grayling Society, Grayling Research Trust, Environment Agency and the Centre for Ecology and Hydrology, the GWCT have been surveying the Wylie grayling population since 1984. In that time, we have captured over 8,500 grayling for a total of 9,800 unique capture records. We mark all individual grayling with a uniquely-coded Passive Integrated Transponder or Visible Implant tags. These allow us to reconstruct individual grayling life-histories, including information such as their time of birth and death, their age and their growth rate. We also collect scale samples and measures of length and weight for each individual at each capture occasion.

The latest survey was October 2018, meaning that the Wylie Grayling Study is currently celebrating its 35th year! To our knowledge, this is the longest dataset on European grayling anywhere in the world and an internationally important dataset on individually marked freshwater fishes.

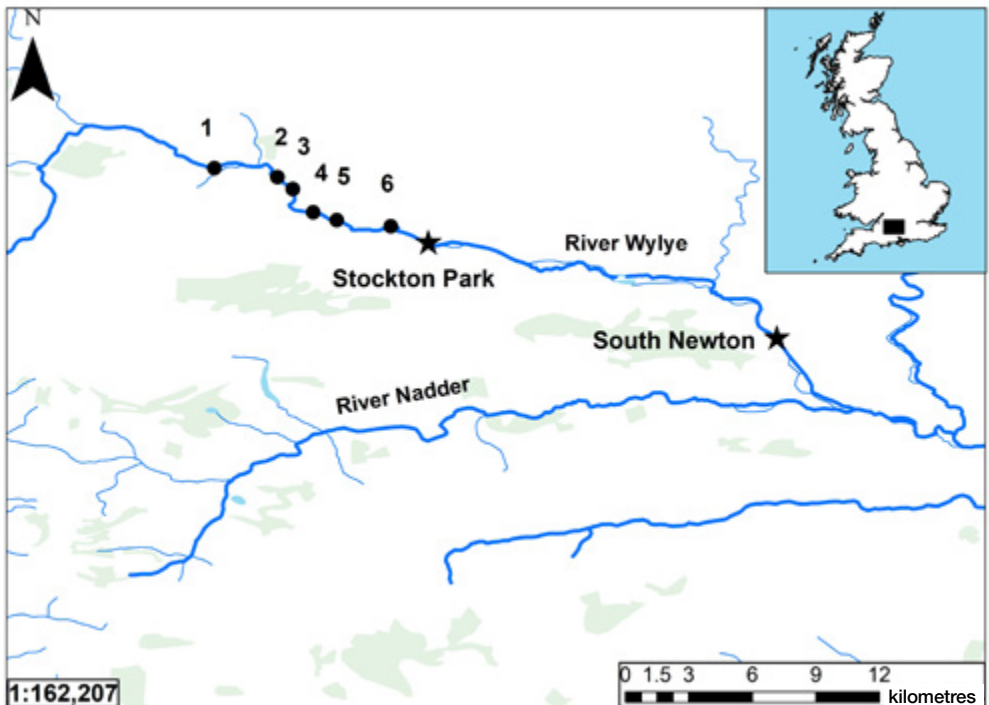
In addition to the Wylie Grayling Study data, the GWCT has access to the 15 minute Wylie depth, flow and temperature data collected by the Environment Agency. From these data we can calculate various metrics of river condition for any given period. In addition, river flow and temperature can be related to rainfall and air temperature records and used to speculate about the effects of future climate change.

What are we learning?

The River Wylie European grayling population has declined over time. The cause of this decline is unknown. The overarching aim of the Wylie Grayling Study is to study the population dynamics of this grayling population to understand why it is declining and what management actions can be taken to rescue it.

Towards this aim, we recently undertook a study to better understand the role of environmental variables in grayling recruitment in the Wylie. The study was undertaken by Dr Tea Basic, under the supervision of GWCT's Dr Stephen

Wylie study map © GWCT





Grayling © GWCT

Gregory and Bournemouth University's Prof. Robert Britton, with funding by the Grayling Research Trust, and has been published in the peer-reviewed journal *Ecology of Freshwater Fish*: 10.1111/eff.12405.

This study utilised eight years of data on 0+ grayling densities collected by the Piscatorial Society between 2009 and 2016 at six sites on the River Wylve. Discharge and temperature data during the study period were extracted from the nearby gauging stations and used together with 0+ brown trout densities collected during grayling surveys to explore their influence on grayling recruitment in a set of statistical models. The analysis showed that elevated discharge during egg incubation did not affect grayling recruitment, while an increasing number of days with low flow post-incubation was detrimental for their survival in this study.

Furthermore, both incubation and post-incubation temperatures were important determinants of grayling survival. While, incubation temperature anomaly was positively related to grayling survival, post-incubation temperature anomaly and 0+ grayling survival had a concave quadratic relationship, with survival increasing up to 13.5 °C beyond which it had a negative effect. Surprisingly, 0+ grayling survival increased with 0+ brown trout densities, indicating that underlying processes regulating both populations might be similar.

These outcomes emphasise the importance of adequate management of salmonid rivers by maintaining and/or restoring natural flows and

riparian areas to provide the required flows for salmonids, while limiting temperature increases. This will be particularly important for southern streams in the future due to climate change scenarios predicting lower precipitation and higher air temperatures, which could negatively affect rivers and adjacent biota. Following on this work, in the future, it would be good to explore the relationship of flow and temperature variables with grayling growth in southern chalk streams and to investigate recruitment and growth drivers of grayling in less stable, rain-fed systems.

Want to help?

We're always looking for help on the Wylve Grayling Study. If you can offer a hand with fieldwork on the River Wylve in October or can spare some time to organise samples or data or crunch numbers, then please get in contact with Stephen Gregory on sgregory@gwct.org.uk or Tel.: 01929 401882.



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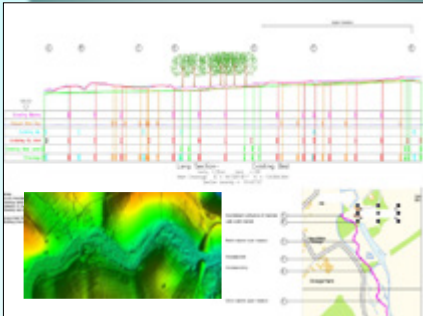
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Low Flows and Wildlife

Valerie Holt discusses the impact of low flows on wildlife and argues for more action.

River Itchen at Ovington © Simon Cain

Do we take water for granted in this country?

We think of our climate as rainy and we turn on the tap and use water without thought!

This was said in the government white paper, 'Water for Life' published in 2011, which was intended to reform the abstraction regime to ensure there was sufficient water for wildlife and economic growth. In 2017 there were changes to the Water Resources Act 1991 that ruled that previous abstractions that were exempt would now require a licence. Such exemptions covered trickle irrigation, transferring water from one water body to another, mining and quarrying operations, warping and other engineering operations.

However, although these measures were welcomed there is still an enormous demand on our water resources and climate change is exacerbating this.

In times past, England was very much wetter, with up to 25% of the country covered by wetlands such as reed-swamp, meres and lakes.

These habitats were home to pelicans, cranes and marsh terns as well as beavers. Centuries of water abstraction, from both surface water and groundwater, agricultural drainage and engineering operations on rivers have changed the face of our countryside. Some parts of the country will suffer more than others and it is expected, that in the south, severe droughts, like those experienced in 1976 and 1995 will become more commonplace.

