# The Salmon's Ocean Life:

## Unravelling the Age-Old Mystery

For years, what salmon did at sea was a complete mystery, but now, as **Ken Whelan**, reports, scientists are finally investigating this vital stage of their life cycle.

For the past 150 years scientists have concentrated on the study of salmon in freshwater, with few if any significant research forays into the briny. Convinced that they could learn all there was to be known about the king of fish from returning adults and migrating smolts, they ignored the marine aspects of the salmon's life cycle; seemingly oblivious to the fact that the ocean feeds the fish for well over half of its life. As far as marine scientists were concerned, salmon were freshwater creatures which spent some time in a mysterious migration across the Atlantic but were rarely encountered by their survey gear. This notion of the salmon as a freshwater fish was so dominant that it was difficult to create any interest in the life of salmon at sea. Indeed it was assumed that even finding the fish at sea would be a costly and largely pointless exercise.

However, all of this began to change in the early 60s when salmon were discovered at their feeding grounds off the west coast of Greenland. Very quickly a massive commercial fishery developed and within a decade over two thousand tonnes of salmon were harvested annually from the sheltered inshore waters off the Greenland coast. Worryingly, it quickly became evident that these fish were not the smaller grilse but the larger multi sea winter salmon. These were the fish which returned to home waters as the much prized spring, summer and autumn salmon. External tagging experiments quickly showed that the fish were of Irish, Scottish, Canadian and US origin.

To combat this fishery and to control the exploitation of these large fish an intergovernmental body, the North Atlantic Salmon Conservation Organisation (NASCO – www.nasco.int), was established in 1983. NASCO's primary role was to control and limit the fishery off west Greenland and also seek closure of a second commercial fishery which had developed close to the Faroe Islands. This fishery expanded at an alarming rate and by the early 80s was taking an additional annual harvest of 1000 tonnes of salmon. Maturing grilse were the mainstay of the fishery south of the Faroes and the harvest included very large numbers of Irish grilse.

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Over the following decade a unique mixture of science and diplomacy resulted in tighter and tighter regulation of these fisheries in line with improvements in the accuracy of scientific stock assessment and advice. The only remaining vestige of these high seas fisheries, which continues to this day, is a locally managed subsistence fishery of some 20 tonnes, taken by the native Inuit people along the west coast of Greenland. Lobbying by a wide range of interest groups played a key role in securing these agreements and the North Atlantic Salmon Fund (www.nasfworldwide.com) and its partner organisation the Atlantic Salmon Federation (www.asf.ca) continue to support a range of alternative commercial activities for those affected by the loss of the west Greenland commercial salmon fishery.

It is interesting to note that when NASCO was established in 1983 consideration was given to how the organisation might eventually be wound up as it was assumed that once the offshore fisheries were eliminated all would be well with the Atlantic salmon. However, as reductions in the level of high seas exploitation were achieved it became obvious that there was a raft of other problems facing the salmon and that these problems could also be effectively tackled by NASCO. Having successfully negotiated scientifically based management arrangements for the suspension of the high sea fisheries, it was agreed by all of the NASCO parties that the organisation was perfectly positioned to develop and recommend best international practice in a range of areas. These included advice on: fisheries management in home or nationally controlled waters, habitat protection and restoration and how best to reduce the impacts of aquaculture, both from fish farming and from direct stock enhancement by the release of reared juvenile salmon.

Salmon post smolts: just 12 weeks at sea and already fully acclimatised to their new briny home.


**Ireland is playing a major part in this research effort.**

As NASCO busied itself with these challenges and as the science relating to marine survival of salmon improved, it became increasingly obvious that survival of salmon at sea was declining and declining fast – and nobody knew why. Worryingly these impacts were occurring in the ocean feeding grounds long before the salmon had reached home waters.

