

Scientific Advisory Group of the International Atlantic Salmon Research Board

ICR(10)7

Inventory of Research Relating to Salmon Mortality in the Sea (revised July 2010)

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Summary

- 1. The Board's inventory of research relating to salmon mortality in the sea was established in 2002 and has been updated annually since then. It is an essential tool in the development of research priorities for potential funding and in better coordinating existing research efforts. Maintaining the inventory involves updating it as new projects are approved (including those commencing in the current year and for which funding has been confirmed), existing projects are changed, and projects are completed. At its 2010 meeting the SAG recommended changes to the presentation of the inventory as detailed in document SAG(10)3. These changes have now been made.
- 2. Having reviewed earlier inventories, the Board agreed that its initial research priority was studies of the distribution and migration of salmon at sea in relation to feeding opportunities and predation. In 2005, the Board adopted a comprehensive and innovative programme of research, the SALSEA Programme, designed to improve understanding of the distribution and migration of salmon at sea. Its three main work packages relate to the development of supporting technologies, early migration through the inshore zone and marine surveys. The Board recognised that studies of the early migration through the inshore zone were largely nationally funded but the Board might play a role in coordinating such research.
- 3. Table 1 provides details of expenditure on on-going research by topic area for each Party. The total annual expenditure on the 44 on-going projects included in the inventory amounts to approximately £6.1 million. In Table 2, on-going and completed projects are listed according to the five research topic areas agreed by the Board on the basis of the main focus of the research, although some projects could have been allocated to a number of these research areas.
- 4. As requested by the Board at its 2006 meeting, those projects that fall within the SALSEA programme have been allocated to the relevant work package in Table 3. In 2007, the Board had agreed that studies involving acoustic tags and DSTs should be listed under work package 3.
- 5. Table 4 provides summary information on both the on-going (44 projects) and completed (53 projects). Full details of these projects are contained in Annex 1. Several of the ongoing projects are in their final stages. Seven projects have been completed since last year. Following its withdrawal from NASCO, the five Icelandic projects have been removed from the inventory altogether. After consulting the EU delegation one project from Finland concerning genetic baseline sampling in Russian

rivers has also been removed. Ten new projects have been included in the inventory. The new projects are as follows:

Canada:

- Genomic basis of adaptive divergence and marine survival among Atlantic salmon populations.

European Union:

- Development and application of salmonid life-cycle models;
- The impacts of contaminants and temperature on freshwater fish populations;
- Impacts on juvenile salmonid populations from a changing freshwater environment;
- Development of a general spatial model of within river population structuring in Scottish Atlantic salmon (POPMOD);
- Focusing Atlantic salmon management on Atlantic salmon (FASMOP).

Norway:

- Origin of Atlantic salmon off Svalbard;
- SALMOTRACK Electronic tracking of northern anadromous salmonids.

Russian Federation:

- Establishing a genetic baseline of northern salmon populations across the Russian – Norwegian border for management purposes.

USA

- SALSEA Greenland

Table 1: Approximate Annual Expenditure on Ongoing Research Projects in Relation to Salmon Mortality at Sea by Topic Area and Party

| | Canada | Denmark | European | Norway | Russian | United | France (in | Totals |
|------------------------|------------|------------|------------|----------|------------|-----------|------------|---------------|
| | | (Faroe | Union | | Federation | States of | respect of | by Topic Area |
| | | Islands | | | | America | St Pierre | |
| | | and | | | | | and | |
| | | Greenland) | | | | | Miquelon) | |
| Long-term monitoring | £639,500 | | £1,060,500 | £134,000 | £80,000 | £14,000 | | £1,928,000 |
| | 1 | | 8 | 1 | 1 | 1 | | 12 |
| Distribution/ | £392,000 | £88,200 | £2,436,500 | £457,500 | £141,950 | £123,250 | - | £3,639,400 |
| migration | 5 | 1 | 8 | 3 | 1 | 4 | 1 | 23 |
| in the sea | | | | | | | | |
| Life history/ | £18,000 | - | £104,700 | - | - | - | - | £122,700 |
| biological processes | 1 | | 3 | | | | | 4 |
| | | | | | | | | |
| Development of methods | - | - | - | - | - | - | - | - |
| | | | | | | | | |
| Specific natural and | - | - | £339,600 | £75,000 | - | £3,500 | - | £418,100 |
| anthropogenic factors | | | 2 | 2 | | 1 | | 5 |
| Totals by Party | £1,049,500 | £88,200 | £3,941,300 | £666,500 | £221,950 | £140,750 | - | £6,108,200 |
| | 7 | 1 | 21 | 6 | 2 | 6 | 1 | 44 |

The figures shown are in pounds sterling. The number of ongoing projects is shown below the expenditure figure. The costs have been allocated on the basis of the NASCO Party coordinating the research project. However, in many cases the projects involve collaboration with other Parties or with NGO partners who may have made financial contributions to the projects (some details of these contributions have been provided and are given in Annex 1).

| Topic Area | Objective/Issue | Comments/examples | Ongoing Projects | Completed Projects | Potential for cooperation among Parties | Priority for access to 'Fund' |
|---|--|---|--|---|--|-------------------------------------|
| 1. Long-term monitoring | a. Time-series of marine survival/growth estimates | Essential on-going tagging/monitoring programmes; require long-term national funding. | C17, Fi1, Fr2, Ir8, Sw1, Ew11, Ni2, Sc3, N14, R2, U6 | | Medium | Low |
| | b. Time series of marine survival in relation to environmental parameters (e.g. SST) | Desk studies on time series. | Sc4 | E1, Ir2, Ni1, N2, N6 | Medium | Medium |
| 2. Distribution/ migration in the sea | a. Distribution of salmon in the sea | Marine surveys of post-smolt distributions in NEAC and NAC areas; identification of fish caught (e.g. tagging, genetics). | | C2, C6, N8 | High | High |
| | b. Migratory behaviour of individual fish | Active smolt tracking; automated data collection by DSTs. | C16, C18, C20, De3, N15, N18, U4, U5 | C1, C3, C4, C5, C10, C11, C12, De1, De2, Ir5, Ew1, N5, N12, U3 | High | High |
| | c. Origin of catches in directed fisheries | Catch sampling in distant water fisheries; genetic analysis and scale analysis, etc; changes over time. | C21, D1, Fi2, Fr3, Ew10, Sc5, Sc7, Sc8, N17. R3, U9, F1 | C9, C13, C14, Ir6, Ew6, N11 | | Low |
| | d. Migration and bioenergetic models | Desk studies based on data obtained from other studies. | | Ew4, U1 | Medium | Medium |
| | e. By-catches in pelagic fisheries | Can be conducted as part of marine surveys of post-smolt distributions; sample commercial pelagic catches. | | N3, R1 | High | High |
| 3. Life history/biolog ical processes | a. Freshwater factors | Age, growth, migration timing, etc. | Ew13, Ew15 | Fr1, Ew8, Ew9 | Low | Low |
| - | b. Pre-fishery recruitment marine factors | Environment, food, predation, growth, parasites and diseases, etc. | | N7 | High | High |
| | c. Post-fishery recruitment marine factors | Environment, food, predation, maturation processes, growth, etc. | C19, Ew12, Sc6 | C8, N1, U2 | High | High |
| 4. Development of methods | a. Post-smolt survey methods | Development of trawls with cameras, tag detection, etc. | | Ir4, Sc1 | Medium | Medium |
| | b. Electronic tag technology | Development of smaller/smarter/cheaper tags. | | | Medium | High |
| 5. Specific natural and | a. Fish farms | Increased sea lice infestations. | N13, N16 | Ir1, Ir3, Ir7, Ew3, N4, N9, N10 | Low | Low |
| anthropogenic factors | b. Predation | Predation by seals, birds, fish, etc. in estuaries/coastal areas. | U8 | Sc2 | Low | Low |
| | c. Obstructions to fish movements | Barrages, etc. | | Ew5 | Low | Low |
| | d. Pollutants | Acidification; freshwater contaminants. | Ew14 | C7, Ew2, Ew7 | Low | Low |

Table 2: Allocation of ongoing and completed projects by topic area

Note: The priorities of low, medium and high assigned to the topic areas in this table are those currently considered appropriate for international cooperation and funding. The Board will keep them under review. They are not intended to reflect overall importance of these topics.

Table 3: Ongoing and completed projects in the inventory of research allocated to SALSEA programme work packages

| SALSEA Work Packages | Ongoing Projects | Completed Projects |
|---|--|---|
| Work Package 1: Supporting Technologies | | |
| Task 1: Genetic tagging to determine stock origin | C21, D1, Fi2, Fr3, Ew10, Sc5, Sc7, Sc8, N17, R3, U9, F1 | C9, C13, C14, Ir6, Ew6, N11 |
| Task 2: Sampling equipment evolution | - | |
| Task 3: Signals from scales | C19, Ew12, Sc4 | C8, N1, U2 |
| Work Package 2: Early Migration through the Inshore Zone: fresh waters, estuaries and coastal waters | | |
| Task 1: Investigate the influence of biological characteristics of Atlantic salmon smolts on their marine mortality | C17, Fi1, Fr2, Ir8, Sw1, Ew11, Ni2, Sc3, N14, R2, U6 | Ir2 |
| Task 3: The impacts of physical factors in fresh water on marine mortality of Atlantic salmon | Ew13, Ew15 | Fr1, Ew8, Ew9 |
| Task 3: Preparing to migrate – investigate the influence of freshwater contaminants on the marine survival of Atlantic salmon | Ew14 | C7, Ew2, Ew7 |
| Task 4: The part played by key predators | U8 | Sc2 |
| Task 5: The impact of aquaculture on mortality of salmon | N13, N16 | Ir1, Ir3, Ir7, Ew3, N4, N9, N10 |
| Work Package 3: Investigating the distribution and migration of salmon at sea | | |
| Task 1: Distribution and migration mechanisms – develop theoretical migration models | - | Ew4, U1 |
| Task 2: A common approach – refine the plans for a large-scale marine survey | - | |
| Task 3: Salmon at sea – carry out a comprehensive survey - marine surveys | C15, E2, U7, | C2, C6, N7, N8 |
| - acoustic tagging surveys | C16, C18, C20, De3, N15, N18, U4, U5 | C1, C3, C4, C5, C10, C11. C12, De1, De2, Ir5, Ew1, N5, N12, U3 |
| - data storage tags | - | |
| - others | | N3, R1 |
| Task 4: Distribution and migration – analyse and collate data | - | |
| Appendix 1: Supporting technologies, further development of which will support the SALSEA programme | | |
| 1. Novel trawl sampling technologies | - | Ir4, Sc1 |
| 2. Data storage tags | - | |
| 3. Coded wire tagging | - | |
| 4. Sonic tags and sonic detector arrays | - | |

Table 4: Summary of ongoing and completed research projects relating to salmon mortality in the sea

