The last 40 years have seen a big increase in the numbers of salmon dying at sea. Now the most ambitious study to focus on the king of fish is investigating why. **Professor Ken Whelan** and **Dr Jens Christian Holst** explain how the project will also provide an insight into the oceans' ecosystem

Detective work in the sea – Investigating depleting salmon stocks

The Atlantic salmon is appropriately known as the 'king of fish'. These powerful, sleek ocean-goers travel up to 5,000km in their lifetime before returning to the freshwater streams where they hatched, displaying a homing instinct that is as mysterious as it is impressive.

Salmon has been a much-prized part of man's diet for at least 1,000 years. But today the fish that was once so common that medieval servants and apprentices refused to eat it more than three times a week is in trouble. The last 40 years have seen a dramatic decline in salmon stocks. Increasing numbers of fish are dying at sea, which means fewer are returning to rivers to spawn. Marine survival has fallen from 25 per cent or more in the 1960s to less than 10 per cent now.

"What we are seeing is that the growth at sea is very poor," says Dr Jens Christian Holst, of Norway's Institute of Marine Research. "There is very little food out there and that clearly affects the growth and survival of salmon stocks." There are plenty of theories as to why – ranging from environmental to manmade causes – but no one really knows what is going on at sea. That's why the largest and most extensive research programme ever undertaken into wild Atlantic salmon was launched in 2008 – a three-year, €5.5 million international scientific project to map the migration and distribution of the fish in the North-East Atlantic.

The SALSEA-Merge project is a public private partnership, funded by a €3.5million European Union grant with a further € 2million from its 20 partner organisations including the Atlantic Salmon Trust, the North Atlantic Salmon Conservation Organisation's International Atlantic Salmon Research Board and the TOTAL Foundation.

Ground-breaking research

It is a unique partnership of geneticists, ecologists, oceanographers and ocean modellers (50 scientists and technicians) and involves three marine survey voyages spanning an area from Ireland to Spitsbergen in Norway. It is the first time so many resources have concentrated purely on salmon, says Dr Holst, the project's scientific coordinator.

As well as using data accumulated over many years including the results of tagging studies and scale and tissue samples, the project is employing novel high seas pelagic trawling technology and a three-dimensional regional ocean modelling system to trace the salmon's migration routes and map the distribution of individual stocks.

It is also using cutting-edge genetic fingerprint technology to analyse the DNA of fish caught at sea and identify where they come from – right down, in some cases, to the river of origin.

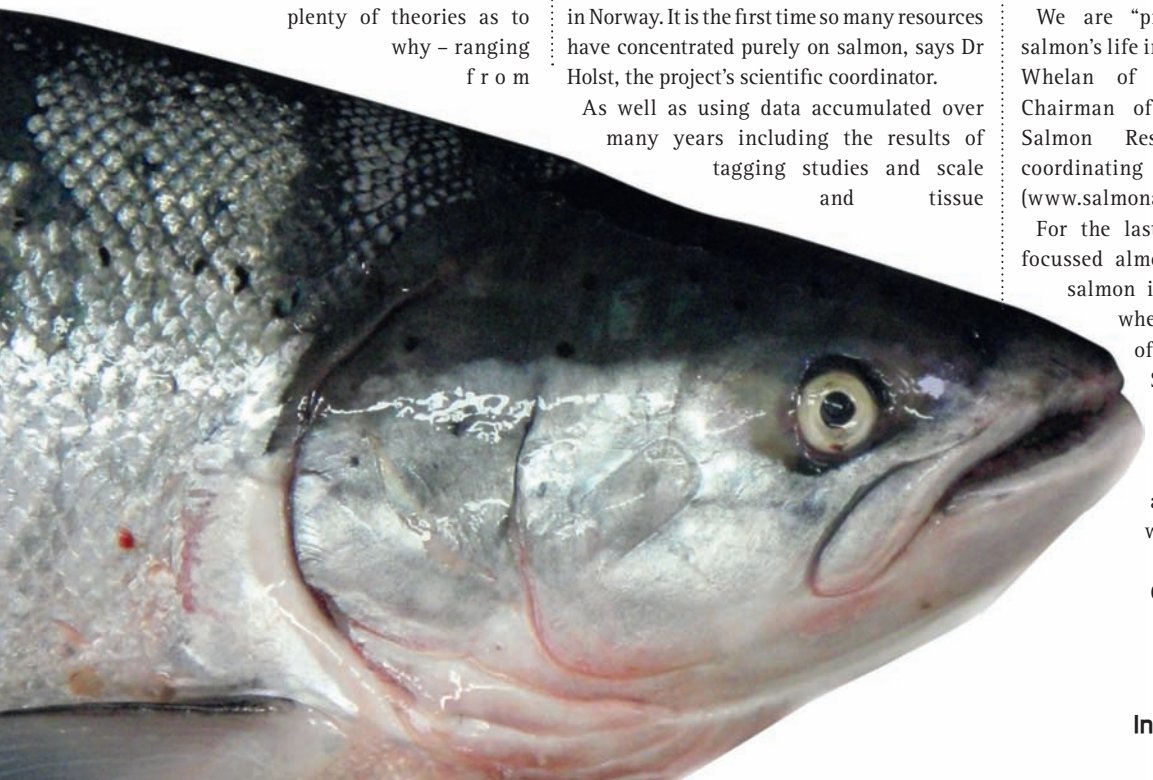
"What's really novel about this project is that we will be able to differentiate between the salmon stocks and, hopefully, with all the other efforts concentrated on the other fish species, we will be able to pinpoint the underlying factors causing the changes," says Dr Holst.