The pattern of increased mortality observed by the scientists was complex and confusing. It was obvious that the impact was greatest in southern European stocks (Spain, France, UK and Ireland) while other countries such as Norway, Russia Finland and Iceland were not, initially at least, suffering the same level of decline. At NASCO meetings in 2000 and 2001 the reality of this serious problem really struck home and in 2002 NASCO

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decided to form the International Atlantic Salmon Research Board whose job it would be to coordinate ongoing research on the survival of salmon at sea and to seek opportunities to find funding and other forms of support for a new major research initiative in the ocean. Over the following three years, primarily at meetings held in Dublin and Bergen, the grand plan was hatched. It was to be called SALSEA or the Salmon and at Sea Programme and would encompass surveys of selected areas of the North Atlantic stretching from the Bay of Bundy in the west to the arctic waters north of Norway and Russia.

It is worth noting that the individuals and organisations involved in the SALSEA initiative did not have a single euro to their name when they initiated the programme but all participants shared a firm resolve and a burning conviction that understanding the life of the salmon at sea and the problems it was encountering was key to safeguarding the future of this iconic species. Once the plan was agreed the Board set about seeking research funding, both in Europe and North America. A wide range of science funders, foundations and private companies were canvassed. Both the Atlantic Salmon Trust (www.atlanticsalmontrust.org) and the Total Foundation (foundation.total.com) agreed to contribute funding to the project. In December 2006 the European Commission launched the first call under their new FP7 research programme (cordis.europa.eu/fp7/), which included a category for projects under the heading of Ecology of Important Marine Species. A planning meeting was held in Galway in January 2007 and a consortium of 20 partners was formed to apply for funding under the FP7 call. The partnership was unique in that it included the public and private sectors, NGO groups and the third level sector.

The submission was successful and the EU agreed to provide some €3.5m of research funding. With matching funding from other partners and contributions from the private sector, the total budget available to the European programme (SALSEA-Merge) rose to €5m. In addition to the application for EU funding, work continued in lobbying support in North America which resulted in agreement on major research surveys to take place in 2008 and 2009. This survey of the western Atlantic was funded jointly by Department of Fisheries and Oceans (DFO) in Canada and the National Oceanographic and Atmospheric Administration (NOAA) in the US. It was also agreed that the annual sampling programme in west Greenland would be expanded to include a range of additional parameters and this component of the programme was to be funded by the International Atlantic Salmon Research Board.

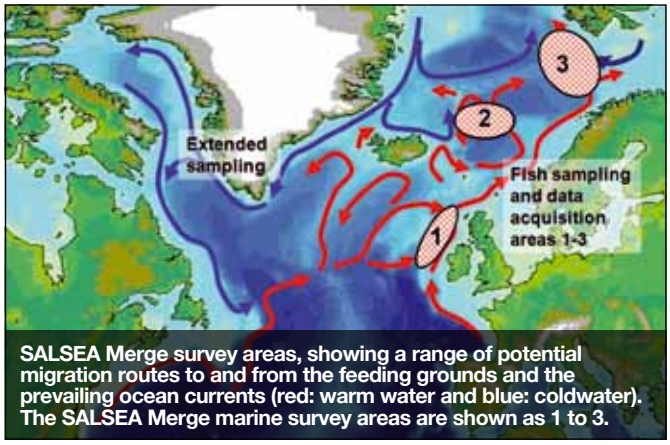
Currently the overall SALSEA programme has three components: SALSEA Merge, covering the North East Atlantic, SALSEA North America covering the Western Atlantic and SALSEA Greenland. A fourth component SALSEA Irminger, to be carried out by Icelandic scientists, is also planned – for more detailed information see the IASRB web site www.salmonatsea.com. The largest and most complex of these initiatives is SALSEA Merge. It comprises 20 European partners, six of whom are net


Shooting the floating survey net.


Profiling the surface layers of the ocean – temperature, currents and water chemistry.


An adult salmon from the Faroese live box trawl.


Shrimps – a favourite food of young salmon.



SALSEA Merge survey areas, showing a range of potential migration routes to and from the feeding grounds and the prevailing ocean currents (red: warm water and blue: coldwater). The SALSEA Merge marine survey areas are shown as 1 to 3.


Salmon rarely travel alone – a mixed bag from the rich surface layers off the Norwegian coast.


The tedious job of sorting the catch.

donors to SALSEA Merge, either in kind (through the provision of staff, facilities or technical expertise) or as cash contributors.