Wildlife needs water

Wildlife needs water and healthy river flows determine the ecology, allow the transport of nutrients and reduce the effects of pollution. When flows reduce the whole aquatic ecosystem is affected. At the top of the food chain are the fish and these are the first to show signs of stress, especially migratory fish such as lamprey and salmon, which are unable to migrate upstream to breed in low flow conditions.

Bird species suffer when there are fewer invertebrates and small fish, which are their

natural prey. This will affect species such as common sandpiper, dippers and kingfishers. Studies at Tewinbury Lagoon Site of Special Scientific Interest (SSSI) have proven there is a link between low flows and kingfisher numbers.

Many wetland birds require damp soils and small ponds and pools to enable them to breed. The habitat of wet grassland has been in decline for many years and has been of concern to conservation bodies for a long time. Re-creation of wet grassland as part of mineral extraction restoration has been crucial to try to halt this decline, but without the water such projects cannot succeed in the long term.

Years of agricultural drainage have resulted in drier grasslands and birds such as lapwing, snipe and redshanks face decline.

The invertebrate population of any watercourse, canal or water body is an essential part of the aquatic lifecycle. Low flows and reductions in water quality have profound effects on most invertebrates, although this is often seen over an extended time period. Droughts reduce the diversity of plants, encourage the growth of algae and reduce water depths and flows upon which aquatic invertebrates depend.

Bats and water voles have declined rapidly over the last few years. Bats such as Daubenton's and greater horseshoe depend on insects and they are seen at night feeding over stillwaters. Water vole burrows are usually underwater and lowering of levels makes them more vulnerable to predation from mink and herons.

There are many habitats at risk from lower water levels, including moorland, heath and bogs. Heaths become more susceptible to fires, with the loss of smooth snakes and lizards, and bogs are home to golden plover, dunlin and plants such as sphagnum and sundew. Thorne and Hatfield Moors, a raised mire in South Yorkshire, is slowly drying out, notwithstanding efforts by Natural England to manage the surface water. The lowering of levels in the Doncaster groundwater unit by abstraction for drinking water means the surface water is lost downwards.

So what can be done?

Action by governments worldwide is urgently needed to manage climate change. Alongside this, we need to do more to safeguard water, which mustn't be taken for granted.

The Environment Agency is responsible for abstractions and the new regulations from 2017 will begin to make a difference in regulating the previous exemptions from licence. Water meters may help to curb profligate use of water in the homes and new homes can be built to higher water efficiency standards. However, more action is needed.

The water distribution system is inherently wasteful and tackling leakage could provide enough water to fill ten reservoirs the size of Grafham Water. The Government needs to resolve this issue with the water companies.

Changes to river flood regimes, where pumps move water away from the land, could be switched off to allow land to flood and become wetter. This would enable previous wetlands to become wet again, which could recharge underground aquifers, save many millions of pounds in pumping costs and reduce carbon emissions.

Using agricultural subsidies to encourage farmers to apply less fertiliser and pesticides to the land would save the massive amounts spent on stripping drinking water of these pollutants. Diffuse pollution of watercourses and water bodies has been an issue for the last several decades and yet very little seems to be done about it.

There are many ways that the public can help save water in the home, and although these are all important, it is going to require some joined up thinking to tackle the greater problems.

"We urgently need to change our attitudes to water, and the ways we manage it. With a little effort, we could save huge amounts of this precious resource, which could then remain in the environment to support wildlife. By using water efficiently in our homes, tackling leakage, reversing historical patterns of drainage and reducing pollution, we have the opportunity to give wildlife a fighting chance in a drying world."

Quote from RSPB publication 2006 *Dry Rot: Is England's countryside dying of thirst.*

UN Report on Nature's Dangerous Decline

1,000,000 species are threatened with extinction. The current global response is insufficient. Transformative changes are needed to restore and protect nature.

Lawrence Talks draws out the keypoints from this landmark report.



Launched on 6th May 2019, by the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) the UN report warns that nature is declining globally at rates unprecedented in human history - and the rate of species extinctions is accelerating, with grave impacts on people around the world now likely.

"The overwhelming evidence of the IPBES Global Assessment, from a wide range of different fields of knowledge, presents an ominous picture," said IPBES Chair, Sir Robert Watson. "The health of ecosystems on which we and all other species depend is deteriorating more rapidly than ever. We are eroding the very foundations of our economies, livelihoods, food security, health and quality of life worldwide."

"The Report also tells us that it is not too late to make a difference, but only if we start now at every level from local to global," he said. "Through 'transformative change', nature can still be conserved, restored and used sustainably – this is also key to meeting most other global goals. By transformative change, we mean a fundamental, system-wide reorganisation across technological, economic and social factors, including paradigms, goals and values."

"The member States of IPBES Plenary have now acknowledged that, by its very nature, transformative change can expect opposition from those with interests vested in the status quo, but also that such opposition can be overcome for the broader public good," Watson said.

"Biodiversity and nature's contributions to people are our common heritage and humanity's most important life-supporting 'safety net'. But our safety net is stretched almost to breaking point," said Prof. Sandra Díaz (Argentina), who co-chaired the Assessment with Prof. Josef Settele (Germany) and Prof. Eduardo S. Brondizio (Brazil and USA).

"The diversity within species, between species and of ecosystems, as well as many fundamental contributions we derive from nature, are declining

fast, although we still have the means to ensure a sustainable future for people and the planet."

Scale of nature loss

1,000,000 animal and plant species are now threatened with extinction, many within decades, more than ever before in human history.

The average abundance of native species in most major land-based habitats has fallen by at least 20%, mostly since 1900. More than 40% of amphibian species, almost 33% of reef-forming corals and more than a third of all marine mammals are threatened. The picture is less clear for insect species, but available evidence supports a tentative estimate of 10% being threatened. At least 680 vertebrate species had been driven to extinction since the 16th century and more than 9% of all domesticated breeds of mammals used for food and agriculture had become extinct by 2016, with at least 1,000 more breeds still threatened.

Scale of nature loss

- >85% of wetlands present in 1700 had been lost by 2000 – loss of wetlands is currently three times faster, in percentage terms, than forest loss.
- Almost 33% of reef forming corals, sharks and shark relatives, and >33% of marine mammals threatened with extinction.
- 33% of marine fish stocks in 2015 being harvested at unsustainable levels; 60% are maximally sustainably fished; 7% are underfished.
- >55% of ocean area covered by industrial fishing.
- Up to 33% is the estimated share in 2011 of world's reported fish catch that is illegal, unreported or unregulated.

"Ecosystems, species, wild populations, local varieties and breeds of domesticated plants and animals are shrinking, deteriorating or vanishing. The essential, interconnected web of life on Earth is getting smaller and increasingly frayed,"

said Prof. Settele. ‘This loss is a direct result of human activity and constitutes a direct threat to human well-being in all regions of the world.’

Causes of nature's dangerous decline

The five direct drivers of change in nature with the largest relative global impacts so far are, in descending order: (1) changes in land and sea use; (2) direct exploitation of organisms; (3) climate change; (4) pollution and (5) invasive alien species.

- Since 1970 the global human population has more than doubled (from 3.7 to 7.6 billion).
- Urban areas have more than doubled since 1992.
- 300% increase in food crop production since 1970.
- More than a third of the world's land surface and nearly 75% of freshwater resources are now devoted to crop or livestock production.
- 45% increase in raw timber production since 1970 (4 billion cubic metres in 2017).
- Plastic pollution has increased tenfold since 1980, 300-400 million tons of heavy metals, solvents, toxic sludge and other wastes from industrial facilities are dumped annually into the world's waters, and fertilizers entering coastal ecosystems have produced more than 400 ocean ‘dead zones’, totalling more than 245,000 km² – a combined area greater than that of the United Kingdom.
- US\$345 billion global subsidies for fossil fuels resulting in US\$5 trillion in overall costs, including nature deterioration externalities; coal accounts for 52% of post-tax subsidies, petroleum for +/-33% and natural gas for +/-10%.
- 1 degree Celsius is the average global temperature difference in 2017 compared to pre-industrial levels, rising +/-0.2 (+/-0.1) degrees Celsius per decade.
- 16-21 cm rise in global average sea level since 1900.

