Salmon under pressure

Atlantic salmon numbers continue to fall throughout their range but what, exactly, are the primary drivers of this decline? Research Director of the Atlantic Salmon Trust, ***Dr. Ken Whelan***, explains a new, consolidated approach to management which aims to identify and quantify the major mortality factors in an effort to save the species from extinction...

Identifying the ‘likely suspects’

A non-technical breakdown of the Atlantic Salmon Trust’s *Likely Suspects Framework*

Following completion of the SALSEA or ‘Salmon at Sea’ project in 2011 I wrote an article for Trout & Salmon magazine summarising the results of the programme and what had been achieved. My final paragraph read as follows:

“Freshwater temperatures are rising, smolts are growing faster and the smolt age is dropping. Younger smolts are often smaller and therefore do poorly at sea. Countering the effects of increasing water temperature through providing cover and shading and ensuring that abstraction and water regulation are done in a manner which ensures overall temperature stability are just some of the actions that must now be prioritised. We have long talked about the impacts from forestry, pollution and aquaculture in the marine and freshwater environments, and perhaps in the past believed that we had the luxury of time to deal with these issues. In the face of what we have recently learned about the stocks which are under pressure and the stocks at risk at sea, taking urgent management action in these areas is no longer a choice - it is an imperative.”

In the intervening years, determined efforts have been made to improve the freshwater lives of salmon and tough conservation measures have been taken to protect wild spawning stocks which were at risk. However, despite such efforts, marine survival has stayed stubbornly low. Adult returns to freshwater have at best stayed stable but in some areas major stocks have plummeted to alarmingly low levels. Fry and parr census data tell us, in general, that freshwater systems are capable of producing adequate numbers of healthy smolts but increasingly the overall production of smolts is being compromised by poor adult returns.

Whatever part of the salmon’s range you find yourself in, you will find advocates for particular mortality factors which they feel passionately are the main cause of these problems. Aquaculture impacts, bird predation, seal predation, water quality, pelagic by-catch, river drainage, hydro-schemes – all have been blamed over the years. Every salmon angler, and indeed every salmon manager, has their own views on the principal causes of the massive decline in overall salmon survival - nearly 70% in just 25 years. Some of these views are well supported by scientific data while others depend solely on raw, sincere passion and outspoken conviction.

We are in a time when arguments for policy change must be evidence-based. It is the job of the research scientist to disentangle and objectively examine each of the arguments put forward by the proponents of the various factors, to see which are supported by factual data and to prioritise areas for urgent research where such data do not exist.

As scientists, we’ve struggled in prioritising which areas should be examined, for in truth salmon populations are extremely complex and the mortality factors impacting on juvenile and adult salmon are highly variable, particularly when looked at on a regional or a catchment scale. To demonstrate the complexity of the salmon’s life cycle and how changes in mortality at various life stages can have surprisingly little or surprisingly large impacts, the Atlantic Salmon Trust (AST) has on its website a salmon modeller (**follow link HERE**). The salmon population modeller is a web-based demonstration tool designed to provide anglers, managers and everyone interested in salmon with a clearer understanding of how salmon populations work. Over the past year the AST has developed a concept that seeks to provide a coherent approach on how to assess the importance of the various candidate mortality factors and how future salmon research areas can be targeted and prioritised. This has become known as the “AST Likely Suspects Framework”.

The building of the Framework is part of the AST’s Missing Salmon project, the main aim of which is to understand where and how salmon are dying so that urgent management measures can be put in place to reverse this decline. In November 2017 a group of experts from around the Atlantic and Pacific attended a technical workshop at the

Below: Returning an autumn salmon, caught for the FishPal cameras, to continue it’s amazing journey. Research is telling us that it’s not the freshwater part of the salmon’s life cycle that is the big issue...

Ken Whelan is a keen angler and a regular contributor to *Off the Scale* magazine. He’s also a research scientist and has for over 30 years studied the biology of Atlantic salmon and their fascinating cousins the sea trout. He’s worked for a range of research and fisheries management organisations and is currently Research Director with the Atlantic Salmon Trust. Ken will be describing in a future article how the International Year of the Salmon came about and the importance of this initiative to anglers and managers in Ireland.

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Salmon under pressure :

Below: Just how many salmon post-smolts are accidentally caught by pelagic fishermen has, until now, remained a worrying mystery. University College Dublin (UCD) and AST have recently developed a genetic eDNA probe to test for salmon DNA in these pelagic catches.

headquarters of the North Atlantic Salmon Conservation Organisation (NASCO) in Edinburgh. This meeting was also the first preparatory event for the forthcoming International Year of the Salmon in 2019.