| Jurisdiction | Project No | Title | Status | Summary of Objectives | Research Dates | Topic Area | Objective/Issue | Area of Research | Collaborating Countries | Coordinating Scientist | Annual Expenditure |
|--------------|---------------|---|-----------|---|----------------|---|--|---|----------------------------|----------------------------------|-----------------------|
| Canada | Cl | Marine migration and survival of post-smolt Atlantic salmon from Bay of Fundy rivers | Completed | Provide knowledge about marine habitat (migration routes and feeding grounds) used by salmon post-smolts from Bay of Fundy rivers. Determine the location, timing and extent of salmon post-smolt mortality at sea. Investigate the causes and mechanisms of marine mortality of salmon post-smolts. Provide information to fuel the recovery programme for inner Bay of Fundy salmon stocks. | 2001 - 2003 | Distribution/ migration in the sea | Migratory behaviour of individual fish | Bay of Fundy and Gulf of Maine | USA | Gilles L Lacroix | |
| Canada | C2 | Distribution, health and condition of Atlantic salmon from Bay of Fundy rivers while at sea | Completed | Provide knowledge about marine habitat and health of salmon post-smolts from Bay of Fundy rivers. Investigate the causes and mechanisms of marine mortality of salmon post-smolts. Provide information to fuel the recovery programme for inner Bay of Fundy salmon stocks. | 2002 - 2004 | Distribution/ migration in the sea | Distribution of salmon in the sea | Bay of Fundy and Gulf of Maine | USA and Norway | Gilles L Lacroix | |
| Canada | C3 | Marine migration and survival of post-smolt Atlantic salmon from the Saint-Jean River (Gaspé) | Completed | Provide knowledge of the marine habitat (migration routes and feeding grounds) used by salmon post-smolts from Bay of Gaspé rivers. Determine the location, timing and extent of salmon post-smolt mortality at sea. Investigate the causes and mechanisms of marine mortality of salmon post-smolts. | 2005 - 2006 | Distribution/ migration in the sea | Migratory behaviour of individual fish | Saint-Jean River, Gaspé Peninsula, Quebec | | Julian Dodson, Francois Caron | |
| Canada | C4 | Marine migration and survival of kelt Atlantic salmon from the Saint-Jean River (Gaspé) | Completed | Provide knowledge of the marine habitat (migration routes and feeding grounds) used by salmon kelts from Bay of Gaspé rivers. Determine the location, timing and extent of kelt mortality at sea. Investigate the causes and mechanisms of marine mortality of salmon kelts. | 2006 | Distribution/ migration in the sea | Migratory behaviour of individual fish | Saint-Jean River, Gaspé Peninsula, Quebec | | Francois Caron | |
| Canada | C5 | Tracking experimentally 'escaped' farmed salmon | Completed | Determine the course tracks and fates of sonically tagged farmed salmon released in winter and spring. | 2005 | Distribution/ migration in the sea | Migratory behaviour of individual fish | Cobscook Bay, Maine, USA; Quoddy region, NB, Canada | | Fred Whoriskey | |
| Canada | C6 | Atlantic salmon distribution and abundance at sea | Completed | Determine salmon distribution and abundance at sea, particularly post-smolts in the Labrador Sea and Northern Grand Banks; collect biological and other data; investigate the relationship between salmon and their prey; investigate the relationship between oceanographic parameters and salmon abundance; tag and release salmon. | 2001 - 2005 | Distribution/ migration in the sea | Distribution of salmon in the sea | Labrador Sea and Northern Grand Banks | | David Reddin | |
| Canada | C7 | Integrated field and laboratory assessment of the effects of endocrine – disrupting substances on Atlantic salmon smolts. | Completed | Laboratory tests of the effects of endocrine-active substances in municipal, and industrial effluents; field tests of the effects of endocrine-active substances in municipal and industrial effluents; field tests on caged smolts near sites with potential for significant agriculture run-off; ocean field tests of link between exposure of smolts to endocrine - disrupting substances and subsequent lower adult returns. | 2003 - 2007 | Specific natural and anthropogenic factors | Pollutants | Atlantic Canada and Co. Mayo, Ireland | Ireland | Wayne Fairchild | |
| Canada | C8 | Use of stable isotopes to assess long-term changes in marine trophic ecology of Atlantic salmon (<i>Salmo</i> <i>salar</i>) | Completed | Assess trophic and dietary information through analysis of stable isotope signatures of carbon and nitrogen from previously compiled scale samples from various salmon stocks; compare isotopic signatures within and among stocks to various differences in feeding ecology in time and space; examine evidence of environmental influences on trends in isotopic signatures; examine linkings of stable isotope signatures with trends in abundance. | 2006 - 2007 | Life history/ biological processes | Post-fishery recruitment marine factors | Desk study examining archived material and samples from Newfoundland, the Maritime Provinces, the Quebec North Shore, and the Barents Sea (Tana River, Finland) | Finland | J Brian Dempson | |
| Canada | C9 | Effective population size, gene flow and population structure of Atlantic salmon in Newfoundland and Labrador | Completed | Document population structure and connectivity (gene flow) among Newfoundland and Southern Labrador rivers. Test for temporal stability of the structure over the past 50 years. | 2003 - 2008 | Distribution/ migration in the sea | Origin of catches in directed fisheries | Newfoundland and Labrador | | Daniel Ruzzante | |

| Jurisdiction | Project No | Title | Status | Summary of Objectives | Research Dates | Topic Area | Objective/Issue | Area of Research | Collaborating Countries | Coordinating Scientist | Annual Expenditure |
|--------------|---------------|--|-----------|---|-----------------------|--|--|---|----------------------------|---|--|
| Canada | C10 | River and extended estuary acoustic tracking of Atlantic salmon (<i>Salmo salar</i>) kelts and bright salmon | Completed | To track and document migratory behaviour of Atlantic salmon kelts as they leave the river for the open ocean and bright salmon at they return to rivers; 2) To identify possible critical habitat sites utilized by kelts and bright salmon during their migration; 3) To examine the mortality rates of kelts and bright salmon during migration. | 2006 - 2008 | Distribution/ migration in the sea | Migratory behaviour of individual fish | LaHave River and estuary, Nova Scotia | | Peter G. Amiro, A Jamie F. Gibson | |
| Canada | C11 | Integrated modelling of juvenile Atlantic salmon movement and physical habitat in fluvial and estuarine environments | Completed | 1) to develop an innovative geomatic approach capable of relating the behaviour of smolts during their migration to the characteristics of the physical habitat in rivers and estuaries; 2) to apply this approach to the analysis of the migration of smolts through the estuaries of the St. Jean, Dartmouth and York rivers and down the Baie de Gaspé. | 2005 - 2008 | Distribution/ migration in the sea | Migratory behaviour of individual fish | York River and Baie de Gaspé, Quebec | UK | Julian Dodson | |
| Canada | C12 | Estuary acoustic tracking of Atlantic salmon (<i>Salmo</i> <i>salar</i>) smolts and kelts – Conne River, Little River, and Bay d'Espoir, Newfoundland | Completed | To tag and track migratory behaviour of Atlantic salmon smolts and kelts as they leave the Conne River, Newfoundland; 2) To determine the movements and migration patterns throughout the Bay d'Espoir fjord;3) To provide insight into the initial survival and residency of smolts and kelts migrating through the fjord. | 2006 - 2008 | Distribution/ migration in the sea | Migratory behaviour of individual fish | Conne River and Bay d'Espoir fjord, Newfoundland | | J. Brian Dempson, Keith Clarke | |
| Canada | C13 | Spatio-temporal distribution of Atlantic salmon stocks and the impact of the West Greenland fishery. | Completed | Provide knowledge about the river origin of the salmon catch in the commercial fishery at West Greenland. | 2006 - 2008 | Distribution/ migration in the sea | Origin of catches in directed fisheries | Samples from West Greenland | | Louis Bernatchez, Tim King | |
| Canada | C14 | Genetic population structure of Atlantic salmon in Eastern Canada and its implication for conservation. | Completed | This project aims at elucidating the genetic population structure of Atlantic salmon from a small (river) to a large (Eastern Atlantic coast) spatial scale and at helping in proposing conservation units for the Canadian distribution range. Samples from 51 rivers in Quebec, New- Brunswick and Labrador have been obtained and their characteristics evaluated at 13 microsatellite loci. Further work is ongoing on the variability in major histo-compatability complex genes and its association with exposure to pathogens. The project began in 2004 and was Completed in 2008 as part of the PhD project of Mélanie Dionne (Université Laval, Québec). | 2004 - 2008 | Distribution/ migration in the sea | Origin of catches in directed fisheries | Rivers in Quebec, Gulf of St Lawrence and Labrador | | Louis Bernatchez, Mélanie Dionne | |
| Canada | C15 | Pelagic ecosystem survey of the Northwest Atlantic | Ongoing | Sample the upper pelagic ecosystem during the period corresponding to the early post-smolt phase. Determine distribution and relative abundance of post-smolts at selected locations and times along hypothesised ocean migration route. Obtain data on relative abundance of other species including macroplankton aggregations to provide information on the role of salmon in the pelagic ecosystem. Obtain oceanographic information. | 2008 - 2010 | Distribution/ migration in the sea | Distribution of salmon in the sea | North West Atlantic (stations north of 52°N in 2009) | USA | Gerald Chaput, Dave Reddin, Tim Sheehan | - |
| Canada | C16 | Miramichi River kelt movements and survival | Ongoing | Document the spring movements and survival of kelts from the Miramichi River as they return to the sea. Use pressure sensitive tags to record the depths used by kelts. | 2008 - 2011 | Distribution/ migration in the sea | Migratory behaviour of individual fish | Miramichi River estuary and Gulf of St Lawrence | | Fred Whoriskey | £12,500 (excluding receiver deployment and other costs recovered under other projects) |
| Canada | C17 | Marine survival of Canadian Atlantic salmon stocks: long-term monitoring | Ongoing | Long-term monitoring of smolt production and adult return estimates from a number of rivers in Newfoundland region, Maritimes region, Gulf region and Quebec. | Annual | Long-term monitoring | Time series of marine survival/growth estimates | Canadian rivers in Newfoundland region, Maritimes region, Gulf region and Quebec | | Gerald Chaput | £639,500 |

| Jurisdiction | Project No | Title | Status | Summary of Objectives | Research Dates | Topic Area | Objective/Issue | Area of Research | Collaborating Countries | Coordinating Scientist | Annual Expenditure |
|-----------------------------|---------------|---|------------------------|---|----------------|--|--|--|--|--|---|
| Canada | C18 | Atlantic salmon smolt migration and survival within Canadian rivers, estuaries and during the marine life stage | Ongoing | Provide a time-series of stage specific estimates of mortality rates for smolts and post-smolts at various points of their at-sea migration, including for their transitions through fresh water, the estuary and to various points in the ocean; examine the relation between biological characteristics of the fish and survival rates to attempt to isolate mortality causes; document the migration pathways and speeds of smolts from different rivers. | 2003 - 2010 | Distribution/ migration in the sea | Migratory behaviour of individual fish | Miramichi River and estuary; Restigouche River and Baie des Chaleurs; Cascapedia River and estuary; St-Jean (Côte-Nord) River and estuary; Western Arm Brook; Strait of Belle Isle, Cabot Strait, Labrador; West River, Sheet Harbour. | USA | Fred Whoriskey | £300,000 |
| Canada | C19 | Stable isotope ratios to infer trophic structure and condition of Atlantic salmon during their life at sea. | Ongoing | Improve understanding of marine ecology of salmon through status of trophic state and condition. Questions to be addressed include: are trophic states of 1SW non-maturing fish similar between NAC and NEAC origin salmon?; are trophic states of 1SW non-maturing fish different from those of maturing 1SW fish of the same cohort? Can this tell us anything about when these different maturity groups separate in the North Atlantic?; has there been a trophic state change between West Greenland and return to home rivers as 2SW salmon? | 2008 - 2010 | Life history/ biological processes | Post-fishery recruitment marine factors | West Greenland and from salmon returning to the index rivers of Eastern Canada. | Greenland | Gerald Chaput, Tim Sheehan | £18,000 (excludes cost of purchase of samples |
| Canada | C20 | Identification of essential habitat for repeat spawning Atlantic salmon of Inner Bay of Fundy origin | Ongoing | Identify the freshwater and marine habitats used by post-spawning Atlantic salmon of inner Bay of Fundy (iBoF) origin for reconditioning until their return as repeat spawners, and identify the sites and times of mortality for those that fail to return. | 2008 - 2010 | Distribution/ migration in the sea | Migratory behaviour of individual fish | Primarily the Big Salmon River but possibly other inner Bay of Fundy rivers (i.e. Stewiacke) as well as the Saint John River and Bay of Fundy | | Gilles L Lacroix, Ross Jones | £15,000. In-kind contributions from Fort Folly First Nation. |
| Canada | C21 | Genomic basis of adaptive divergence and marine survival among Atlantic salmon populations | Ongoing – New Entry | Elucidate the genetic basis of adaptive divergence and marine survival in Atlantic salmon populations from eastern Canada. Contribute to the identification of management units. | 2010 - 2013 | Distribution/ migration in the sea | Origin of catches in directed fisheries | Eastern Canada: Québec, Maritimes, Newfoundland and Labrador | Norway, USA | Louis Bernatchez, Mélanie Dionne, Patrick O'Reilly, Vincent Bourret | £64,500 |
| Denmark - Greenland | D1 | West Greenland Salmon Fishery Sampling Programme | Ongoing | Continue time series of data on the continent of origin and biological characteristics of salmon in the fishery. Provide data on mean weight and length and continent of origin for input to models. Collect information on the recovery of internal and external tags. Collect other additional biological samples as required. | Annual | Distribution/ migration in the sea | Origin of catches in directed fisheries | West Greenland | USA, UK, Ireland, Canada | Helle Siegstad | £88,200 |
| European Union | El | SALMODEL Concerted Action – A co-ordinated approach towards the development of a scientific basis for management of wild Atlantic salmon in the North-East Atlantic | Completed | Improve ability to set conservation limits and examine methods of estimating pre-fishery abundance (PFA) and determine how these PFA estimates can be used to provide catch advice. | 2000 - 2002 | Long-term monitoring | Time series of marine survival in relation to environmental parameters | Desk study | Norway, Iceland, Canada | Dr Walter Crozier | |
| European Union | E2 | SALSEA-Merge: Advancing understanding of Atlantic salmon at sea: Merging genetics and ecology to resolve stock – specific migration and distribution patterns. | Ongoing | Merge genetic and ecological investigations to advance understanding of stock specific migration and distribution patterns and overall ecology of the marine life of Atlantic salmon and gain an insight into the factors resulting in recent significant increases in marine mortality. | 2008 - 2011 | Distribution/ migration in the sea | Distribution of salmon in the sea | North-East Atlantic with marine surveys off coast of Ireland and UK, around the Faroes and in the Northern Norwegian Sea and Barents Sea | Denmark, Finland, France, Faroes, Iceland, Ireland, Norway, Spain, UK | Jens Christian Holst | £1.8 million |
| European Union - Denmark | De1 | Estuarine migration of smolts in the Rivers Skjern Å (North Sea) and River Guden Å | Completed | To assess the effect of restoration of habitat in the River Skjern Å on the smolt runs of salmon and sea trout, in particular with regard to predation by piscivorous birds. To investigate the migration of salmon smolts in the River Guden Å. | 2002 - 2003 | Distribution/ migration in the sea | Migratory behaviour of individual fish | | | Gorm Rasmussen | |
| European Union - Denmark | De2 | Mortality of Atlantic salmon smolts during estuary migration | Completed | Estimate mortality of salmon smolts during migration through estuaries and compare the return ratio of wild, stocked ½- and one-yearlings. | 2000 - 2008 | Distribution/ migration in the sea | Migratory behaviour of individual fish | River Skjern Å (North Sea) and River Guden Å (Kattegat) and their estuaries | | Anders Koed, Kim Aarestrup | |