Need for transformative change

“To better understand and, more importantly, to address the main causes of damage to biodiversity and nature's contributions to people, we need to understand the history and global interconnection of complex demographic and economic indirect drivers of change, as well as the social values that underpin them,” said Prof. Brondízio. “Key indirect drivers include increased population and per capita consumption; technological innovation, which in some cases has lowered and in other cases increased the damage to nature; and, critically, issues of governance and accountability. A pattern that emerges is one of global interconnectivity and ‘telecoupling’ – with resource extraction and production often occurring in one part of the world to satisfy the needs of distant consumers in other regions.”

The Report also presents a wide range of illustrative actions including the importance of, among others, adopting integrated management and cross-sectoral approaches that take into account the trade-offs of food and energy production, infrastructure, freshwater and coastal management, and biodiversity conservation. Also identified as a key element of more sustainable future policies is the evolution of global financial and economic systems to build a global sustainable economy, steering away from the current limited paradigm of economic growth.

- ***In agriculture***, there is a need to promote good agricultural and agroecological practices; multifunctional landscape planning (which simultaneously provides food security, livelihood opportunities, maintenance of species and ecological functions) and cross-sectoral integrated management. It also points to the importance of deeper engagement of all actors throughout the food system (including producers, the public sector, civil society and consumers) and more integrated landscape and watershed management; conservation of the diversity of genes, varieties, cultivars, breeds, landraces and species; as well as approaches that empower consumers and producers through market transparency, improved distribution and localisation (that revitalises local economies), reformed supply chains and reduced food waste.

- ***In marine systems***, there is a need for ecosystem-based approaches to fisheries management; spatial planning; effective quotas; marine protected areas; protecting and managing key marine biodiversity areas; reducing run-off pollution into oceans and working closely with producers and consumers.
- ***In freshwater systems***, policy options and actions include: more inclusive water governance for collaborative water management and greater equity; better integration of water resource management and landscape planning across scales; promoting practices to reduce soil erosion, sedimentation and pollution run-off; increasing water storage; promoting investment in water projects with clear sustainability criteria; as well as addressing the fragmentation of many freshwater policies.
- ***In urban areas***, there is a need to realise a healthy urban environment for low-income communities; with improved access to green spaces; sustainable production and consumption and ecological connectivity within urban spaces, particularly with native species.

Across all examples, the Report recognises the importance of including different value systems and diverse interests and worldviews in formulating policies and actions. This includes the full and effective participation of Indigenous Peoples and Local Communities in governance, the reform and development of incentive structures and ensuring that biodiversity considerations are prioritised across all key sector planning.

First stirrings of action

“We have already seen the first stirrings of actions and initiatives for transformative change, such as innovative policies by many countries, local authorities and businesses, but especially by young people worldwide,” said Sir Robert Watson. “From the young global shapers behind the #VoiceforthePlanet movement, to school strikes for climate, there is a groundswell of understanding that urgent action is needed if we are to secure anything approaching a sustainable future.



Indian Ocean coral reef Maldives © Andrey Armyagov Shutterstock.com



Sobering conclusion.....

Negative trends in nature will continue to 2050 and beyond in all of the policy scenarios explored in the Report, except those that include transformative change – due to the projected impacts of increasing land-use change, exploitation of organisms and climate change, although with significant differences between regions.

Further reading: For media resources go to: bit.ly/IPBESReport The full six-chapter Report (including all data) is expected to exceed 1,500 pages and will be published later in 2019.



Island of Sommarøy

NASCO 2019

Dr Nigel Milner, who is the IFM's representative at NASCO (North Atlantic Salmon Conservation Organisation), files his report from the 36th Annual Meeting.

I attended the 36th Annual meeting of the North Atlantic Salmon Conservation Organisation (NASCO) in Tromsø 3-7 June 2019 on behalf of the IFM, as a member of the Non-Governmental Group (NGO) at NASCO and gave a talk to the International Year of the Salmon (IYS) Symposium. This year was notable for four things: the International Year of the Salmon (IYS) Symposium, which occupied the first two days of the week, the review of the NASCO Implementation Plan process, the readjustment

of the catch quota for the West Greenland salmon fishery and some interesting developments in research and assessment. The workings of NASCO were outlined in FISH last year, but for a full account see: <http://www.nasco.int/about.html>. The many reports given at the meeting are all available at <http://www.nasco.int/pdf/2019%20papers/> and some are referenced in this article.

International Year of the Salmon Symposium

The International Year of the Salmon (IYS) was described in FISH last year; but in summary it is a multinational, collaborative mission to raise awareness and generate meaningful action to protect and restore wild salmon species in the Pacific and Atlantic basins of the Northern hemisphere – the so-called “Salmosphere”. The severe problems of habitat degradation, loss of connectivity, over-fishing, climate change and the risks from marine aquaculture affect all salmon species, because they traverse many habitats in rivers and sea to complete their life cycles. Their exposure and vulnerability makes them a sentinel group for environmental degradation in all its forms. IYS seeks to bring these matters to wider public attention and to stimulate action. 2019 has been designated the Year of the Salmon and the Tromsø Symposium, 2-3 June, organised under the auspices of NASCO was a flagship IYS event bringing together people from the Pacific and Atlantic regions.

The Symposium focussed on climate change and the current challenges for salmon conservation, with an emphasis on matters that NASCO might be able to take forward in supported action on key research and improvements to assessment. The organising committee produced a meeting summary and recommendations in a report entitled: “*Managing the Atlantic salmon in a rapidly changing environment - management challenges and possible responses*”, see CNL(19)16. Its main outcomes were recommendations to further control the impacts on salmon production through an ecosystem-based approach by protecting the genetic integrity of stocks, enhanced water quality and habitat protection including improving access for salmon to important habitats, and minimising human impacts that reduce growth and survival in rivers and coastal areas. It drew attention to current shortcomings and made recommendations to tighten controls on marine farming and hatchery stocking. A notable new development was the emphasis on better inclusion of the wider public in decision making, specifically first nation people in America and Scandinavia, whose interests have been underrepresented in the past. Additional recommendations were made on actions that

NASCO should take and, for slogan-lovers, the mantra that summarised this was “Control the Controllable”. The elephant in the room remains climate change of course, control of which is far less sure.

Presentations were given to NASCO on the Symposium outputs and on the global nature of salmon issues and IYS activities. The same issues arise in the Pacific and Atlantic basins. For example, effects of a warm oceanic “blob” in 2016-2018 are still being seen in the East and West Pacific, mirroring changes in the North Atlantic. Meetings and collaborations of NASCO and NPAFC (North Pacific Anadromous Fish Commission) staff and representative scientists have been extensive and productive in developing high seas research into salmon migrations and environment and promoting outreach programmes.