The Likely Suspects Framework places candidate mortality factors ("likely suspects") within an overall framework covering the freshwater, migration and marine phases of the salmon's life cycle. The workshop concluded that it would be best to start by identifying zones or "ecosystem domains" in the life cycle of salmon where significant mortality is believed to be taking place. Such domains can be placed at geographical locations or allocated to particular phases where significant marine mortality factors operate (e.g. estuarine/coastal; near-shore; migration to feeding grounds, coastal return/river entry). However, what happens during other phases lying outside the marine environment, such as smolt migration through freshwater, may influence subsequent survival at sea and these must also be represented in the Framework.

The overall objective of the framework is to identify the various mortality factors involved and quantify the potential for each factor to influence salmon survival. In an approach more akin to financial accounting than mathematical modelling, the cumulative effect of these factors is made to account for the observed survival of smolts to sea or the number of adults returning from the sea. You start with the answer and build a framework which explains why and where the observed mortality over the life of the salmon from smolt to adult is taking place. This can be used to identify the likely impact, both individually and cumulatively, of the various "suspects".

The workshop concluded that there will be domains where mortality factors impact many stocks, while others where only a few stocks or even a single stock are impacted. In visualising this, the workshop advised that it may be useful to think of salmon from a given stock on their migratory journey passing through successive mortality domains, where they are joined by salmon from other stocks, and so on. It is important to concentrate on the big numbers and on places or periods where any mortality impacts are likely to affect a large number of stocks. Major areas of interest are not necessarily at an oceanic scale – e.g. space/time axes in freshwater and estuaries can be very discrete, such as hotspots where fish get slowed down and get preyed upon. Conversely, oceanic domains may be on a very wide scale. Lessons from the Pacific are that marine survival is a very dynamic process and factors that cause significant losses to some stocks in some years, may be less significant or even absent in others.

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At a local scale, a sensible management strategy would be to maximise output of smolts and to maximise their chances of success at the critical freshwater-marine interface and during their early marine period. This is a main objective of the ASTs Moray Firth Project, planned for next spring (2019), which targets seven of the major salmon fisheries in Scotland.

In relation to climate change the workshop concluded that impacts on salmon populations are likely to be spread over several parts of the life cycle, with responses to changes in river growth, growth at sea and hence overall year class survival, having cumulative and confounding effects on resultant population levels. Climate change is likely to be a driver of major significance, with effects being felt at very broad scales and in different ways. For example, there are clear trends towards general ocean warming, but also there is potential for short term or single year anomalous occurrences, where "big" events, such as unusually severe floods or droughts, have a disproportionally high impact. Climate change may also have a worldwide impact on salmon species. Significant impacts may be felt in freshwater as well as at sea. The mechanisms of change involved are likely to be very complex and multi-factorial. Teasing these apart will be challenging.

One particularly important conclusion was that in periods of high marine survival, generating a significant surplus of salmon, some of the mortality factors have a far less significant effect. In years of bad oceanic conditions, when

Below and right: The Zolotaya (Golden River - Kola Peninsula, Russia) - my favourite little salmon river. Heaving with fresh grilse, sea trout and some larger salmon this little Arctic stream remains unaffected by the warming seas plaguing southern populations of Atlantic salmon. The Likely Suspects Framework is designed to tell us why...

salmon populations are poorly buffered against such impacts, the overall effects of mortality factors at the early stages of their migration is far more significant. This can result in low numbers of post-smolts reaching their feeding grounds at sea and poor overall marine survival. As can be seen from the AST's salmon modeller, protecting smolts is vitally important during challenging periods of high ocean mortality, as we are experiencing at present.

The workshop provided a set of very detailed recommendations on how best to build the Likely Suspects Framework and how, over-time, it can be developed into a practical and functional model to assist with the management and the rebuilding of salmon stocks, both in the Atlantic and in the Pacific. It has been agreed that the Likely Suspects Framework will form the basis for a major International Year of the Salmon Signature Project and work is ongoing to convene a series of salmon data workshops to develop hypotheses relating to the principal mortality factors impacting on salmon stocks, and to then compile the relevant marine data sets for the building of Likely Suspects Frameworks for both the Atlantic and the Pacific oceans.

Ken Whelan

The full report of the Likely Suspects Framework Workshop is available online in the form of an Atlantic Salmon Trust 'Blue Book'.

Please click the below link to download a copy:

Below: The Missing Salmon Project is firmly based on the belief that saving salmon smolts in freshwater, in estuaries and at sea and can help to boost adult returns – such as this magnificent male from Russia's Eastern Litza River.

"I fish to dip into that great and awesome pool of power that propels these epic migrations. I fish to feel - and steal - a little of that energy"

Carl Safina
The View from Lazy Point
(2010)