| Jurisdiction | Project No | Title | Status | Summary of Objectives | Research Dates | Topic Area | Objective/Issue | Area of Research | Collaborating Countries | Coordinating Scientist | Annual Expenditure |
|-----------------------------|---------------|--|------------------------|--|----------------|---|--|--|----------------------------|--|-----------------------|
| European Union - Denmark | De3 | Salmon Rehabilitation Plan: monitoring numbers of spawners, spawning and nursery areas in four Atlantic Salmon rivers | Ongoing | The Danish national salmon rehabilitation plan describes four rivers with natural wild salmon populations. This project monitors the effect of the rehabilitation plan and the development of the populations (the goal is at least 1,000 spawners in each river to fulfil the plan). This study will allow estimates of marine mortality of salmon to be made. | 2008 - | Distribution/ migration in the sea | Migratory behaviour of individual fish | River Skjern Å, River Ribe Å, River Storå and Varde Å. The rivers flowing into the North Sea | | Anders Koed, Einar Eg Nielsen | £14,000 |
| European Union - Finland | Fi1 | Long-term variation in population dynamics, life history characteristics, sea growth and origin (wild/reared) of salmon in the rivers Teno (Tana) and Näätämöjoki (Neidenelva) | Ongoing | Collect long-term data on variation in the stock components, life histories, sea growth and abundance of escaped farmed salmon in the salmon stocks of the rivers Teno and Näätämöjoki. Relate the population dynamics of the juvenile salmon and returning adult salmon in preceding and subsequent generations | Annual | Long-term monitoring | Time series of marine survival/growth estimates | Northern Finland and Norway | Norway | Jaakko Erkinaro | £275,000 |
| European Union - Finland | Fi2 | Joint use of high- throughput SNP assay infrastructure in Atlantic salmon | Ongoing – New Entry | The key aims of the project include: I) A concerted effort to identify genomic regions that affect ecologically and economically important phenotypic traits in domesticated and wild Atlantic salmon; II)efficient joint utilization of a state-of-the-art Nordic genomics infrastructure to generate large-scale salmon SNP datasets; | 2009 - 2010 | Distribution/ migration in the sea | Origin of catches in directed fisheries | Norway and Finland | Norway | Craig Primmer | £50,000 |
| European Union - France | Fr1 | Evolution of biological characteristics in Atlantic salmon from all the Armorican massif rivers (Brittany and Low- Normandy, France) | Completed | Examine relationships between the cumulative effects of climate warming and other anthropogenic stresses and changes in biological features in populations in the Southern part of the European distribution range of the species. | 1972 - 2005 | Life history/ biological processes | Freshwater factors | Armorican massif rivers, France | | Jean-Luc Baglinière | |
| European Union - France | Fr2 | The sea survival of Atlantic salmon from the River Scorff, Brittany | Ongoing | Estimation and long-term monitoring of survival at sea in the southern part of the European distribution range of the species. | Annual | Long-term monitoring | Time series of marine survival/growth estimates | River Scorff (Southern Brittany) | | Etienne Prévost | £165,000 |
| European Union - France | Fr3 | Atlantic salmon metapopulation investigation in Normandy rivers | Ongoing | Estimate exchanges between rivers flowing into the Mont Saint-Michel Bay and the impact on management of salmon populations. | 2007-2010 | Distribution/ migration in the sea | Origin of catches in directed fisheries | Rivers flowing into Mont Saint-Michel Bay, Normandy | | Jean-Luc Bagliniere | £50,000 |
| European Union - Ireland | Ir1 | Assessment of the levels of the parasite <i>Lepeophtheirus</i> <i>salmonis</i> on Atlantic salmon post-smolts in salmon aquaculture bays along Ireland's western seaboard | Completed | Determine whether sea lice from marine salmon farms are a contributory factor in increased marine mortality of salmon post-smolts migrating from bays with salmon aquaculture. Gather information on salmon post-smolt migration patterns. | 2002 | Specific natural and anthropogenic factors | Fish farms | South-West Coast (Kenmare Bay), West Coast (Killary Harbour, Bertraghboy Bay, Clew Bay), North-West Coast (Inver Bay). | | Paddy Gargan | |
| European Union - Ireland | Ir2 | Oceanic factors influencing marine survival of Irish salmon stocks | Completed | Provide information on marine survival at various stages of ocean migration. | 2001 - 2005 | Long-term monitoring | Time series of marine survival in relation to environmental parameters | Desk study utilising oceanic data from around North Atlantic | USA | Niall O'Maoileidigh, Kevin Friedland | |
| European Union - Ireland | Ir3 | Sustainable management of interactions between aquaculture and wild salmonid fish | Completed | Assess efficacy of prophylactic treatments for salmon smolts migrating through aquaculture bays. | 2003 - 2006 | Specific natural and anthropogenic factors | Fish farms | Kilkerran Bay, Bertraghbouy Bay, Connemara | UK, Norway | Paddy Gargan, Niall O'Maoileidigh | |
| European Union - Ireland | Ir4 | Early distribution and migration of Atlantic salmon smolts off the West of Ireland | Completed | Test new pelagic trawl in open waters off Irish coast; train and familiarise staff on the operation and development of the trawl for further surveys in 2008 and 2009; obtain samples of post-smolts for background and genetic analysis; relate run- timing, timing of migration, swimming speed, growth, etc to oceanographic parameters. | 2007 | Development of methods | Post-smolt survey methods | North-west coast of Ireland | | Niall O'Maoileidigh | |

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|---|---------------|---|-----------|--|----------------|---|--|--|---|--|-----------------------|
| European Union - Ireland | Ir5 | Migration of salmon in estuarine and coastal waters | Completed | Investigate the timing, route of migration and aspects of the biology of migrating ranched salmon smolts in comparison to the native wild smolt migration. | 2005 - 2008 | Distribution/ migration in the sea | Migratory behaviour of individual fish | Burrishoole catchment, Newport and Clew Bay, Co. Mayo | UK | Russell Poole, Deirdre Cotter Niall O'Maoileidigh | |
| European Union - Ireland | Ir6 | National Development Plan - National Genetic Stock Identification Project | Completed | Identify and map discrete spawning areas within tributaries of Irish salmon rivers and collect juveniles for establishment of genetic baseline for mixed sample analysis. Undertake molecular genetic analysis of juvenile salmon tissue and adult scales to determine relative contributions of different baseline river populations within mixed samples. | 2006 - 2008 | Distribution/ migration in the sea | Origin of catches in directed fisheries | All Irish rivers | UK, Spain | Tom Cross, Paddy Gargan, Philip McGinnity | |
| European Union - Ireland | Ir7 | Interactions between aquaculture and wild salmonid fish | Completed | Assess efficacy of prophylactic treatments for salmon smolts migrating through aquaculture bays. | 2008 - 2009 | Specific natural and anthropogenic factors | Fish farms | Burrishoole, Shannon, Lee and Screebe, and drift net fishery around Irish coast | | D Jackson | |
| European Union - Ireland | Ir8 | Marine survival of wild and hatchery reared salmon: National coded wire tagging and tag recovery programme and Burrishoole wild salmon census | Ongoing | Provide information on marine survival and exploitation rates by commercial fisheries; estimate contribution of individual river stocks to catches; examine performance of selected experimental groups; and evaluate potential for salmon ranching. | Annual | Long-term monitoring | Time series of marine survival/growth estimates | Tag recovery from around North Atlantic salmon census facility Newport | Norway, UK, Faroes, France, Spain, Germany, Denmark | Niall O'Maoileidigh, Russell Poole | £372,000 |
| European Union - Sweden | Sw1 | Long-term variation in population dynamics, life- history and exploitation of salmon stocks in monitored rivers | Ongoing | Estimate long-term variation of survival in different life-stages, life-history characteristics and growth of wild salmon in the River Åtran and its major tributary. Estimate sea survival, growth and exploitation for wild fish in the River Åtran and wild and reared fish in the rivers Lagan and Nissan. | Annual | Long-term monitoring | Time series of marine survival/growth estimates | Rivers Åtran, Lagan and Nissan | | Lars Karlsson | £8,500 |
| European Union - UK England and Wales | Ew1 | Salmonid migration and climate change | Completed | Describe and model the environmental factors affecting the migration of salmonids and investigate the effects of climate change on salmonid migration and survival both in fresh water and the sea. | 1999 - 2004 | Distribution/ migration in the sea | Migratory behaviour of individual fish | Coastal waters around the UK and extending to salmon feeding grounds in Faroes and Greenland Seas | | Andrew Moore | |
| European Union - UK England and Wales | Ew2 | Impacts of agricultural contaminants on wild salmonids | Completed | Identify and describe the effects of environmental levels of agricultural pesticides on salmonid embryo survival, smolt emigration and marine survival and model their potential impacts at the population level. In addition, the role of pheromones in sea trout biology was investigated in order to predict the effects of water quality on sea trout reproduction. | 1999 - 2004 | Specific natural and anthropogenic factors | Pollutants | England and Wales | Sweden and Canada | Andrew Moore | |
| European Union - UK England and Wales | Ew3 | Impact of intensive in-river aquaculture on wild salmonids | Completed | Describe the nature and extent of the impact of aquatic contaminants derived from intensive freshwater aquaculture (effluents, pesticides, antibiotics and hormones) on reproduction and migration of wild salmonids. | 2001 - 2005 | Specific natural and anthropogenic factors | Fish farms | England and Wales | | Andrew Moore | |
| European Union - UK England and Wales | Ew4 | Modelling the bioenergetics of Atlantic salmon migration | Completed | Model the energetic requirements of salmon during their marine migrations and predict the effects of environmental and oceanographic changes on smolt growth and survival. | 2002 - 2005 | Distribution/ migration in the sea | Migration and bioenergetic models | England and Wales | | Andrew Moore | |
| European Union - UK England and Wales | Ew5 | Cardiff Bay Fisheries Monitoring Programme | Completed | Assess the impact of Cardiff Bay barrage on salmon stocks of the rivers Taff and Ely. | 1990 - 2006 | Specific natural and anthropogenic factors | Obstructions to fish movements | Cardiff Bay at mouth of rivers Taff, Ely, South Wales, UK | | Peter Gough, | |
| European Union - UK England and Wales | Ew6 | Atlantic Salmon Arc Project, ASAP | Completed | Define exploitation at sea on a regional basis using genetic tools. Create a long-term database for these studies and create an international management tool to inform decision-making. | 2004 - 2008 | Distribution/ migration in the sea | Origin of catches in directed fisheries | Europe, North Atlantic | Spain, France, Ireland, Scotland, USA, Iceland | Dylan Bright | |
| European Union - UK England and Wales | Ew7 | Diffuse pollution and freshwater fish populations | Completed | Investigate the role of diffuse aquatic contaminants in regulating populations of freshwater fish with particular reference to salmonid stocks and fisheries. | 2005 - 2010 | Specific natural and anthropogenic factors | Pollutants | England and Wales | | Andrew Moore | |