There was an IYS opening meeting in Vancouver, in October 2018. Numerous IYS-driven events have been logged, such as a climate change



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NASCO Annual Meeting

workshop, big data workshops, outreach and fundraising and of course the Tromsø IYS Symposium. Hundreds of activities and events were reported across all Pacific and Atlantic rim countries. A video was shown of North American events, which was focussed mainly on outreach and communications. A *State of North Atlantic Salmon* report has been produced by NASCO to inform the wider public. Norway has engaged particularly well with the IYS. A really good Norwegian film on salmon was shown at Tromsø and public promotion of IYS was evident, including big displays at Tromsø airport. The Atlantic Salmon Trust and NASCO have produced a short feature film narrated by David Attenborough, which is well worth watching and is available on YouTube: <https://www.youtube.com/watch?v=riO36JBni4M>. The IFM has also got involved and supported Salmon and Trout Conservation in an IYS-related meeting in Built Wells in April 2019. Other activities can be found at the following websites: <https://yearofthesalmon.org/> <http://atlanticsalmonrestoration.org/opportunities/international-year-of-the-salmon> https://www.npafc.org/new/science_IYS.html

We now need to assess the value and success of IYS in achieving its big ambitions. The IYS Symposium summary gives a re-energising focus on current thinking and made some important recommendations, including further periodic Symposia and State of Salmon Reports; delivery of key research projects, specifically ROAM and “The Likely Suspects Framework”; and a final IYS report to be given at next year’s NASCO meeting. Lastly, NASCO is to have an external performance review next year and the achievement of the recommendations from the Symposium was seen as an important success criterion.

Implementation Plans and Annual Progress Reports

NASCO set up a system in 2013 to record and check progress with member states’ actions to conserve salmon. This has two stages of (1) Implementation Plans that describe what will be done in the next three year cycle and (2) Annual Progress Reports that describe what has been done each year. There has been much criticism of the process and rigour in the drafting and use

of Implementation Plans and Annual Progress Reports. The results of a review were reported in Tromsø (CNL(19)14). New Implementation Plans and Annual Progress Reports are now being produced for the 3rd cycle and revised versions will be available online for public scrutiny from 30th November 2019. This is an important task: NASCO is the only international body that oversees this work, which is at the heart of salmon protection and restoration, so it needs to be done rigorously. The effectiveness of the Implementation Plan / Annual Progress Report process will feed into NASCO's external performance review in 2020. IFM plays an important role by commenting on the Implementation Plans through consultation, both directly and through the NASCO NGO Group.

Stock status and catch advice

ICES (International Council for the Exploration of the Sea) advice for all stock complexes was unchanged in 2019, see CNL(19)08.

North Atlantic Commission. US harvest fisheries are closed and stocks continue to decline. However, St Pierre and Miquelon fishery (small) continues and is regarded as potential threat to recovery of North American stocks.

West Greenland Commission. All the fishermen are now licensed and the sale of fish is restricted to Greenland open air markets only. Factory fishing continues to be banned. In 2018, a total catch of 40.5t was reported, which exceeded the 30t Total Allowable Catch (TAC) quota. This significant exceedance of the quota occurred due to catch recording difficulties. To compensate for this over harvest, the 2019 quota was reduced to 19t, in compliance with the multi-annual quota agreement for the fishery.

North East Atlantic Commission (NEAC). No fishing at Faroes is the continuing ICES advice, but Denmark (in respect of the Faroes and Greenland) retains the right to conduct scientific surveys. For home waters, ICES advice remains that exploitation be allowed only on stocks at full reproductive capacity, i.e. a 95% chance of being above the Conservation Limit. In many NEAC (North) rivers stock status does permit some harvest. In the NEAC (South) stock complex as a whole, both One-Sea Winter (1SW) and Multi-

Sea-Winter (MSW) abundances have declined since 2010/11. In NEAC (South) individual countries (except Northern Ireland) saw reduced 1SW spawner returns and reproductive capacity in 2018. In contrast, MSW salmon (except for Scotland) are regarded as being at or above full reproductive capacity.

Smolt return rates for wild 1SW fish in NEAC (South) continue to decline; but in the Two-Sea-Winter (2SW) group, following a long period of decline, they have fluctuated but overall have been stable since around 2000.

Research and assessment

Considerable resources and effort are being put into studying the migrations, ecology and environment of salmon in the sea and some of the key research programmes are described below.

SALSEA-Track is NASCO's flagship research programme, which aims to understand pressures at sea affecting marine survival. As a follow-on to Salsea, it has been established to identify the migration routes of emigrating post-smolts and to quantify the mortality at different points along the migration route, and the factors causing the mortality, e.g. predation, aquaculture or renewable energy installations. It links with the "Likely Suspects Programme" through life cycle modelling to understand the impact of mortality factors acting in key space-time domains of the salmon's life cycle.

Sea Monitor is an EU INTERREG V funded marine tracking project. The project aims to establish an acoustic tracking network between the north coast of Ireland and west coast of Scotland with the additional support of two Autonomous Underwater Vehicles (UAV's) to enable tracking on the continental shelf. The project aims to monitor multiple taxa, including salmon, sea trout, eel, bass, sun fish, common skate, porbeagle, blue and basking sharks. Hydrophones will be deployed to investigate cetacean distribution and common seals will be satellite tagged on the Irish east coast. The proposed receiver locations are Loch Lomond and the Clyde estuary, the River Bush and Lough Foyle, Malin Head to Islay and the Boyne, Liffey, Lee, Burrishoole and Erne estuaries.



Panorama view over Tromsø during the midnight sun

SAMARCH (SAlmonid Management Round the CHannel) is an England-France part Interreg funded, 5-year project (2017-2022) studying salmon and sea trout in the English Channel. It has four work packages: (1) Tracking in estuaries and the coastal zone to study migration and mortality; (2) Genetic tool development (mainly brown trout); (3) Salmonid stock assessment models, including growth rate changes from scales; (4) Stakeholder engagement and training to improve and develop new policies for fisheries management in estuaries and coastal waters. Further information about SAMARCH is available online at www.samarch.org

The Missing Salmon Project is an Atlantic Salmon Trust initiative on tagging and tracking salmon smolts on the Moray Firth and Scottish west coast, which is being partly funded by a £1m crowdfunding initiative. See: <https://www.crowdfunder.co.uk/themissingsalmonproject>

Life cycle modelling (ICES stock assessment model). This has made significant progress since 2018 with the development of a single Bayesian full life cycle model which is now applied simultaneously to the North American Commission and North East Atlantic Commission stock complexes. Its outputs include Pre-Fishery Abundance estimates (PFA) and life



International Year of the Salmon celebratory beer

cycle parameters such as post-smolt mortality and proportions of PFA maturing salmon. It can also be used to test the effects of changes in environmental factors such as food availability and temperature. It is yet to pass ICES benchmarking processes that are applied to all new assessment models though, it is hoped to start using its PFA outputs for catch advice in 2021, which illustrates the level of technical review and long lead time for such developments.

Conceptual Framework on Marine Mortality – the Likely Suspects Framework. This important Atlantic Salmon Trust initiative continues to develop. The NASCO life cycle model was applied to examine environmental drivers and the population mechanisms of the widespread decline in salmon marine survival rates in the North Atlantic. The results support the idea of simultaneous salmon responses driven by bottom-up environmental factors.

In addition to the above, reports were given on:

- **International Ecosystem Summer Survey of the Nordic Seas (IESSNS):** a collaborative programme between Iceland, Faroes and Norway based on pelagic marine fish surveys, on salmon movements and survival in the North Atlantic.
- **SeaSalar:** A Norwegian programme (started 2018, for four years) on factors affecting salmon growth and survival using genetics, isotopes, fatty acids and electronic tagging.
- **PIT automatic tag screening:** at pelagic marine fish processing factories (23 in UK, Iceland, Norway, Denmark, Faroes) to study marine bycatch of post-smolts.
- **Coastal tagging and arrays in Gulf of St Lawrence:** now extended to coastal arrays off the Labrador coast to study migration routes, timing and smolt survival.
- **ROAM (RAFOS Ocean Acoustic Monitoring)** project. Popup satellite tagging at West Greenland: started in 2018, ongoing, aiming for 50 tags to be deployed in 2019 on adult fish caught by trolling to study marine distribution, migration routes and environmental factors.