This ground-breaking research merges hydrography, oceanographic, genetic and ecological data to provide scientists with unique insights into the salmon at sea for the first time. It is part of a wider SALSEA research programme with projects in North America and West Greenland.

We are "profoundly ignorant" of the salmon's life in the briny, says Professor Ken Whelan of Ireland's Marine Institute, Chairman of the International Atlantic Salmon Research Board which is coordinating the SALSEA programme (www.salmonatsea.com).

For the last 150 years, scientists have focussed almost entirely on studying the salmon in rivers – hardly surprising when you consider the challenges of going to sea. Even for the SALSEA-Merge project, spurred on by concern about plummeting salmon stocks and with access to all the latest technology, it was a massive undertaking.

"It was a huge risk to get these 60-metre ships to go to sea chasing 20cm (or less) fish, which was a very difficult



The Celtic Explorer sets sail to gather postsmolts of Atlantic salmon for analysis

ask and the chance of finding them was very slim," says Professor Whelan.

"Here, Jens was a pioneer in terms of developing the techniques for finding where these fish were at sea, so with his experience and guidance we were able to pull off two very successful sets of cruises. We've collected 1,700 baby salmon or post smolts – fish that left the rivers that summer – which was very good. We also have quite a lot of archival material so we have a very good basis for moving forward."

'Aquatic canary of the ocean'

There are two distinct groupings of salmon at sea: those that stay just one year in the sea, known as the grilse or one-winter fish, and those that stay longer, known as the multi-sea winter fish.

"The longer the fish stay in the sea, the higher the mortality rate because they are more subject to predators," says Professor Whelan.

"By the mid- to late-1970s it was very obvious there were some problems in relation those bigger salmon, the multi-sea winter fish. But I think we missed it. We weren't actually looking at what was happening at sea. I think it was happening a lot earlier than we realised."

Important though this study is to uncovering the reasons for the salmon's decline, it has much wider implications. It is, in effect, measuring the state of the marine environment, and will advance understanding of oceanic-scale ecological and ecosystem processes, says Professor Whelan.

"If you needed to find a way of travelling across the oceans, picking up all sorts of biological clues and indicators and designing a piece of equipment that would leave your hands, go away for two years, and swim straight back into your hands again, people would say you were absolutely mad and it would cost a fortune," he says.

"But with the migratory fish, that's exactly what we have. We've got a fish that traverses the ocean very widely, moves very fast but homes back in to a single point. They're a very good bio-monitor – what I always call the aquatic canary of the ocean.

"These creatures are basically a test organism to tell us how well the oceans are doing which is why we're trying to make sure we look at every level of biology within the fish – the species of fish themselves, the genetic changes, the changes in terms of the health of the fish, and their welfare in terms of how well they're feeding rather than just what they're feeding on."

The project findings will be announced at a major summit in France in October 2011. But as recently as April, at a steering group meeting in Bergen, the early results of the survey ships' sampling were announced internally.

"It confirmed our wildest dreams about the potential in the DNA method – in other words, it really works!" says a delighted Dr Holst.

"SALSEA-Merge will produce important results with a big impact for the future management of European salmon," he added. And that will be thanks to the unique cooperation between scientists across Europe, who have provided free access to data from earlier north Atlantic projects on oceanography, plankton, fish, mammals and general ecology, he says: "This combination of competence and accessibility of data is extremely important and really directs how science must be run in the future – cooperation and open data sources." ★

Funding for this article from the International Atlantic Salmon Research Board is gratefully acknowledged.

At a glance

Full Project Title

Advancing understanding of Atlantic Salmon at Sea: Merging Genetics and Ecology to Resolve Stock-specific Migration and Disribution Patterns (Salsea-Merge)

Project Objectives

SALSEA Merge provides the basis for a comprehensive investigation into the problems facing salmon at sea.

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Dr Jens Christian Holst (left)
Professor Ken Whelan (right)

Project Coordinator

Dr Jens Christian Holst is a senior scientist at the Pelagic Research group at the Institute of Marine Research in Norway. His specialised working areas are related to the pelagic fish resources in the Norwegian Sea, in particular herring and salmon, but also blue whiting and mackerel. In the later years his focus has shifted towards ecosystem dynamics and ecosystem management of the pelagic resources.

Chairman of IASRB

A former President of NASCO, Ken Whelan was elected Chairman of the International Atlantic Salmon Research Board (IASRB) in June 2007. He is an Executive Director with the Marine Institute in Ireland and an Adjunct Professor at University College Dublin and Research Director of the Atlantic Salmon Trust.

SEVENTH FRAMEWORK PROGRAMME

SALSEA MERGE

INTERNATIONAL ATLANTIC SALMON RESEARCH BOARD