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| European Union - UK England and Wales | Ew8 | The influence of the freshwater environment on salmonid populations | Completed | Investigate the impact of environment change on juvenile salmon production and ecology. One aspect of the research directly related to marine survival is the potential role of assessment techniques (trapping, anaesthetisation tagging) in influencing marine survival. | 2005 - 2010 | Life history/ biological processes | Freshwater factors | England and Wales | | Andrew Moore | |
| European Union - UK England and Wales | Ew9 | Factors affecting the distribution and behaviour of salmonid populations | Completed | Investigate the habitat requirements of adult salmonids within the estuarine and freshwater environments. One key element of the research is to investigate how changes in prey availability within the marine environment may influence recruitment of stocks between years. | 2005 - 2010 | Life history/ biological processes | Freshwater factors | England and Wales | | Andrew Moore | |
| European Union - UK England and Wales | Ew10 | Genetic sampling to type British salmon stocks | Ongoing | Coordinate and support the establishment of baseline information on the genetic character of breeding populations within and among rivers in Britain. | 2008 - 2010 | Distribution/ migration in the sea | Origin of catches in directed fisheries | England, Wales, Northern Ireland and Scotland | Scotland, Northern Ireland | Miran Aprahamian | £60,000 |
| European Union - UK England and Wales | Ew11 | Deriving estimates of marine survival and exploitation for monitored river stocks in England and Wales | Ongoing | Establish 'monitored' rivers where estimates of marine survival can be derived and compared with other North Atlantic stocks. | Annual | Long-term monitoring | Time series of marine survival/growth estimates | River Dee (North Wales), River Tamar (SW England) | | Ian Davidson, Rob Hillman, Ian Russell | £120,000 |
| European Union - UK England and Wales | Ew12 | The marine life of Atlantic salmon : evidence from the microchemistry of scales | Ongoing | The objectives include measuring the stable isotope and trace element compositions from salmon scales in relation to variations in the marine environment and develop a model to predict impacts of changes in the marine environment on return rates of salmon. | 2007 – 2010 | Life history/ biological processes | Post-fishery recruitment marine factors | England and Wales | | Clive Trueman | £22,200 |
| European Union - UK England and Wales | Ew13 | Development and application of salmonid life cycle models | Ongoing – New Entry | The objectives include reviewing available models to assess suitability and to build on existing models or develop new models to inter alia compare marine and freshwater factors affecting stocks. | 2009 - 2013 | Life history/ biological processes | Freshwater factors | England and Wales | | Ted Potter | £52,500 |
| European Union - UK England and Wales | Ew14 | The impacts of contaminants and temperature on freshwater fish populations | Ongoing – New Entry | Undertake further studies of the impacts of contaminants derived from intensive agriculture and aquaculture facilities on wild salmonids and investigate the implications of predicted climate change scenarios on the impacts of different sources of diffuse and point source pollution on wild fish populations. | 2009 - 2014 | Specific natural and anthropogenic factors | Pollutants | England and Wales | | Andy Moore | £159,000 |
| European Union - UK England and Wales | Ew15 | Impacts on juvenile salmonid populations from a changing freshwater environment. | Ongoing – New Entry | Investigate how predicted changes in the freshwater environment might impact on juvenile salmonid populations and how changing conditions during the early life history stages may influence their behaviour and subsequent survival within the marine environment. | 2009 - 2014 | Specific natural and anthropogenic factors | Freshwater factors | England and Wales | | Bill Riley | £180,600 |
| European Union - Northern Ireland | Ni1 | Development of conservation limits, pre- fishery abundance and management of the Foyle salmon fishery | Completed | To build upon the existing Foyle salmon management system, to develop it into a precautionary catch advice framework that fully takes account of biological data on stock abundance and which fulfils all the main requirements of the Precautionary Approach. | 2005 - 2008 | Long-term monitoring | Time series of marine survival in relation to environmental parameters | Foyle area, Ireland | Ireland, France, Scotland | Patrick Boylan | |
| European Union - Northern Ireland | Ni2 | The marine survival of Atlantic salmon from the River Bush, Northern Ireland | Ongoing | Investigate factors influencing the survival at sea of salmon smolts migrating from the River Bush until their return as adults. | Annual | Long-term monitoring | Time series of marine survival/growth estimates | River Bush, N. Irish/Irish coastal waters and distant- water fisheries | Ireland (tag recovery programme) | Richard Kennedy | £60,000 |
| European Union - Scotland | Sc1 | Testing and development of Institute of Marine Research (IMR), Bergen, Norway, salmon trawl gear | Completed | Test a prototype trawl developed by IMR, Bergen, Norway, which, rather than capturing post-smolts, records, by use of CCTV, their passage as they pass through an open-ended trawl net. A supplementary objective, dependent on the success of the gear trials, was to conduct a post- smolt survey at the shelf edge. | 2006 | Development of methods | Post-smolt survey methods | Scalloway Deeps (Shetland), the Minches | Norway | Jens Christian Holst (Norway), Julian MacLean, Dick Shelton | |

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| European Union - Scotland | Sc2 | Protecting salmonid fisheries from seal damage | Completed | Develop and apply new molecular tools for discriminating among species of fish in the diets of seals from their remains in scats. Test the possibility of using molecular tools to quantify the occurrence of diet components. Identify factors influencing the migration routes of salmon in estuaries and relate to the presence of predators. Recommend strategies for the most effective deployment of methods for protecting salmonid stocks in inshore waters. | 2003 - 2008 | Specific natural and anthropogenic factors | Predation | Principally North-East Scotland (Cromarty Firth). Possible work in other estuaries and extension into West Coast | | John Armstrong (Fishery Research Services) | |
| European Union - Scotland | Sc3 | Post-smolt mortality of Atlantic salmon | Ongoing | Assess post-smolt mortality rates of Atlantic salmon from three Scottish rivers, and the contribution of these salmon to fisheries that exploit them. | Annual | Long-term monitoring | Time series of marine survival/growth estimates | North Esk, Western catchment of River Dee, River Conon salmon fishery district | | Julian Maclean (N. Esk and Dee), John Armstrong (River Conon) | Approximately £50,000 |
| European Union - Scotland | Sc4 | Analysis of post-smolt life history by scale reading | Ongoing | Investigate the relationship between growth and mortality, particularly during the marine phase, by analysis of scale growth patterns. | Annual | Long-term monitoring | Time series of marine survival in relation to environmental parameters | Samples from around Scotland but North Esk and Girnock Burn in particular | USA and Canada | Julian Maclean | Approximately £10,000 |
| European Union - Scotland | Sc5 | Fisheries-induced evolution | Ongoing | Determine the incidence and extent of heritable genetic changes in salmon stocks due to fishery programmes. | 2007-2010 | Distribution/ migration in the sea | Origin of catches in directed fisheries | Scotland and across European species' distribution, including marine migration routes. | Austria, Norway, France, Denmark, Belgium, UK, Netherlands, Finland, Germany | Ulf Dieckman, John Gilbey, Philip McGinnity | Scotland £52,000 (FRS cost). Ireland £3,500 (travel for meeting costs only) |
| European Union - Scotland | Sc6 | Size and condition of returning grilse (1SW) and MSW salmon | Ongoing | Investigate decadal trends in the size and condition of adult salmon returning to Scotland. | Annual | Life history/ biological processes | Post-fishery recruitment marine factors | Six locations in Scotland, in particular North Esk. | | Philip Bacon | £30,000 |
| European Union - Scotland | Sc7 | Development of a General Spatial Model of within river population structuring in Scottish Atlantic salmon (POPMOD) | Ongoing – New Entry | To improve the scientific basis for inter alia setting biologically appropriate conservation limits, providing advice on conservation and restoration initiatives, accurately and cost- effectively monitoring the status of salmon stocks. This project will provide baseline information in support of project E2. | 2008-2011 | Distribution/ migration in the sea | Origin of catches in directed fisheries | River systems across Scotland | | Dr. Eric Verspoor | £267,000 |
| European Union - Scotland | Sc8 | Focusing Atlantic salmon management on Atlantic salmon (FASMOP) | Ongoing – New Entry | To establish the number and spatial boundaries of breeding populations of salmon within any Scottish river system; establish the ancestral relationships and functional biological differences between wild salmon stock components across Scottish rivers; improve local management practice and increase the focus of management on local breeding populations. This project will provide baseline information in support of project E2. | 2009-2011 | Distribution/ migration in the sea | Origin of catches in directed fisheries | River systems across Scotland | | Dr. Eric Verspoor | £140,000 |
| Norway | NI | Identification of salmon by geochemical signatures; further development and testing of methods | Completed | Main objectives: test if geochemical signatures are stable from year to year; test if geochemical signatures of salmon scale samples can be used to discriminate among fish from different rivers; develop analytical procedures (otolith core sampling, chemical and statistical analyses) for application of this method in ecological studies on Atlantic salmon. | 2002 | Life history/ biological processes | Post-fishery recruitment marine factors | Laboratory study | | Peder Fiske | |
| Norway | N2 | Development of models to predict marine survival and return of salmon to Norway | Completed | Identify and examine the feasibility of applying time series of marine environmental data, ecoplankton productivity, productivity of pelagic fish and salmon life-history information for model development. Develop appropriate models. | 2002 - 2005 | Long-term monitoring | Time series of marine survival in relation to environmental parameters | Desk study of existing data | USA, Canada, EU | Lars Petter Hansen | |

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| Norway | N3 | By-catch in pelagic fisheries as a population-regulating factor in wild salmon stocks | Completed | Investigate the extent of by-catch of salmon post- smolts and develop management advice to reduce by-catch while maintaining catch rates in the mackerel fishery. | 2001 - 2005 | Distribution/ migration in the sea | By-catches in pelagic fisheries | Norwegian Sea | Russia, Scotland | Jens Christian Holst | |
| Norway | N4 | Sea lice as a population- regulating factor in Norwegian salmon: status, effects of measures taken and future management | Completed | Further clarify the effects of sea lice on wild salmon populations and propose measures to reduce sea lice infections in wild salmon and develop alternative measures in critically affected stocks. | 2002 - 2005 | Specific natural and anthropogenic factors | Fish farms | Sognefjord and Altafjord | | Jens Christian Holst | |
| Norway | N5 | Distribution of salmon in relation to environmental parameters and origin in the North Atlantic – capture, tagging and release of salmon with data storage tags (DSTs) | Completed | Investigate the temporal and spatial distribution of DST-tagged salmon in the Norwegian Sea and adjacent areas, with emphasis on spatial distribution and temperature preferences; growth in relation to environmental parameters; and diurnal vertical distribution. | 2003 - 2006 | Distribution/ migration in the sea | Migratory behaviour of individual fish | Northern North Sea, Norwegian Sea | Faroe Islands, Iceland | Marianne Holm | |
| Norway | N6 | Temporal variation in abundance of the northern- most populations of Atlantic salmon with emphasis on the River Tana | Completed | Examine the influence of ocean climate, predation, marine fisheries and smolt production on the abundance of salmon in the River Tana | 2002 - 2006 | Long-term monitoring | Time series of marine survival in relation to environmental parameters | River Tana | Finland, Russia, Canada | Martin Svenning | |
| Norway | N7 | The importance of early marine feeding on the growth and survival of Atlantic salmon post-smolts in Norwegian fjords. | Completed | Analyse spatial variation in early marine post- smolt feeding and growth along a north-south geographical scale; investigate how post-smolt feeding and growth is associated with timing of smolt descent, "marine prey availability, parasite infection", fjord migration; and abiotic factors. | 2002 - 2007 | Life history/ biological processes | Pre-fishery recruitment marine factors | Central and Northern Norway | Canada | Bengt Finstad | |
| Norway | N8 | Distribution and ecology of post-smolts and salmon at sea. | Completed | Analyse age, growth and migratory paths in relation to environmental conditions and competitors so as to expand understanding of salmon marine life-history in order to explain observed variations in salmon survival. | 2002 - 2007 | Distribution/ migration in the sea | Distribution of salmon in the sea | West of Ireland – Faroes, northern North Sea, Norwegian Sea | Faroe Islands | Marianne Holm | |
| Norway | N9 | Dispersal of salmon lice in Norwegian fjords. | Completed | Estimate and describe to what extent free-living salmon lice larvae disperse from wild and farmed sources within and between areas. | 2007 | Specific natural and anthropogenic factors | Fish farms | Hardangerfjord, Norway | | Karin Kroon Boxaspen | |
| Norway | N10 | Experimental tagging programme for investigating the behaviour of escaped farmed salmon: pilot study. | Completed | Examine the migration of escaped large farmed salmon and test if they are transported with the currents and appear in Norwegian waters. | 2006 - 2007 | Specific natural and anthropogenic factors | Fish farms | | | Lars Petter Hansen | |
| Norway | N11 | Individual assignment of salmon caught in the ocean to region of origin | Completed | Investigate genetic variation in Norwegian Atlantic salmon populations on different spatial scales. Provide calibrated data from micro- satellite markers for a database. Analyse samples caught in the ocean and assign to country/region of origin. | 2006 - 2009 | Distribution/ migration in the sea | Origin of catches in directed fisheries | Norway | Finland | Oystein Skaala, Vidar Wennevik | |
| Norway | N12 | Migratory behaviour of smolts and post-smolts of cultured Atlantic salmon | Completed | Study the change in migratory behaviour from smolt during the post-smolt stages in cultured Atlantic salmon. | 2008 - 2009 | Distribution/ migration in the sea | Migratory behaviour of individual fish | Masfjorden, western Norway | | Ove Skilbrei | |
| Norway | N13 | Significance of salmon lice for growth and survival of salmon in the sea | Ongoing | Estimate the effects of salmon lice on post-smolt growth and survival, dependent on release site and time and year of release. | 2006 - 2010 | Specific natural and anthropogenic factors | Fish farms | Western Norway, River Dale, Matre Aquaculture Station | | Ove Skilbrei | £75,000 |
| Norway | N14 | Marine survival, growth and exploitation of salmon from the Rivers Figgjo, Imsa, Drammenselv and Halselv | Ongoing | Estimate marine survival, marine growth and changes in marine exploitation of salmon from four rivers in Norway. Develop predictive models. | Annual | Long-term monitoring | Time series of marine survival/growth estimates | Rivers Figgjo, Imsa, Drammenselv and Halselv with tag recovery programme in fisheries along Norwegian coast and elsewhere | | Lars Petter Hansen, Nina Jonsson. Arne Johan Jensen | £134,000 |