For the NASCO research inventory, see: <http://www.nasco.int/sas/research.htm>

New and emerging threats to salmon

This regular item at NASCO is covered in the ICES report CNL(19)08 and included:

- an update on Red Vent Syndrome;
- updates on *Gyrodactylus salaris* eradication efforts, sea lice investigations and sea lice management in Norway;

- the presence of *Gyrodactylus salaris* in the Russian Federation;
- the continued presence of diseased salmon in rivers in Sweden, with incidence noted also in Norway and Russia rivers in 2018;
- an update on sea lice investigations and sea lice management programmes in Norway;
- two projects reported on monitoring programmes for pathogens and parasites from wild salmon sampled from the marine environment at West Greenland;
- environmental and ecosystem interactions with Atlantic salmon;
- update on the Atlantic salmon stocks in Germany;
- research on links between smolt size and marine survival.


Trips and other fun

Tromsø lies at latitude 69.6° North and the effect of this in June is continuous daylight and no incentive to go to sleep; but the advantage is that there was time outside of meetings to visit the surroundings and do some fishing with Simon Toms, Lawrence Talks and Alan Walker, jigging for small haddock, codling and coalfish in the harbour: not La Grande Pêche granted, but fun. A feature of Norway is the price of beer; but our wonderful, generous Norwegian hosts eliminated this problem by a succession of excellent evening events which were great opportunities to mix with the delegates.

The county of Troms is a huge, wild and a beautiful place. Trips were arranged at the end of the week to visit the island of Sommarøy, the Lyngen Alps and its rivers. We learnt about the protection afforded to the environment, flora and fauna and visited the fishery enforcement service who gave a comprehensive account of their work to protect salmon. Illegal netting is a big problem in Troms and so is plastic rubbish, even up there. It was a really good, intense week and I'd like to thank the IFM for supporting my attendance. Now I really must get some sleep!

***Anguillicola crassus* in Glass Eels**

Ian Wellby, head of IFM Training, discusses the implications of a recent diagnosis of an infection of *Anguillicola crassus* in glass eels.



The adult of *A. crassus* clearly inside the lumen of the swimbladder

Summary

Information contained in this document indicates that there is a possibility of glass eels becoming infected with the *Anguillicola crassus* parasite as they migrate through estuaries and into freshwater habitats. If this is shown to be the case then this has implications for the widespread restocking of glass eels and elvers. Furthermore it might indicate an opportunity to improve the success of these restocking operations by ensuring only uninfected eels are chosen for restocking or treatments are applied which might improve the survival of the eels and allow them to become a successful adult spawner.

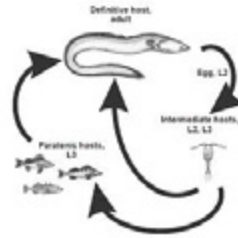
Background

Anguillicola crassus is a native parasite of the Japanese eel, *Anguilla japonica*. It was first recorded in Europe, infecting European eels, *Anguilla anguilla*, in 1983 (Italy and Germany) where it was probably introduced with infected Japanese eels. It had found its way into the UK by 1987, infecting European eels in the River Thames catchment. This introduction probably resulted from the importation of infected European eels from continental Europe for the food market. By the mid 1990s it was recorded in many catchments throughout the UK.

Since these first introductions, the parasite has been recorded throughout the range of the European eel, including parts of North Africa. In the 1990s it was first recorded infecting the American eel, *Anguilla rostrata* in North America. Again, it has spread quickly into many catchments along the East Coast of America, the natural range of this eel.

A. crassus infections tend to be very heavy within European eel populations, with a high percentage of eels being infected. As well as disturbance, and even destruction, of the swimbladder experimental evidence suggests a significant reduction in the overall fitness of an infected eel. Although infections have been shown to cause direct mortality of infected eels, potentially a more significant threat is the possibility that infected eels would be significantly less likely to make the return migration to their spawning grounds in the Sargasso Sea.

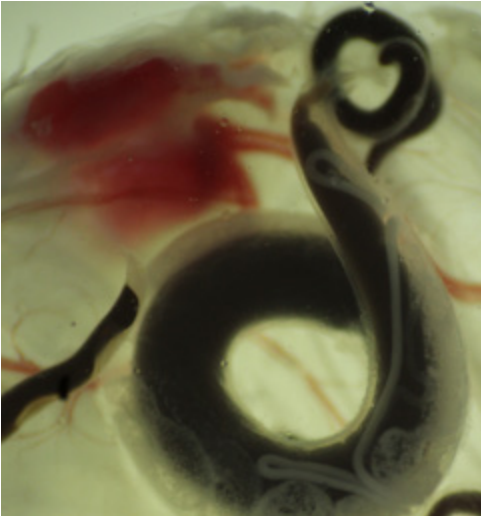
The lifecycle of *Anguillicola crassus*



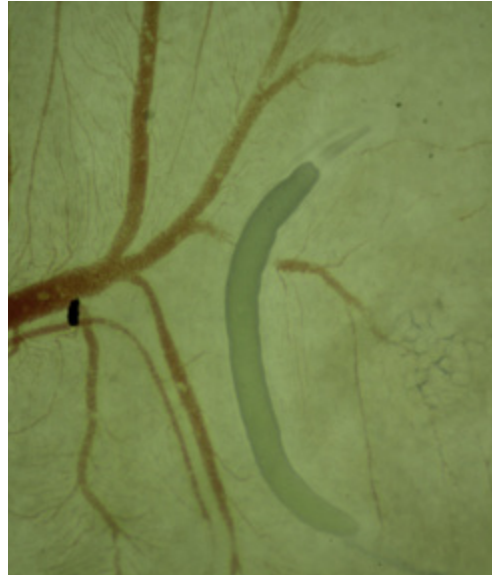
Anguillicola crassus is a nematode parasite of Japanese eels. Since its introduction into different continents it has been able to infect and cause disease in a range of other anguillid species.

The eggs usually hatch within the swimbladder and the L2 stage move through the pneumatic duct and gut until being released with the faeces. They then settle to the bottom of the water body and the mobile L2 larvae settle onto a substrate from where they will actively encourage predation by their normal intermediate host, a cyclopid copepod. It has been shown that a wide range of crustaceans can act as intermediate hosts. In the intermediate host the parasite develops further into an infective L3 stage and waits until this intermediate host is eaten by an eel. At this stage the larva's intermediate host is digested and the infective larva can leave the intestine and migrate to the eel's swimbladder. Here it develops into an L4 stage and feeds on the extensive blood supply of the swimbladder. It can take 5-6 months for the larvae to mature into adults, or as little as two months at 20°C. Unusually for parasites, both male and female parasites are present infecting the swimbladder and copulation takes place within the swimbladder. The adult female parasite lays eggs directly into the swimbladder lumen, often simply by bursting, and the eggs pass out of the eel through the pneumatic duct and then the digestive tract.

One of the reasons for the successful colonisation of *A. crassus* is that it can utilise a clever trick, known as a 'paratenic host'. Many lifecycle parasites are very host specific. In these cases, if the infected intermediate host is eaten by the wrong species of predator then that is



The swimbladder dissected open to reveal the adult *A. crassus*. The larger parasite is a female showing the white ovaries. The males are smaller. The dark area within the parasite is the blood of the host.