### SALSEA Merge – Surveying the North East Atlantic

SALSEA Merge is designed to provide a unique insight into the spatial and ecological use of the marine environment by different regional and river stocks, which are known to show variation in marine growth, condition, and survival. Different stocks use different marine zones whose environmental conditions will potentially vary independently, differentially affecting growth, condition and survival. In short, we need to understand what routes the different stocks take, how fast they travel, where they feed and what they feed on. To date it has been impossible to identify the origin of sufficient numbers of wild salmon to enable these questions to be addressed. The SALSEA Merge programme is currently tackling these difficult and complex questions and will deliver novel, stock-specific, migration and distribution models merging hydrographic, oceanographic, genetic and ecological data.

The marine sampling programme commenced in May 2008 and since that time research vessels from Ireland, Norway and the Faroe Islands have carried out extensive surveys stretching from the west coast of Ireland to the far North West coast of Norway. The surveys have followed the off shore migration pathways of post smolts during their first summer at sea.

### Progress to Date

The Irish surveys were carried out on the two Irish research vessels, the RVs Celtic Voyager and Celtic Explorer. In 2008 The Explorer survey collected 358 salmon post-smolts, taken in 27 separate hauls over an 8-day period and from a wide area of the southern range of the early salmon migration. Data relating to water temperatures, depth and salinity were also recorded. Some 76 post-smolts were taken during the cruise of the Celtic Voyager, resulting in a total catch of 434 salmon. In 2009 the Celtic Voyager again sampled off the west of Ireland but few fish were taken due to very stormy conditions. However the Explorer survey, which took place off the west coast of Norway in June 2009, was very successful and overall the two cruises resulted in a total sample of 466 post smolts and 10 adult salmon.

The Faroese cruise took place from July 2-16th 2008, on the RV Magnus Heinason. Salmon post-smolts were caught in almost every haul, on average 7.3 per tow. In total 363 post-smolts were caught, with three hauls accounting for 184 fish. The 2009 survey was equally successful and resulted in a sample of 310 post smolts and 10 adult salmon.

The Norwegian research cruises, aboard the RV Eros and Libas, ventured much further North and surveyed areas of the North Atlantic which had not previously been sampled for post smolts. In 2008 a total of 82 post smolts were taken in 31 net hauls. The westerly distribution of the smolts was of particular interest. Although not numerous, salmon post-smolts were caught in almost every haul, on average three post smolts per two-hour tow with three tows containing more than 10 salmon. Six adult salmon were also caught, five of them fish had spent at least one winter at sea (1SW salmon, mean length 50.2 cm) and one 2SW (98 cm) was a previous spawner. In 2009 a further 87 post smolts and adult were taken during the Norwegian surveys.

Each fish taken was extensively sampled and the biological examination included: scale samples, pectoral fin for DNA sample, disease sample (gill filament, pyloric caeca, spleen, and kidney), disease samples (gill filament and kidney), isotope samples (liver, dorsal muscle, adipose fin, heart, and tip of caudal fin), lipid sample (dorsal muscle), stomach sample, and otolith sample. All of the material collected from the 1750 post smolts taken over the summers of 2008 and 2009, in combination with the large set of archival material (over 3,500 samples) available to the researchers, will provide the basis for the extensive analysis to be carried out as part of SALSEA Merge. Over the next eighteen months all of the material will be analysed and the resulting data will be assimilated into a comprehensive migration and distribution model of salmon stocks in the North Atlantic. The results from the programme will be presented to an International Salmon Summit incorporating scientific results from surveys of both Pacific and Atlantic salmon stocks, planned for La Rochelle in France in autumn 2011.

> 'THE SALSEA MERGE PROGRAMME IS THE LARGEST ATLANTIC SALMON SURVEY EVER CARRIED OUT IN THE NORTH ATLANTIC.'

The SALSEA Merge programme is the largest Atlantic salmon survey ever carried out in the North Atlantic. It involves a total of 15 research laboratories and over 50 scientists and technicians. There is a dedicated website (www.salmonatsea.com) where you can find updated information on the full SALSEA programme, including cruise reports from the work package leaders and details of those involved in the programme.

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