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| Norway | N15 | Population-limiting mechanisms for Atlantic salmon during early estuarine and coastal migration (SALPoP) | Ongoing | Map migratory behaviour and quantity where, when and why mortalities occur; correlate data on migration and mortalities with health status and major population-limiting factors; develop improved mitigating actions and management strategies to contribute to sustainability of salmon populations. | 2008 - 2012 | Distribution/ migration in the sea | Migratory behaviour of individual fish | Eresfjord in Møre and Romsdal, mid Norway | Sweden, UK, Canada | Bengt Finstad | £200,000 |
| Norway | N16 | The Hardangerfjord salmon lice project | Ongoing | Improve sea lice monitoring and management; evaluate success of sea lice management strategies; quantify the abundance and distribution of salmon lice in the Hardangerfjord area; analyse data sets for possible risk factors associated with varying lice infection pressure. | 2007 – 2010 | Specific natural and anthropogenic factors | Fish farms | Hardangerfjord on the Norwegian west coast | Canada, UK | Bengt Finstad | - |
| Norway | N17 | Origin of Atlantic salmon off Svalbard | Ongoing – New Entry | Identify the origin of Atlantic salmon occurring in gill net fisheries at Isfjorden, Spitsbergen, by life history (age, growth) and genetic analyses. | 2008 – 2011 | Distribution/ migration in the sea | Origin of catches in directed fisheries | Isfjorden, Spitsbergen | | Arne Johan Jensen | £7,500 |
| Norway | N18 | SALMOTRACK - Electronic tracking of northern anadromous salmonids | Ongoing – New Entry | Track different life-stages of northern Atlantic salmon and other anadromous species in river, fjord and open ocean. | 2006 - 2012 | Distribution/ migration in the sea | Migratory behaviour of individual fish | Northern Norway (2007- 2012); Mid Norway (2010); Western Norway (2006) | Denmark, UK, Finland, USA, Japan, Ireland, Canada | Audun H. Rikardsen, | £250,000 |
| Russian Federation | R1 | Assessment of by-catch of post-smolts of Atlantic salmon in pelagic fisheries in the Norwegian Sea. | Completed | Assess the occurrence of post-smolts in catches by Russian vessels engaged in the pelagic fisheries for mackerel, blue whiting and herring. | 2002 - 2007 | Distribution/ migration in the sea | By-catches in pelagic fisheries | Norwegian Sea | | Boris Prischepa, Alexander Zubchenko | |
| Russian Federation | R2 | Monitoring of the stock status, abundance assessment and provision of advice on the allowable level of harvest of Atlantic salmon | Ongoing | Estimate survival of juveniles and adult return rates, estimate natural and fishing mortality, study population dynamics; assess population sizes and spawning escapement; and estimate allowable catch. | Annual | Long-term monitoring | Time series of marine survival/growth estimates | Atlantic salmon rivers of the Kola Peninsula, Archangel Region and Karelian Republic | | Sergey Prusov, Gennady Ustuzhinsky | £80,000 |
| Russian Federation | R3 | Establishing a genetic baseline of northern salmon populations across the Russian – Norwegian border for management purposes. | Ongoing – New Entry | Establish a genetic baseline of sufficient resolution for the purposes of partitioning bag net catches between Russian and Norwegian regions. | 2009 - 2010 | Distribution/ migration in the sea | Origin of catches in directed fisheries | Northern Norway, North West of the Russian Federation | Norway | Dr. Vidar Wennevik (IMR), Dr. Sergey Prusov (PINRO) | £141,950 |
| United States of America | U1 | Forecasts of Atlantic salmon transoceanic migration: climate change scenarios and anadromy in the North Atlantic | Completed | Develop and evaluate marine migration models for Atlantic salmon from North America and Europe; evaluate the potential effects of climate change on migration patterns of Atlantic salmon. | 2002 - 2004 | Distribution/ migration in the sea | Migration and bioenergetic models | Desk study | Canada | Kevin Friedland | |
| United States of America | U2 | Stable isotope composition of Atlantic salmon scales | Completed | Develop a retrospective time series of stable isotope ratios for the DPS in Maine to evaluate feeding patterns of the stocks over time. | 2001 - 2002 | Life history/ biological processes | Post-fishery recruitment marine factors | Desk study. Analysis of scale samples collected at West Greenland and from US returns. | International collaboration in obtaining samples | Kevin Friedland | |
| United States of America | U3 | Ultrasonic telemetry of smolts and post-smolts in the Narraguagus River and Narraguagus Bay | Completed | Evaluate migration timing and pathways in the lower Narraguagus River and Narraguagus Bay and estimate survival of migrating smolts and post-smolts. | 2002 - 2009 | Distribution/ migration in the sea | Migratory behaviour of individual fish | Narraguagus River and Narraguagus Bay (2002- 2005). Gulf of Maine (2002- 2004) | Canada | James Hawkes | |
| United States of America | U4 | Penobscot hatchery versus wild smolt telemetry | Ongoing | Evaluate migration timing and pathways in the Penobscot Estuary and Bay and estimate survival of migrating smolts and post-smolts. | 2005 - 2012 | Distribution/ migration in the sea | Migratory behaviour of individual fish | Penobscot Estuary,Penobscot Bay | Canada | James Hawkes | £66,750 (public funding) |

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| U5 | Comprehensive evaluation of marine survival of hatchery-stocked smolts: migration behaviour and success of Dennys River smolts | Ongoing | Evaluate migration speed and behaviour from lower river release sites through estuarine habitat; estimate survival of migrating smolts and identify areas where mortality may be occurring. | 2001 - 2010 | Distribution/ migration in the sea | Migratory behaviour of individual fish | Dennys River, Cobscook Bay, Gulf of Maine | Canada | James Hawkes | £3,500 (public funding) |
| U6 | Comprehensive evaluation of marine survival of hatchery-stocked smolts: Dennys River smolt stocking assessment | Ongoing | Evaluate smolt-to-adult survival rates based on temporal and spatial patterns of release; determine optimal stocking levels to achieve stock rebuilding objectives. | 2001 - 2010 | Long-term monitoring | Time series of marine survival/growth estimates | Dennys River, Cobscook Bay, Gulf of Maine | Recovery of marked fish through NASCO West Greenland sampling programme | Greg Mackey | £14,000 (public funding) |
| U7 | Evaluation of estuary and nearshore marine distributions of Atlantic salmon post-smolts in Penobscot Bay and the Gulf of Maine | Ongoing | Evaluate nearshore distribution and migration pathways of smolts and post-smolts; estimate the relative contribution of stocked hatchery smolts to overall post-smolt populations; evaluate the relative contribution of spatially and temporally distinct smolt releases on post-smolt populations; evaluate the physiological condition of post- smolts in marine environments. | 2001 - 2010 | Distribution/ migration in the sea | Distribution of salmon in the sea | Penobscot Bay, Gulf of Maine | | Tim Sheehan | £20,000 (public funding) |
| U8 | Cormorant harassment in the Narraguagus River/Narraguagus Bay | Ongoing | Reduce predation on migrating salmon smolts by excluding double-crested cormorants from the Lower Narraguagus River and Bay, and assess the efficiency of non-lethal predator exclusion as a means of reducing predation on migrating salmon smolts. | 2005 - 2010 | Specific natural and anthropogenic factors | Predation | Lower Narraguagus River, Estuary and Narraguagus Bay, Maine | | James Hawkes | £3,500 (public funding) |
| U9 | SALSEA Greenland | Ongoing – New Entry | Advance understanding of the ecology of the Atlantic salmon West Greenland stock complex and to gain an insight into the factors resulting in recent significant increases in marine mortality across the North Atlantic.(The baseline sampling programme at West Greenland is described in project D1) | 2009 - 2012 | Distribution/migr ation in the sea | Origin of catches in directed fisheries | Sisimiut, Nuuk and Qaqortoq, Greenland | | Tim Sheehan | £33,000 |
| F1 | St Pierre and Miquelon Salmon Fishery Sampling Programme | Ongoing | To improve the understanding of the biological characteristics and origin of salmon harvested in the fishery at St Pierre and Miquelon. | Annual | Distribution/ migration in the sea | Origin of catches in directed fisheries | Around St Pierre and Miquelon | | Herlé Goraguer | |
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| | No U5 U6 U7 U8 U9 | NoComprehensive evaluation of marine survival of hatchery-stocked smolts: migration behaviour and success of Dennys River smoltsU6Comprehensive evaluation of marine survival of hatchery-stocked smolts: Dennys River smolt stocking assessmentU7Evaluation of estuary and nearshore marine distributions of Atlantic salmon post-smolts in Penobscot Bay and the Gulf of MaineU8Cormorant harassment in the Narraguagus River/Narraguagus BayU9SALSEA GreenlandF1St Pierre and Miquelon Salmon Fishery Sampling | NoImage: Comprehensive evaluation of marine survival of hatchery-stocked smolts: migration behaviour and success of Dennys River smoltsOngoingU6Comprehensive evaluation of marine survival of hatchery-stocked smolts: Dennys River smolt stocking assessmentOngoingU7Evaluation of estuary and nearshore marine distributions of Atlantic salmon post-smolts in Penobscot Bay and the Gulf of MaineOngoingU8Cormorant harassment in the Narraguagus River/Narraguagus BayOngoing - New EntryU9SALSEA GreenlandOngoing - New EntryF1St Pierre and Miquelon Salmon Fishery SamplingOngoing | NoImage: Comprehensive evaluation of marine survival of migration speed and behaviour from lower river release sites through estuarine habitat; 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Annex 1

Inventory of Research relating to Salmon Mortality in the Sea

Project Details

1. CANADA

| Project No. C1 | Status: Completed |
|--|---|
| Party or relevant jurisdiction | Canada Maritimes Region |
| Title of project | Marine migration and survival of post-smolt Atlantic salmon from Bay of Fundy rivers |
| Objective of research project | Provide knowledge about marine habitat (migration routes and feeding grounds) used by salmon post-smolts from Bay of Fundy rivers. Determine the location, timing and extent of salmon post-smolt mortality at sea. Investigate the causes and mechanisms of marine mortality of salmon post-smolts. Provide information to fuel the recovery programme for inner Bay of Fundy salmon stocks. |
| Brief description of research project | Salar MAP , the Atlantic Salmon Marine Acoustic-tracking Project, tagged wild Atlantic salmon smolts from inner and outer Bay of Fundy rivers and monitored their movements in the Bay of Fundy and Gulf of Maine over a period of up to 6-8 months after entry into sea water. A new generation of coded acoustic tags, automated underwater receivers, and new methodology developed and tested by Salar MAP over the past 6 years was used to map the migration routes and fine-scale distribution of post-smolts over time. Wild smolts captured using rotary screw traps or other live traps were tagged and released throughout the migration period to examine issues of synchrony related to the transition from fresh to salt water and subsequent distribution. Naturally-emigrating wild smolts were used to clarify possible environmental influences originating in fresh water on migration and survival. A key feature of the approach developed is that the high efficiency of the tag detection screens (ref. 1999 pilot study) could provide a direct measure of survival of tagged post-smolts over specific periods and to specific points along the migration route. Other fishery-independent information obtained by tagging included the timing, location and rate of departure from the river and inner and outer bay sectors, travel direction, behaviour and movements in relation to environmental associations. The potential for interaction with aquaculture cage sites was also determined by tracking. Post-smolt migration routes and distribution throughout the Bay of Fundy were determined during the first summer at sea. Extended monitoring to early winter could discover where salmon of inner bay stocks go to over-winter, which may be crucial to any recovery plans. The information obtained from tagging will help direct the efforts of marine surveys using trawling to capture live Atlantic salmon for examination and release. |
| Dates during which research took place | This project, which commenced in 2001, was completed in September 2002. Data were analyzed through to the fall of 2003. |
| Area in which research took place Estimated number and | Bay of Fundy and Gulf of Maine None. All smolts sampled and those surgically tagged were released |
| weight of salmon retained Resources | alive. |
| Estimated cost of the | Estimated £176,000 per year (includes DFO ship time and salaries |

| research project | including overheads) |
|---|---|
| | Approx. £245,000 spent in 2000/01 by NGO partners for capital acquisitions and O&M to start up project. |
| | Principal Supporting Partners (NGO): Atlantic Salmon Federation VEMCO Limited |
| | First Nations |
| Number of participating scientists | |
| Name of coordinating scientist in charge of project | Gilles L Lacroix LacroixG@dfo-mpo.gc.ca |
| Details of research vessels, e.g. name, registration, call sign and description of vessel | Tracking vessel: SALAR (licence no. C02371NB; Rosborough RF-247, 7.5 m fibreglass boat with twin 115 hp outboard motors, based at St. Andrews Biological Station) |
| | Gear deployment vessels: CCG Pandalus III (Canada Coast Guard, 12.5 m research vessel, based at St. Andrews Biological Station) Commercial Charters (inshore and offshore lobster boats) Other CCG vessels (as required) |
| Type and amount of gear and other equipment used | Coded acoustic tags (Vemco, various pinger types, sizes, and durations, approx. 200-300 tags per year). Automated underwater acoustic monitoring receivers (Vemco, various types, approx. 200 units). Tracking receivers (Vemco, various types for detection and active tracking). |
| | Receiver moorings (various types and designs, approx. 200). Traps for capture of live smolts in rivers (various types and designs, including E.G. Solutions rotary screw fish traps, approx. 4 traps). Surgical gear and method as per established protocol. |
| Details of any collaborating countries | U.S.A.: John Kocik, National Marine Fisheries Service, NOAA Ken Beland, State of Maine Atlantic Salmon Commission (smolt tagging and collaboration in tracking post-smolts in the Gulf of Maine) |

Atlantic salmon smolts were tagged in the spring of 2002 (n=378) and released from inner and outer Bay of Fundy rivers (241 inner bay, 137 outer bay). Two lines comprising 132 receivers (VR-2, Vemco Ltd.) were deployed for tracking inner and outer bay movements of post-smolt salmon. Data is being analyzed to publish in 2004.