The L4 larvae of *A. crassus* embedded in the swimbladder wall of the infected host

the end of the journey for the parasite. With *A. crassus* if the copepod intermediate host is eaten by another predator, for example a perch, then the parasite still journeys to the swimbladder where it can even develop to an L3 larvae. Should this infected perch be eaten by an eel then the parasite can still complete its lifecycle. These paratenic hosts are also known as 'reservoir' hosts. The list of identified paratenic hosts is large, including many other freshwater fish, invertebrates and even amphibians. Some marine species such as the goby have also been shown to act as a paratenic hosts for *A. crassus*.

Pathology

The parasite causes many significant pathological reactions within the host. Damage to the swimbladder lining and tissue is caused by the feeding of the L3 and L4 larvae and by the presence of the adult parasite, but most significantly by the vast numbers of eggs, along with debris left after the laying of the eggs and the death of the female parasites. This irritation to the swimbladder wall causes thickening and inflammation of the swimbladder and, in heavy infections, can result in the complete loss of

the swimbladder lumen. This damage to the swimbladder and the energy drain created by the parasite's blood feeding activities are very significant and it has been concluded that moderately or heavily infected eels are unlikely to complete their spawning migration.

Current issue

Recently a health check sample was submitted to a fisheries consultant from a Recirculation Aquaculture System, these eels were found to be infected with *A. crassus*; with heavy infection and infestation rates. These fish had been purchased as glass eels (recently returned eels that have yet to develop in to coloured elvers) and were stocked into the system, where they have been kept for up to 18 months. The Recirculation Aquaculture System was enclosed in an industrial unit, the tanks were originally filled with tap water and a biosecurity system is in operation to reduce the risks of fish diseases gaining access to the system.

In the system described, the eels on site should not have been subject to infection from possible infective agents coming on to site. Although a recirculating system should not contain any

copepods or other possible intermediate hosts, it is possible in some circumstances. This means that it would be possible for the infection to be spread within the population of eels held in a Recirculation Aquaculture System.

These facts suggest that the glass eels were already infected when they arrived at the Recirculation Aquaculture System. The percentage of infected eels further suggests that glass eels are possibly becoming heavily infected with this parasite within a very short period of time from arriving in freshwater. Literature shows that young eels with a length of 6 - 7 cm, which have just left their marine environment, can already be infected.

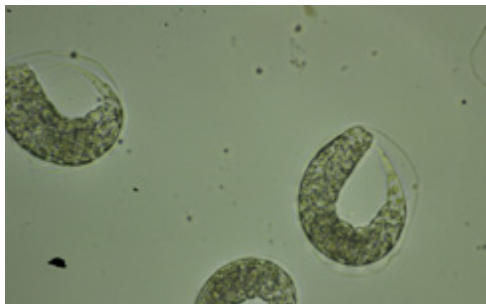
Implications

All the glass eels and elvers caught in the UK are captured by artisanal fisheries, as the glass eels and elvers make their initial migratory journey into the estuary and tidal river. Once captured they are all processed by UK Glass Eels, with a certain percentage used for restocking of upper catchments and other wild fisheries. The implication that some of these glass eels and elvers are already heavily infected with *A. crassus* could significantly reduce the possibility of success from these restocking activities. It could even mean that, potentially, these efforts are counterproductive because of the potential to spread infections into previously uninfected catchments or sub-catchments. Even increasing the rate of infection, by adding heavily infected eels into a system, could have potential consequences to the fitness of any adult eel escapement from these catchments.

Small schemes that take elvers and on-grow them for a few months in captivity are becoming increasingly popular. It is possible that if these schemes do not take steps to ensure correct husbandry that they may inadvertently help the spread of this parasite through the population they are holding.

Conclusion

From the findings it appears there is a possibility that eels are becoming infected very shortly after they enter the freshwater systems



The eggs of A. crassus clearly showing the developing larvae

in the UK, and that at least some of the glass eels caught are already infected. If this proves to be the case then there is an opportunity to improve the restocking programme of elvers.

It is important therefore to establish at what stage glass eels and elvers are becoming infected and if this hypothesis is correct.

It should then be established if all capture sites (e.g. rivers Parrot and Severn) reveal similar infections of *A. crassus* in the glass eel and elvers captured, and if there is any seasonality to infection rates or any annual changes.

Potentially this would allow selective restocking programmes, choosing elvers from areas or seasons with the lowest infection rates.

There is also a potential to treat infected eels, for example with Levamisol, which has been shown to be partially effective in eradicating infections.

Many other countries have also suffered massive reductions in eel populations and have resorted to restocking with elvers caught on their initial migration to supplement impacted populations. *A. crassus* is widespread and found in most, if not all catchments, that have populations of the European or American eel. If this is shown to be a widespread issue, then development of a vaccine against *A. crassus* may be an economically viable proposition.

Ongrowing facilities could be improved with suitable advice about husbandry of the glass eels and elvers to reduce any possible spread of the parasite within the holding systems.

The Paul Coulson BLOG



Dutch eel barge

Specialist conference

As you will have already seen from the earlier articles we had a very interesting couple of days in York back in May for our 9th Specialist Conference. The theme for this year was Fish, Flows and Climate Resilience. As always with our specialist events we had a diverse range of speakers and topics, which always leads to a thoroughly interesting conference. This year's theme also attracted delegates from fields and organisations that we don't always see at our conferences and it was great to have their input. We also had a visiting speaker from the University of Madrid, which helped to broaden the areas covered even further.

Harriet Orr of the Environment Agency gave the Keynote presentation and she has kindly written this up as an article for FISH so you can read in detail all of the areas she covered. There were some eye-opening, and quite worrying, statistics related to the potential impacts of climate change in the UK in her talk. This is something we need to be acting on now, especially as we live on a small island surrounded by an ever-rising sea, however this is a global issue (as we all know) and one we can't fix on our own.

The presentations from the conference are now on the website if you would like to see what was covered.

Double celebrations

Away from IFM business I have attended not one but two special celebrations over the last couple of months. The first of these was the Society for the Environment's 15th birthday at Kew Gardens. This was my first trip to Kew and as is typical for my luck, it rained! This didn't stop us from having a tour round, we just spent a bit more time in the glass houses, which was still pretty amazing, especially as they had the world's smallest water lily on display under which swam an array of tropical fish, so I got my fish fix for the day at the same time. The event tied in with World Environment Day and the lectures, which were themed around Net Gain, also picked up on air pollution, which was the subject area for World Environment Day. The lectures were followed by the SocEnv Awards and there was also an excellent cake.

The second birthday was that of the Sustainable Eel group who are celebrating 10 years of championing the eel this year. They managed to stretch their celebrations to almost a week, which culminated in a two-day conference at the Natural History Museum. The conference rightly centred on the illegal trade in European eel, which I am sure you will have all seen in the coverage by the mainstream press over the past few months. This is a multi-million, if not billion, pound industry that is pushing this already critically endangered animal even further from recovery.

The highlight of the week was the arrival of a Dutch Eel Barge into London. As we found out the boat has been painstakingly built from scratch with minimal, if any, formal plans and was as close a copy as could be. The craftsmanship was unbelievable and it was a real treat to be able to visit and enjoy a drink on deck.