Field components of this post-smolt tracking project were completed in 2002. Results from the 1999, 2001, and 2002 tracking of tagged smolts were combined in an overall analysis which took place during 2003. The results of these analyses will be summarized in a series of manuscripts to be completed during 2004. At this stage, all results are preliminary. Results will be made available as soon as manuscripts have been completed and approved by the Department for submission and distribution.

No resources were allocated to this project in 2003, and no resources will be allocated in 2004. The project represented the first phase of research to define the migration and early marine survival of post-smolts from rivers of the Bay of Fundy, and it has now been completed.

Findings from this project will be made available as soon as the draft manuscripts are completed (in 2004) and they receive approval for submission and release. In the interim the summary of findings submitted last year can be used since no new research was conducted during 2003.

| Party or relevant jurisdiction | Canada | | |
|--|--|--|--|
| | Maritimes Region | | |
| Title of project | Distribution, health and condition of Atlantic salmon from Bay of | | |
| | Fundy rivers while at sea | | |
| Objective of research project | Provide knowledge about marine habitat and health of salmon post- smolts from Bay of Fundy rivers. Investigate the causes and mechanisms of marine mortality of salmon post-smolts. Provide information to fuel the recovery programme for inner Bay of Fundy salmon stocks. | | |
| Brief description of research project | The project proposed to conduct annual marine surveys using specialised trawling gear and techniques developed specifically to capture live Atlantic salmon of all sizes for examination and release. Gear and method development and testing cruises were conducted in 2000 and a 3-week survey was successfully completed in the Bay of Fundy in 2001. The survey determined the distribution of salmon from Bay of Fundy rivers during post-smolt migration at sea and may help discover the location of critical feeding habitat for assessment. The capture of live salmon at sea allowed assessment of health and condition over time and provided key information on growth, prey items, diseases and parasites, genetic origin, physiology, and environmental associations. This knowledge is essential in uncovering potential causes of marine mortality (through identification of factors involved or reduction of hypotheses listed to explain mortality). The project benefitted from the Salar MAP research activities because prior knowledge of migration routes and timing obtained through tagging and tracking helped find increasingly rare wild salmon of inner bay origin and decrease requirements for expensive ship time in the search for salmon. | | |
| Dates during which research took place | May to June, 2002-2004 Surveys during late May to mid-June 2003. | | |
| Area in which research took place | Bay of Fundy and Gulf of Maine | | |
| Estimated number and weight of salmon to be retained | All wild post-smolts and wild adult salmon captured alive were sampled and released. Fishing mortality (expected to be <5% based on 2001 survey) and salmon identified as having escaped from aquaculture sites retained. | | |
| Resources | | | |
| Estimated cost of the research project | Estimated £112,500 per year (includes DFO ship time and salaries including overheads) Approx. £22,200 spent in 2000/01 by NGO partners for capital acquisitions to start up project. Principal Supporting Partners (NGO): Atlantic Salmon Federation First Nations | | |
| Number of participating scientists | | | |

| Project No. | C2 | Status: | Completed |
|-------------|----|---------|-----------|
| | | | |

| Name of coordinating | Gilles L Lacroix |
|------------------------------|--|
| scientist in charge of | LacroixG@dfo-mpo.gc.ca |
| project | |
| Details of research | Trawling vessel: |
| vessels, e.g. name, | CCG Alfred Needler (Canada Coast Guard, 40 m fishing/research |
| registration, call sign | vessel, based at Bedford Institute of Oceanography, Dartmouth) |
| and description of | |
| vessel | |
| Type and amount of | Akrehamn post-smolt trawls (2 prototypes designed for surface |
| gear and other | trawling) and various extensions and accessories. |
| equipment used | Thyboron trawl doors (Type 8 doors for pelagic trawling). |
| | Light bridles and main warps for surface trawling. |
| | Live fish capture and holding cod-end tanks (several prototypes |
| | designed after fish-lift and aquarium developed by J.C. Host, IMR, |
| | Norway). |
| | Live fish holding tanks (aboard ship) and fish sampling gear. |
| Details of any collaborating | U.S.A.: Russell Brown, National Marine Fisheries Service, NOAA, |
| countries | Woods Hole (post-smolt trawling survey in the Gulf of Maine) |
| countries | Kevin Friedland, Umass/NOAA CMER Programme (retrospective |
| | |
| | growth analysis from scales) |
| | Norway: J.C. Holst and M. Holm, Institute of Marine Research, |
| | Bergen (post-smolt trawling surveys in fjords and at sea) |

Atlantic salmon Salmo salar post-smolts migrating through the Bay of Fundy and Gulf of Maine were surveyed and sampled in 2001-2003 by trawling in surface waters. Post-smolts were aggregated in several areas while in the Bay of Fundy and then dispersed over a broader area in the Gulf of Maine, and their distribution reflected major surface current patterns. There was considerable spatial and temporal overlap between migrating post-smolts and the herring fishery. Post-smolt origin (e.g., wild vs. hatchery, inner vs. outer Bay of Fundy) did not affect their distribution. The low density of postsmolts indicated that they were too scarce to form large schools that offer protection from pelagic predators. The recapture rate of marked post-smolts was higher for wild than for hatchery fish, but it was nil for wild fish from the salmon farming area. The health and condition of post-smolts was excellent; they had no bacterial or viral pathogens and no salmon sea lice. Environmental conditions and food supply apparently did not limit growth of post-smolts; new circuli on scales and their spacing indicated that growth at sea had started and was accelerating. Post-smolts had shifted to a pelagic foraging behaviour, feeding opportunistically on different prey depending on location; the main food items were amphipods, euphausiids, and fish larvae. Post-smolts of hatchery and wild origin consumed the same prev but the larger hatchery fish did so in much greater quantity than the wild post-smolts, possibly giving them a growth and survival advantage.

A trawling survey for post-smolts was conducted 4-18 June 2003 in Canadian waters of the outer Bay of Fundy and northern Gulf of Maine. Catches (n = 42 post-smolts) were lower than in the previous two years, and only 24% of the post-smolts captured were wild. They were in good health and free of diseases and sea lice. Analyses of growth and feeding habits were completed. The observed distribution confirmed and extended the distribution and origin data obtained in 2002. Results from surveys conducted in 2001, 2002, and 2003 were combined in a manuscript, "Distribution, origin and health of Atlantic salmon post-smolts migrating through the Bay of Fundy and Gulf of Maine", that has been completed and will be submitted in 2004 pending Departmental approval.

No resources will be allocated to this project in 2004. No marine survey will be conducted in 2004 for several reasons; the availability of ship time in the region is severely constrained because of a

recent fire aboard the research vessel CCGS Alfred Needler, and the initial goals of the project have been met. The project is therefore considered as completed.

Publications:

- Lacroix, G. L. 2008. Influence of origin on migration and survival of Atlantic salmon (Salmo salar) in the Bay of Fundy, Canada. Canadian Journal of Fisheries and Aquatic Sciences 65: 2063-2079.
- Lacroix, G. L and D. Knox. 2005.Distribution of Atlantic salmon (Salmo salar) postsmolts of different origins in the Bay of Fundy and Gulf of Maine and evaluation of factors affecting migration, growth, and survival. Canadian Journal of Fisheries and Aquatic Sciences 62: 1363-1376.

| Party or relevant jurisdiction | Canada |
|---------------------------------------|---|
| Title of project | Marine migration and survival of post-smolt Atlantic salmon from the Saint-Jean River (Gaspé) |
| Objective of research | Provide knowledge of the marine habitat (migration routes and feeding |
| project | grounds) used by salmon post-smolts from Bay of Gaspé rivers Determine the location, timing and extent of salmon post-smolt mortality at sea. Investigate the causes and mechanisms of marine mortality of salmon post-smolts. |
| Brief description of research project | |
| Dates during which research | |
| took place | |
| Area in which research took place | |
| Estimated number and | |
| weight of salmon to be | |
| retained | |
| Resources | |
| Estimated cost of the | |
| research project | |
| Number of participating scientists | |
| Name of coordinating | Julian Dodson |
| scientist in charge of | julian.dodson@bio.ulaval.ca |
| project | François Caron |
| | francois.caron2@mrnf.gouv.qc.ca |
| Details of research | |
| vessels, e.g. name, | |
| registration, call sign | |
| and description of | |
| vessel | |
| Type and amount of | |
| gear and other | |
| equipment used | |
| Details of any collaborating | |
| countries | |

Project No. C3 Status: Completed

Summary of Findings

Migration patterns of wild Atlantic salmon smolts were studied in a coastal embayment (consisting of a partially enclosed inner bay and an open outer bay) in the Gaspé peninsula of Québec, Canada. In 2005 and 2006, 24 and 30 smolts respectively were tagged with coded short-term internal ultrasonic transmitters, and their migration throughout the bay was monitored using an array of fixed hydrophones coupled with a characterization of the physical habitat (current and salinity). The migration patterns were complex, with some smolts taking a direct route through the coastal embayment and other smolts repeatedly changing direction over short spatial and temporal scales. Migration was mainly an active process involving an overall seaward (outward) migration in the face of an inward residual circulation. Smolt swimming direction, as determined from current velocity and smolt ground velocity, was predominantly seaward. Swimming direction was significantly more focussed towards the sea but swimming speed was less during inflowing currents than during outflowing currents. Similarly, swimming direction was significantly more focussed toward the sea but swimming speed was less during the night than during the day. Swimming direction was significantly more focussed towards the sea and swimming speed was greater when there was a positive salinity gradient (salinity increasing towards the sea) than when there was a negative salinity gradient. Exposure to more saline waters resulted in increased migration rates.

These observations are consistent with the hypothesis that smolts exploit an innate compass to maintain a preferred bearing and that the speed and direction of swimming is controlled by salinity, residual circulation and the diurnal cycle.

| Project No. C4 | Status: Completed |
|---|--|
| Party or relevant jurisdiction | Canada |
| Title of project | Marine migration and survival of kelt Atlantic salmon from the Saint-Jean River (Gaspé) |
| Objective of research project | Provide knowledge of the marine habitat (migration routes and feeding grounds) used by salmon kelts from Bay of Gaspé rivers. Determine the location, timing and extent of kelt mortality at sea. Investigate the causes and mechanisms of marine mortality of salmon kelts. Provide information about migration routes used at sea, using code that can be detected by ASF project (see Fred Whoriskey project) at sea. |
| Brief description of research project | |
| Dates during which research took place | |
| Area in which research took place | |
| Estimated number and weight of salmon to be retained | |
| Resources | |
| Estimated cost of the research project Number of participating | |
| scientists | |
| Name of coordinating scientist in charge of project | François Caron francois.caron2@mrnf.gouv.qc.ca |
| Details of research vessels, e.g. name, registration, call sign and description of vessel | |
| Type and amount of gear and other equipment used | |
| Details of any collaborating countries | |

Migration patterns of wild Atlantic salmon kelts were studied in a coastal embayment (consisting of a partially enclosed inner bay and an open outer bay) in the Gaspé peninsula of Québec, Canada. In 2006, 24 kelts were tagged during last week of April with coded short-term (3 months) internal ultrasonic transmitters, and their migration throughout the bay was monitored using an array of fixed hydrophones coupled with a characterization of the physical habitat (current and salinity). Kelts stayed for some days in the upper part of the estuary, staying mainly in a limited range. Migration was an active process involving an overall seaward (outward) migration in the face of an inward residual circulation. Kelt swimming direction, as determined from current velocity and kelt ground velocity, was seaward. Swimming direction was significantly more focussed towards the sea and swimming speed was rapid when there was a positive salinity gradient (salinity increasing towards the sea).

| Project No. C5 | Status: Completed |
|--|---|
| Party or relevant jurisdiction | Canada Scotia Fundy Region NGO (Atlantic Salmon Federation)/DFO collaboration (St. Andrews Biological Station) |
| Title of project | Tracking experimentally "escaped" farmed salmon |
| Objective of research project | Determine the course tracks and fates of sonically tagged farmed salmon released in winter and spring |
| Brief description of research project | Salmon were obtained from a commercial grower in Cobscook Bay, Maine, fitted with tags and released. Their short-term displacements were compared to current circulation models developed by DFO for the region. Receivers were placed in rivers during the spawning season to determine if the fish survived to enter them. Results were used to evaluate the potential to recapture escaped farmed salmon in this fast (3kn – 5kn) environment. |
| Dates during which research took place | Winter/spring 2005 |
| Area in which research took place | Cobscook Bay, Maine, USA; Quoddy Region, NB, Canada |
| Estimated number and weight of salmon retained | 400 fish, tagged and released |
| Resources | |
| Estimated cost of the research project | Approx. £114,000 for operations, salaries and acoustic tags |
| | Approx. £68,000 for receiver arrays |
| | Approx £91,000 for smolt wheels (Partner contribution: 6 wheels and their operation) |
| | Total Approx £273,000 |
| | Principal Supporting Partners: Heritage Salmon |
| Number of participating scientists | 8 |
| Name of coordinating scientist in charge of project | Dr. Fred Whoriskey: asfres@nb.aibn.com |
| Details of research vessels, e.g. name, registration, call sign and description of vessel | Small boats (less than 20 feet in length) Chartered fishing vessel (approx 35 feet) for gear deployment |
| Type and amount of gear and other equipment to be used Details of any | Up to 76 VR 2 acoustic receivers 400 acoustic tags |
| collaborating countries | |

Project No. C5 Status: Completed

Publication:

Whoriskey, FG; P. Brooking, G. Doucette, S. Tinker, and J.W. Carr. 2006. Movements and survival of sonically tagged farmed Atlantic salmon released in Cobscook Bay, Maine, USA. ICES Journal of Marine Science 63: 1218-1223.