ArEELY good read

I am pleased to say that the book that Andy Don and I have been working on for the past two years is now finished (hoooray) and will shortly be available to purchase. The book, which is loosely based on the proceedings of the Eel Symposium of 2017, has 23 chapters in six parts with 85 contributing authors. It has been a real labour of love for Andy and I and we are both

really pleased with how it has come out. If you are attending the Annual Conference in October you will be able to see the finished product as we are having the official launch on day one.

Ireland escapades

Mike and I travelled over to Ireland at the end of June to deliver an electric fishing course to the Inishowen Rivers Trust. They are based in the north west tip of Southern Ireland very close to the border with Northern Ireland and what a lovely part of the world it is.



Inishowen Rivers Trust

The Trust covers a number of different waters across the area and they have some really keen volunteers. Our training was part of a series of courses they have lined up that will help the volunteers to be able to monitor a number of key features and biotic indicators across the catchment. We were also lucky enough to have Mark McCauley and a colleague from the Loughs Agency in attendance. They also very kindly helped us out with some equipment without which we would have struggled somewhat.

As is the way in Ireland, the first day, when we were indoors, was glorious sunshine and not a breath of wind, the second day however, was somewhat different with squally showers and blustery winds to deal with. This didn't deter us and we still managed to get out and survey a local stream, which turned out to be full of salmon, which was nice.

Mud, fire, water and electric

This year instead of waiting until the winter to do an obstacle course race, my mate Phil and I thought we would have a go at a summer one instead. As a result of this we booked on to the

Total Warrior race at Bramham Park near Leeds in June; we also roped my brother, Mark, in this time as well. This was a 12k, 26 obstacle race around the lovely park grounds which included the usual selection of pleasant obstacles such as the ice plunge, log carry, BBQ jump, barbed wire crawl and my personal favourite the 10,000 volt "shocker"! Now, these races are really supposed to be done for fun and times aren't important however, our competitive nature normally gets the better of us and we try and get around as quickly as possible.

I'm not sure Mark got the message however, as he spent far too long trying to help others navigate the trickier obstacles. This included five minutes trying to talk a lady over a high wall and two minutes showing a bloke how to use a rope!!

We managed to get around the course in 1hr 35, which was pretty good; however, we would have broken 90 minutes if it wasn't for Sir Galahad! I did finish 55th in my age range (40-49), which I was quite pleased with, next year it will be top 50 as we are just leaving Mark behind.



Total Warrior

I also managed to get the rods out in mid-July for what was only the second time this year as Mike and I made our annual jaunt down to the River Severn to fish with our old Sparsholt mate Jason for a couple of days. As always with trips like this you just have to put a date in the diary and take the weather and river conditions that come your way. Although the conditions were far from ideal what with bright sun, low water and high temperatures we still managed to winkle a few out. We both had good bags of beam with fish

to over 6lbs and Mike snared a zander (by design this time). I also lost what felt like a big barbel which will take me some time to get over.

The Nettle files

It appears my delinquent Beagle is getting quite the following, as I have had several people ask me how she is doing at events and meetings over the past few months. Well, she is currently going through a used teabag phase. This involves her shredding and destroying them in her bed thus covering everything with old tealeaves!! In order to get to the used teabag receptacle, which are preserved for composting, she has to jump on the worktop, navigate her way around the draining board and pick them out of the pot next to the kettle. She has the option of umpteen other things to destroy on route to the teabags but no the teabags are what she goes for. Oh, she also destroyed a pillow and left the stuffing all over the kitchen but my therapist says its best if I don't bring that up again.



Tight lines.



Paul Coulson - Director of Operations

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Iain Turner

iain.turner@ifm.org.uk

IFM News

For further details on up and coming events: www.ifm.org.uk/events

Event	Date	Location
IFM Diploma Course	Now open for new students until October	
50 th Annual Conference <i>Learning from the Past, to Inform the Future</i>	October 8th – 10 th 2019	Nottingham Conference Centre and the annual dinner will be held in the Council House
IFM Big River Fish Hunt	June 16th until March 15th 2020	Get involved.

Training Report

Exam Success

Summer is exam time for the students on our Certificate and Diploma courses and following this round we congratulate the following students for successfully passing their courses.

IFM Certificate

David Walsh
Steve Bailey
David Kelly
Holly Mayer
Jonathan Coates
Ruth Cacharrón
Fernández
Thomas Griffiths
Tom Sayer
Paul McCulloch
Chris Lea
Lewis Froggatt

IFM Diploma

Nabil Bisig
Eddie Cardus
Mark Fordham
Dan Martin
Ben Cornick
Bryan Hemmings
Steve Schreck
Courtney Rowland

Training Events

We are pleased to say that we have been asked to run another round of Fishery Management Workshops for the Environment Agency which will begin in October. The first workshop will take place at the Carp Society's Horseshoe Lake followed by weekends in Kent and Norfolk before Christmas.

Following the success of the first event in Holmfirth earlier this year, we will now be holding a second Weed Control Workshop. This will take place in Kettering on February 15th; full details will be out shortly.

Over the summer we have delivered two electric fishing training courses. The first of these was for the recently formed River Holmes Connections Group and the second was a volunteer refresher for the team at the North York Moors National Park. Both courses will help the organisations to get a fuller understanding of the fish populations in their waters and allow them to put targeted interventions in place to help boost numbers.

The Training Team was out in force at the recent Coarse Fish Meeting at Sparsholt College. Iain Turner gave a talk on training opportunities for people interested in entering the fisheries management profession and this was followed by Ian Wellby's presentation on representation for the coarse fishery industry. It was also great to see several students, both past and present, in attendance.

This is an excellent meeting that has been running for over 10 years and it is well worth taking the time to attend if possible.

Paul Coulson Branch News

Southwest Branch

The Southwest branch met in August for a screening of the award-winning Patagonia film 'Artifishial'. The event was kindly hosted by Fishtek Consulting at their offices near Totnes. Those that attended enjoyed good company, fine food and craft beer and an interesting and thought-provoking film.

London and South East Branch

On 28th August we repeated an old favourite, an evening visit at low tide to explore the archaeology of the tidal Thames South Bank foreshore. Fiona Haughey expertly and humorously led the group through the history and fisheries of the tidal Thames through the perspective of surface artefacts and archaeology of the foreshore. The visit ended up (of course!) at a suitable hostelry, overlooking the river.

During the weekend of 7th and 8th September, the Branch contributed muscle and brain power to seine-netting and fish identification at the Firing on the Foreshore and Thames Tidefest events at Bankside and Strand on the Green respectively. These drew much interest from the public and as in previous years, catches of juvenile sea bass and flounder showed how important the Thames Estuary is as a nursery area. Later in the summer we hope to be able to arrange a guided tour into the depths of the Natural History Museum, looking at fish and other historical items not normally on display to the public.



Iain Turner and Steve Colclough netting at the River Thames Tidefest

The first meeting of our autumn programme will be our prestigious Annual Sherry Evening on 3rd October at our new King's College venue in the old Bush House on Aldwych. In addition to a delicious buffet and wines, Dom Martyn (EA/Rivers Trust) and John Bryden (Thames21) will give a joint presentation on 'Catchment Partnerships for Floods, Fish and Infrastructure – best practice, future opportunities'.

On 6th November, we repeat another annual favourite at King's College, an eclectic mix of presentations on recent University of London postgraduate projects, arranged by Mike Chadwick of KCL. Then on December 5th we hold our Annual General Meeting, again at King's College, when there will be the usual political chicanery as people fight desperately to get elected to the Branch Committee and as Officers. Even more exciting will be a presentation by an up-and-coming new-kid-on-the-block called Peter Spillett on '50 Years of the IFM - looking back over the years and lessons for the future'.