Abstract. We sonically tagged and released farmed Atlantic salmon (Salmo salar) from a cage site in Cobscook Bay, Maine, USA. The fish were released in January (n=75) and in April and May (n=198) 2004 to study their movement patterns and survival and to assess the possibility of recapturing them. Inshore and offshore waters in this region are subject to intense tidal currents. Tagged salmon dispersed >1km from the cage site within a few hours of their release. Mortality was high within Cobscook Bay and the surrounding coastal region (56% of the winter (January) releases; 84% of the spring (March) releases), probably the result of seal predation. Most surviving fish exited the coastal zone and entered the Bay of Fundy along the routes of the dominant tidal currents, passing through Canadian waters. No tagged fish were detected during the wild salmon spawning season in autumn 2004 in any of the 43 monitored salmon rivers draining into the Bay of Fundy, or during 2005 either in the Magaguadavic River, the site of the hatchery in which the fish were reared to the smolt stage, or by a limited coastal receiver array.

| Party or relevant jurisdiction | Department of Fisheries and Oceans, Newfoundland Region |
|---|--|
| Title of project | Atlantic salmon distribution and abundance at sea |
| Objective of research | (1) Determine the distribution and abundance of salmon, particularly |
| project | post-smolts, in the Labrador Sea and northern Grand Banks; (2) |
| | Collect biological, meristic, morphometric, and biochemical data on |
| | salmon; (3) Investigate the relationship between salmon and prey by |
| | collecting stomach contents; (4) Investigate the relationship between |
| | sea temperature and other oceanographic parameters and salmon |
| | abundance; (5) Tag and release salmon in good condition. |
| Brief description of research | The distribution of Atlantic salmon were studied using multiple mesh |
| project | drift nets, and a surface trawl in the autumn. Relative abundance with |
| | respect to spatial distribution and sea temperature were inferred from |
| | catch rates. Fishing took place between 49° 00' N and 57° 00' N and |
| | 40° 00' W and 60° 00' W. |
| Dates during which research | September, 2001 |
| took place | Autumn 2003 and 2005 |
| Area in which research took | Labrador Sea and Northern Grand Banks |
| place | |
| Estimated number and | 500 post-smolts, ~ 0.5 t |
| weight of salmon retained | |
| Resources | |
| Estimated cost of the | £146,500 (including overheads) in 2005 |
| research project | |
| Number of participating | 1 |
| scientists Name/e-mail of | David Reddin |
| | |
| coordinating scientist in charge of project | ReddinD@dfo-mpo.gc.ca |
| Details of research | CCGS Wilfred Templeman |
| vessels, e.g. name, | Canadian |
| registration, call sign | CGDV |
| and description of | 50 m long of 925 GRT |
| vessel | |
| Type and amount of | ~2000 fathoms of monofilament drift gill nets of 77, 89, 102, 115, and |
| gear and other | 127 mm stretched measure. |
| equipment to be used | Surface trawl |
| Details of any collaborating | |
| countries | |
| Summary of Findings | |
| | |

Completed

Status:

Project No.

C6

Trip program was reduced due to the need to survey for scallops in St. Pierre-Miquelon area and due to Search and Rescue missions. The Norwegian surface trawl was successfully fished from the Templeman. In total, there were 9 trawl sets with only one salmon post-smolt capture. Comparative fishing with gillnets resulted in the capture of 60 post-smolts. Other species caught in the trawl included billfish, Atlantic mackerel, lantern fish, jelly fish, squid, and amphipods. Two drift net sets were completed in the Labrador sea. Forty-seven post smolt salmon and 11 adult salmon were caught with an average length of each set being approx. 16 hrs. Disease survey on 35 specimens indicated no pathogens present. This trip brings to a close at sea research in the Labrador Sea/Grand Banks area.

| Project No. C7 | Status: | Completed |
|----------------|---------|-----------|
|----------------|---------|-----------|

| Party or relevant jurisdiction | Canada |
|--|--|
| Title of project | Integrated field and laboratory assessment of the effects of endocrine-disrupting substances on Atlantic salmon smolts |
| Objective of research project | Laboratory tests of the effects of endocrine-active substances in municipal and industrial effluents, including estrogens, androgens, phytosterols and nonylphenol ethoxylates Field tests of the effects of endocrine-active substances in municipal and industrial effluents, including estrogens, androgens, phytosterols and nonylphenol ethoxylates (caging and exposure and release studies) Field tests caging smolts near sites with potential for significant agricultural runoff Ocean field test of link between exposure of smolts to endocrine-disrupting substances and subsequent lower adult returns (Burrishoole River, Ireland, initially and Canada if methods prove feasible) |
| Brief description of research project | This project proposal was based on research conducted over the past three years under ESSRF/TSRI (DFO projects 95052 and 92548) funding which evaluated the effects of nonylphenol and other endocrine-disrupting substances on growth and survival of Atlantic salmon (<i>Salmo salar</i>) during and after smoltification. Nonylphenol, and the larger group of nonylphenol ethoxylates, are in use in almost all commercial, industrial and domestic sectors. These compounds are members of the second-largest class of non-ionic surfactants in use today, the alkylphenol polyethoxylates. Concentrations of these compounds occurring presently in the environment have been shown to have endocrine-disruptive effects on fish in rivers and estuaries downstream of municipal sewage treatment works. Sewage treatment works emit about 4% of their total nonylphenolic compound input as nonylphenol itself. This is a significant percentage as nonylphenol has a greater bioaccumulation potential than the nonylphenol ethoxylates. Nonylphenol ethoxylates are also used in about 20-25% of all pesticide and herbicide formulations available today. Nonylphenol itself (4- nonylphenol) has been used in the past as a major constituent in certain pesticide formulations, some of which were applied in Canada. The current research indicating estrogenic effects on fish at low 4- nonylphenol levels ($\mu g/r^{-1}$ range) raises the potential that pesticide formulations containing nonylphenol ethoxylates and leaving residues in water may be capable of affecting fish due to the presence of nonylphenol ethoxylate degradation products (including 4-NP), and not necessarily due to the presence of the pesticide's active ingredient. Atlantic salmon inhabit streams and lakes for their juvenile stages, and in eastern Canada have been exposed to pesticides applied for forest protection most years since the 1950s. Sensitive life stages may be affected by exposure to nonylphenol. Smoltification is a time of great stress for salmon, as they are changing physiologically and adapting |

| | survival of smolts as they enter salt water. |
|------------------------------|--|
| Dates during which research | 2003-2007 |
| took place | |
| Area in which research took | Atlantic Canada and Co. Mayo, Ireland |
| place | |
| Estimated number and | 600 wild smolts per year from Miramichi River (Canada); about |
| weight of salmon retained | 14,000 smolts per year from Burrishoole River (Ireland). |
| Resources | |
| Estimated cost of the | About £115,000 per year during 2003-2005, majority from DFO |
| research project | ESSRF plus other funds and in-kind support from Environment |
| | Canada, DFO, Marine Institute, Ireland, and others In 2006 and 2007 |
| | no funding is expected but analysis of results will be ongoing. |
| Number of participating | 12 (DFO, Env Can, UNB, Marine Institute) plus two graduate students |
| scientists | |
| Name and e-mail of | Wayne L. Fairchild |
| coordinating scientist in | FairchildW@dfo-mpo.gc.ca |
| charge of project | |
| Details of research | None |
| vessels, e.g. name, | |
| registration, call sign | |
| and description of | |
| vessel | |
| Type and amount of | Trap nets and fish holding cages in rivers in Canada |
| gear and other | |
| equipment used | |
| Details of any collaborating | Collaboration with Ken Whelan and Deirdre Cotter of the Marine |
| countries | Institute, Salmon Management Services Division, Furnace, Newport, |
| | Co. Mayo, Ireland - hatchery facilities, fish husbandry, capture and |
| | counting capability for Burrishoole River salmon. |
| | |

In 2004, smolts were exposed to pesticides (herbicides and nonylphenol) while in fresh water, and subsequent growth and survival was measured in the aquarium at the St. Andrews Biological Station, St. Andrews, NB. In 2003 and 2004, smolts were exposed to nonylphenol and estrogen at the Marine Institute, on the Burrishoole River, County Mayo, Ireland, and were then released to the North Atlantic. Adults were monitored in the returns to the river and in the interceptions in the coastal fisheries. Results from both treatment years (2003 and 2004) indicate variable survival among years and a decrease in sea survival of a cohort exposed to nonylphenol relative to controls. Field operations are complete, data are still being verified and analysed.

Publications:

- Jardine, T.D., MacLatchy, D.L., Fairchild, W.L., Chaput, G. and Brown, S.B. 2005. Development of a short-term in-situ caging methodology to assess long-term effects of industrial and municipal discharges on salmon smolts. Ecotoxicology and Environmental Safety, 62:331-340.
- Jardine, T.D., MacLatchy, D.L., Fairchild, W.L., Cunjak, R.A. and Brown, S.B. 2004. Rapid carbon turnover during growth of Atlantic salmon (*Salmo salar*) smolts in sea water, and evidence for reduced food consumption by growth-stunts. Hydrobiologia 527:63-75.

Arsenault, J.T., Fairchild W.L., Maclatchy, D.L., Burridge, L., Haya, K. and Brown, S.B. 2004. Effects of water-borne 4-nonylphenol and 17ß-estradiol exposures during parr-smolt transformation on growth and plasma IGF-I of Atlantic salmon (*Salmo salar* L.). Aquatic Toxicology 66:255-265.

| Project No. C8 | Status: Completed |
|--|--|
| Party or relevant jurisdiction | Canada |
| Title of project | Use of stable isotopes to assess long-term changes in marine trophic ecology of Atlantic salmon (<i>Salmo salar</i>) |
| Objective of research project | To assess trophic and dietary information through analyses of stable isotope signatures of carbon and nitrogen (□¹³C and ¹⁵N) from previously compiled scale samples of various stocks of Atlantic salmon; To compare isotopic signatures within (temporal) and among (spatial) stocks to infer differences in salmon feeding ecology in time and space; To examine evidence for any environmental influences on trends in isotopic signatures; To examine linkages with stable isotopic signatures with trends in abundance of salmon. |
| Brief description of research project | Recent investigations have proposed that marine food webs have changed dramatically owing to ever-increasing and unsustainable levels of exploitation – the so-called 'fishing down marine food webs' hypothesis - while others have provided evidence of trophic cascades. In addition, evidence exists for dramatic changes in ocean climate conditions in the northwest Atlantic, particularly during the early 1990s, prompting some to suggest there has been a marine climate regime shift. Ocean climate conditions have been shown to affect productivity and survival of Atlantic salmon. Salmon are considered opportunistic feeders during the marine life-history phase, often targeting prey in the upper end of the size spectrum, with a preference for fish over crustaceans should both be available. Thus, the species lends itself well to studies associated with marine environmental conditions and food web interactions. Accordingly, long-term variability in the trophic ecology of Atlantic salmon were examined using analyses of stable isotope signatures of carbon and nitrogen ($\delta \square^{13}C$; $\delta \square^{15}N$). Specifically, changes in stable isotope signatures were evaluated for evidence of Pauly's food web hypothesis and also in relation to variation in marine climate conditions in the north Atlantic over the past several decades. These analyses should provide an additional means to understand, in whole or in part, observed variability in abundance and survival of various stocks of Atlantic salmon. |
| Dates during which research took place | 2006 - 2007. |
| Area in which research took place | Newfoundland salmon stocks, two (2) Maritime stocks and one (1) Quebec north shore population. In addition, to provide a greater geographic contrast with Eastern Canadian populations, analyses have also been carried out on a north European stock that empties into the Barents Sea, the River Tana (Teno). |
| Estimated number and weight of salmon retained | N/A |
| Resources | |
| Estimated cost of the | £27,500. Project funded by Fisheries and Oceans Canada under the |

| 17 | |
|----|--|
|----|--|

| research project | International Governance of High Seas Fisheries program. Scientist |
|------------------------------|--|
| | time for analysis of about £5,000. |
| Number of participating | Two scientists: one from DFO Newfoundland Region, the other from |
| scientists | the University of Waterloo, Waterloo, Ontario, Canada. |
| Name and e-mail address | J. Brian Dempson |
| of coordinating scientist | dempsonb@dfo-mpo.gc.ca |
| in charge of project | |
| Details of research | N/A |
| vessels, e.g. name, | |
| registration, call sign and | |
| description of vessel | |
| Type and amount of gear | N/A |
| and other equipment to be | |
| used | |
| Details of any collaborating | Samples obtained from the River Tana (Teno) were provided by |
| countries | scientists from Finland. |
| | |

Publication:

Niloshini Sinnatamby, R., J. B. Dempson, G. Chaput, F. Caron, E. Niemelä, J. Erkinaro, and M. Power. 2009. Spatial and Temporal Variability in the Trophic Ecology of Atlantic Salmon in the North Atlantic Inferred from Analyses of Stable Isotope Signatures. American Fisheries Society Symposium 69:447–463.