Welsh Branch

Branch members were joined by the Cardiff University Water Research Institute in July to co-host another screening of 'Artifihsial' followed by a Q&A session involving our own branch Chair, Nic Teague.

Branch Contacts

If you want more information on IFM activities in your region, please contact the branch secretaries through the email addresses below:

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Breaking News...

England coarse fishing close season retained

The Environment Agency has decided to retain the current coarse fishing close season on English rivers.

The decision follows a detailed review of the evidence and responses provided to a public consultation which indicate that removing the close season would pose a risk to coarse fish in some locations.

The close season for coarse fishing on rivers was introduced in 1878 and is in force from 15 March to 15 June. It aims to reduce risks to fish caused by angling.

The review also showed that amending the start and end dates of the close season would increase protection for some fish that spawn later but would increase risks for those that spawn early.

Support among anglers for retaining a close season and removing it is finely balanced. The 8 week public consultation received 13,680 responses with 38.8% of anglers supporting retaining the current close season; 9.2% support retaining a close season, but changing the dates to 15 April to 30 June; and 49.8% support removing the close season altogether. 2.2% were undecided or didn't respond.

Rivers used as 'open sewers', says WWF charity

Targets for 75% of rivers to be healthy by 2027 are "very unlikely" to be met in England, a charity has warned.

The World Wide Fund for Nature (WWF) says rivers are "used as open sewers". The Environment Agency predicts 75% of rivers in England and along the Scottish and Welsh borders will meet EU expectations by 2027, compared with just 14% now.

It is planning an autumn consultation on "challenges and choices" faced in cleaning up water. The Environment Agency said it would



review the target based on "what can realistically be achieved". Sewage discharging into rivers has been one of the most common reasons for ecological health tests being failed, while water companies in England have been told their efforts to protect the environment were "unacceptable".

The European Union (EU) asked nations to grade rivers between poor, moderate, good and high. Governments should aim for rivers to be "good" - meaning relatively unaffected by human activity. "High" refers to upland streams in sparsely-populated areas. Under its Water Framework Directive the EU set a target for all rivers to be "good" by 2027 but exceptions were allowed if the cost of doing so would be too high.

The UK government has aimed for 75% of rivers to be in good health "as soon as is practicable", according to its 25-year environment plan. As of the latest data available just 14% of rivers in England were in good health. By 2021 the Environment Agency currently predicts 19% of rivers to be "good", rising to almost 75% by 2027. But the WWF said this was "very unlikely" to be achieved without tougher regulation and work to restore rivers to a more natural state.

The B-Lines Initiative

Buglife has launched B-Lines to create a network of 'insect pathways' across the country to restore and create a series of wildflower-rich habitats to provide large areas of brand new habitat that will benefit not only bees and butterflies, but also a host of other wildlife. Our bees, butterflies and hoverflies have suffered badly over the last fifty or so years, due to changes in land use as a result of modern farming methods, urban spread and new transport links. Over 97% (an area the size of Wales) of all flower-rich grasslands have been lost in England since the 1930s, reducing pollen and nectar sources and leading to a serious decline in the wildlife depending on wildflower-rich habitat. Everyone is able to contribute to this ambitious project including local authorities, conservation land managers, businesses, private land owners and the wider public.



What on Earth is the Doughnut?...

Humanity's 21st century challenge is to meet the needs of all within the means of the planet. In other words, to ensure that no one falls short on life's essentials (from food and housing to healthcare and political voice), while ensuring that collectively we do not overshoot our pressure on Earth's life-supporting systems, on which we fundamentally depend – such as a stable climate, fertile soils, and a protective ozone layer. The Doughnut of social and planetary boundaries is a playfully serious approach to framing that challenge, and it acts as a compass for human progress this century.



Find out more:
<https://www.kateraworth.com/doughnut/>

Lost Bills - legislative deficit builds as Fisheries and Agriculture bills fall - more wasted effort

The Fisheries Bill and Agriculture Bill are both likely to fall. In part because of the proroguing of Parliament and probably compounded by the likelihood of another election. The Environment Bill was never introduced formally.

Brown trout genome will help explain species' genetic superpowers

Better conservation and management of fish stocks is on the horizon, after the completion of the brown trout reference genome by scientists at the Wellcome Sanger Institute and their collaborators. The genome will help settle a longstanding debate about whether the physically-varied brown trout is actually a single species or several, and give insights into their ability to quickly adapt to multiple environments.



The newly-sequenced brown trout genome will allow scientists and conservationists to better understand the genetic roots of this highly specialised species. It will enable researchers to identify any sub-species currently classified as brown trout, facilitating conservation efforts targeted at specific populations during a period of rapid climatic change.

Find out more: <https://www.sanger.ac.uk/news/view/brown-trout-genome-will-help-explain-species-genetic-superpowers>

Book Review

Trout from Scottish Reservoirs A Valuable Recreational Resource

By Drew Jamieson

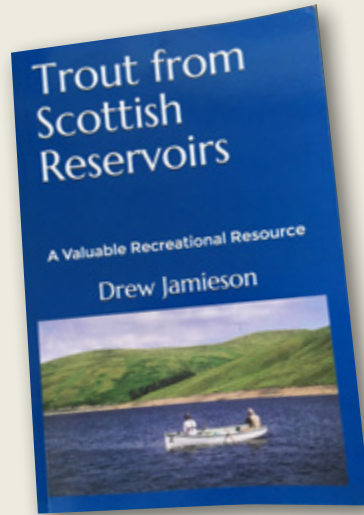
- A review by Lawrence Talks

This is a fascinating read about the trout reservoirs of the Lothian Region of East Scotland, which is based on the author's experience of managing the public trout fisheries of Lothian Regional Council and East of Scotland Water from 1979 until 2000.

Illustrated with 21 photographs and numerous maps, graphs and tables, this book provides a wealth of information, which will be of interest to the angler, fisheries scientist and fisheries manager.

I hadn't realised, for example, that there are 850 stillwaters in Scotland that are used to supply water both to the public and to provide compensation flows for river regulations. Some of these are huge natural lochs such as Loch Lomond but others are medium to large stillwaters built in the hills around the Central Belt of Scotland, and easily accessible to the urban populations of Glasgow, Edinburgh and Dundee. Some of these reservoirs are triumphs of Victorian engineering by famous names like Thomas Telford and Robert Jardine and many have become excellent trout fisheries, such as Carron Valley, Loch Turret, Gladhouse, Megget and Talla.

After providing an overview and historical context, of particular interest to the fisheries manager, the author describes the approach taken to manage Lothian's trout reservoirs and how a fisheries strategy was developed based on catch return information that identified 'Wild Trout Fisheries', 'Supplementary Stocked Fisheries' and 'Hatchery Maintained Fisheries'.



The mantra highlighted in the book is that, "Good fisheries management has to be based on good science", with details of electro-fishing surveys of juvenile trout in the nursery streams of several reservoir catchments, and trends given of angler visits, catches, fishing effort and stocking.

In many ways this book is a little gem, which provides both an historical account but also a reference for the management of trout reservoirs.

Trout from Scottish Reservoirs A Valuable Recreational Resource

Author: Drew Jamieson

Publisher: Independently published 2019
available from Amazon

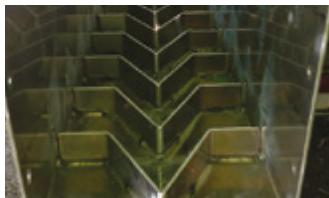
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Members and their **FISH**



Dr Nigel Milner with a 6lb Dyfi salmon
caught in 2019

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