In many areas of the North Atlantic, populations of Atlantic salmon Salmo salar are now either in a state of decline or extirpated such that concern over the continued survival of the species has been given more attention in recent years despite large reductions in directed ocean fisheries. Previous investigations have established linkages between ocean climate conditions and variability in abundance or survival. However, one avenue not previously explored considers whether changes in marine food webs owing to ever increasing and unsustainable levels of exploitation on many marine species-the so-called "fishing down marine food webs" hypothesis-could influence survival and abundance of salmon as a result of shifts in trophic position or changes in energy flows. Since Atlantic salmon are opportunistic feeders during the marine life history phase, the species lends itself well to studies associated with marine environmental conditions and food web interactions. Here, we examine long-term variability in the trophic ecology of Atlantic salmon using analyses of stable isotope signatures of carbon and nitrogen (d13C and d15N). Signatures were extracted from the marine growth portion of scales of maiden one-sea-winter fish. Data were obtained from nine Canadian and one north European river (Teno) covering periods extending over three to four decades. Significant differences in d13C and d15N signatures were found to exist among rivers, as well as among years within rivers. Trends over time in either d13C or d15N signatures were evident in only a few situations, thus providing little evidence of substantive changes in the trophic ecology of salmon in the North Atlantic. In addition, isotopic signatures were largely invariant in relation to variations in abundance or to various environmental measures characterizing ocean climate conditions in the North Atlantic.

| Project No. C9 | Status: Completed | | | |
|--|---|--|--|--|
| Party or relevant jurisdiction | Canada | | | |
| Title of project | Effective population size, gene flow and population structure of Atlantic salmon in Newfoundland and Labrador | | | |
| Objective of research project | To document population structure and connectivity (gene flow) among Newfoundland and southern Labrador rivers To test for the temporal stability of the structure over the past 50 years. | | | |
| Brief description of research project | Population structure arises as a consequence of genetic drift, gene flow, mutation, natural selection and their interactions. Population size plays a central role in determining the balance between these forces: Large populations are though to be better able to respond to natural selection than small populations. Small populations, in turn, are thought to be more influenced by genetic drift, which is more likely to lead to the loss of genetic variation, accumulation of inbreeding depression and increased extinction risk. Gene flow can alleviate such genetic adversity while simultaneously limiting the extent of adaptive divergence between populations. This type of information is thus essential to effective management and conservation as well as restoration efforts, especially for species of conservation concern. | | | |
| | The objective was to estimate effective population sizes and connectivity (gene flow) among Atlantic salmon populations from Newfoundland and Labrador. We examined genetic variability in a suite of 14 microsatellite DNA loci among ca 3000 individuals from some 20 populations from around Newfoundland and from southern Labrador collected over the period of the last 5 decades starting in the 1950s to the present. The availability of extensive temporal samples allowed for tests of changes in effective population size related to the declines and subsequent closure of commercial fisheries. Our analyses provided information on the relationship between effective population size and gene flow. We are also examined the genetic basis for phenotypic and life history differences by means of common garden experiments with salmon from two populations in Newfoundland. | | | |
| Dates during which research took place | 2003 - 2008. | | | |
| Area in which research took place | Contemporary samples were analyzed from 18 rivers in Newfoundland and 2 in southern Labrador. Temporal replicates were available from 10 Newfoundland and 2 Labrador rivers. Samples for common-garden experiments were secured from 2 rivers in Newfoundland. | | | |
| Estimated number and weight of salmon to be retained | NA | | | |
| Resources | | | | |
| Estimated cost of the research project. | £ 28,000 Fisheries and Oceans Canada (DFO) Academic Subvention Grant to DER at Dalhousie | | | |

| | £ 16,000 Dalhousie University grants. £ 20,000 NSERC (DER) |
|---|--|
| Number of participating scientists | Three scientists: Daniel Ruzzante (Dalhousie University), Friso Palstra (PhD student), and Michael O'Connell (DFO). |
| Name and e-mail address of coordinating scientist in charge of project | Daniel E Ruzzante, <u>Daniel.ruzzante@dal.ca</u> Friso Palstra (PhD student), fpalstra@dal.ca |
| Details of research vessels, e.g. name, registration, call sign and description of vessel | NA |
| Type and amount of gear and other equipment used | NA |
| Details of any collaborating countries | NA |
| Summary of Findings | |
| No summary provided. | |

| Party or relevant jurisdiction | Canada | | |
|--|--|--|--|
| Title of project | River and extended estuary acoustic tracking of Atlantic salmon | | |
| | (Salmo salar) kelts and bright salmon | | |
| Objective of research project | To track and document migratory behaviour of Atlantic salmon kelts as they leave the river for the open ocean and bright salmon at they return to rivers; To identify possible critical habitat sites utilized by kelts and bright salmon during their migration; To examine the mortality rates of kelts and brigh salmon during migration. | | |
| Brief description of research project | The population of Atlantic salmon in the LaHave River on the Atlantic coast of Nova Scotia has been in decline in the 1990s and | | |
| Dates during which research took place | continues to decline because of low marine survival of both smolts and post-spawning adult salmon (kelts). Reasons could include poor physiological condition, interference with migration or increased predation. In this study acoustic tags and receivers are being used to provide evidence on the migration, timing and fate of migrating adult salmon. Thirty kelts were captured and implanted with the acoustic tags, including 5 tags that transmit depth data. Continuous recording acoustic receivers have been placed in the river 15 km above tide to 24 km below tide at the outer limits of the estuary to monitor the passage of tagged fish. Active searches were also used to locate marine summer holding habitat and to locate missing tags that may indicate mortalities. The array remained in place from May to October. Environmental data were also collected at each receiver location on a periodic basis and temperature was continuously recorded at some receiver locations. 2006 - 2008. | | |
| Area in which research took place | LaHave River, and estuary, Lunenburg, Nova Scotia, Northwest Atlantic Ocean, Canada. 44°23' N, 64°32' W | | |
| Estimated number and weight of salmon retained | N/A | | |
| Resources | | | |
| Estimated cost of the research project | £30,000 per annum. Project is funded by Fisheries and Oceans Canada, LaHave River Salmon Association and affiliates. | | |
| Number of participating scientists | Three scientists from DFO Maritimes Region. Also one graduate student and scientist from Acadia University, Wolfville Nova Scotia, Canada. | | |
| Name and e-mail address of coordinating scientist in charge of project | Peter G. Amiro AmiroP@mar.dfo-mpo.gc.ca A Jamie F. Gibson GibsonAJF@mar.dfo-mpo.gc.ca | | |
| Details of research vessels, e.g. name, registration, call sign and description of vessel | N/A | | |
| Type and amount of gear and other equipment used | Vemco VR2 and VR60 receivers, Vemco V13 transmitters | | |

Project No. C10

Status:

Completed

| Details of any collaborating | N/A |
|------------------------------|-----|
| countries | |
| | · |

Summary of Findings

Hubley, P.B., P.G. Amiro, A.J.F. Gibson, G.L. Lacroix, and A.M. Redden. 2008. Survival and behaviour of migrating Atlantic salmon (Salmo salar L.) kelts in river, estuarine, and coastal habitat. ICES Journal of Marine Science 65; 1626-1634.

Abstract:

The downstream migration of 30 Atlantic salmon (Salmo salar) kelts tagged with acoustic transmitters was monitored using 26 underwater receivers at eight locations from April to October 2006 in the LaHave River and Estuary. In all, 27 tags were detected as they left the coastal environment by the middle of May, 5 weeks after release, indicating a possible 90% kelt survival to coastal departure. Two missing tags and one dropped tag were assumed to be attributable to natural mortality in the estuary. Migration time from release to the outermost coastal receivers 24 km below the tide limit took an average of 14 d, but varied from 3 to 32 d. Some 40% of the kelts lingered and were active in the lower estuary. Five kelts monitored with depth transmitters migrated mostly at the surface in all habitats, with occasional brief descent to the bottom. A consecutive spawning salmon returned after 79 d outside the outermost array. The low rate of returns is consistent with the historical repeat spawning schedule for this river, and more precisely documents the temporal and spatial habitat use of migrating kelts.

| Project No. C11 | Status: Completed | | |
|--|--|--|--|
| Party or relevant jurisdiction | Canada Québec, MRNF University Laval, Mc Gill, UQARimouski, UQAMontreal, INRS NGO (Atlantic Salmon Federation)/DFO collaboration | | |
| Title of project | Integrated modelling of juvenile Atlantic salmon movement and physical habitat in fluvial and estuarine environments | | |
| Objective of research project | (1) To develop an innovative geomatic approach capable of relating the behaviour of smolts during their migration to the characteristics of the physical habitat in rivers and estuaries. (2) To apply this approach to the analysis of the migration of smolts through the estuaries of the St. Jean, Dartmouth and York rivers and down the Baie de Gaspé. (3) In the case of aquaculture development planned in the Baie de Gaspé, to detect potential changes in the migration pattern of smolts in response to the presence of sea cages. | | |
| Brief description of research project | The spatial and temporal distribution of smolts was assessed by tagging smolts with coded transmitters during their downstream migration. The plan was to release 60 tagged smolts during years 1, 2 and 3. These smolts were monitored by (a) a boat-mounted directional hydrophone and receiver to track their migration in the estuaries (b) an array of fixed, GPS geo-referenced, hydrophones moored across the Baie de Gaspé. Particle image velocimetry and image analysis techniques and passive acoustic drifters were used to determine surface flow velocity fields within the estuaries and Baie de Gaspé. | | |
| Dates during which research took place | Spring/summer 2005 to 2008 | | |
| Area in which research took place | York River and Baie de Gaspé, Québec, Canada | | |
| Estimated number and weight of salmon retained | 50 smolts, tagged and released | | |
| Resources | | | |
| Estimated cost of the research project | Approx. £100,000 for operations, salaries and acoustic tags | | |
| | Approx. £30,000 for receiver arrays | | |
| | Approx. £20,000 for smolt wheels | | |
| | Total Approx £150,000 per annum | | |
| | Principal Supporting Partners: Atlantic Salmon Federation, Fred Whoriskey Centre Interuniversitaire de Recherche sur le Saumon Atlantique (CIRSA) Fédération Québécoise du Saumon Atlantique Fondation pour le saumon du Grand Gaspé Génivar Hydro-Québec Ministère des Ressources Naturelles et de la Faune BC Ministry of Sustainable Resource Management, Information | | |

| 2 | 2 |
|---|---|
| 4 | 5 |

| | Services Division, Evert Kenk Principal investigators Normand Bergeron, INRS-Eau, Terre et Environnement. Deputy leader | | |
|--|---|--|--|
| | Thomas Buffin-Bélanger, Université du Québec à Rimouski François Caron, Ministère des Ressources naturelles et de la Faune Michael Church, University of British-Columbia Stuart Lane, University of Leeds, UK | | |
| Number of participating scientists | Michel Lapointe, McGill University 10 | | |
| Name and e-mail address of coordinating scientist in charge of project | Julian Dodson julian.dodson@bio.ulaval.ca | | |
| Details of research vessels, e.g. name, registration, call sign and description of vessel | Small boats (less than 20 feet in length) Chartered fishing vessel (approx. 35 feet) for gear deployment | | |
| Type and amount of gear and other equipment used | Up to 50 VR 2 acoustic receivers 50 acoustic tags | | |
| Details of any collaborating countries | Canadian and UK collaboration (University of Leeds) | | |
| Summary of Findings | | | |

<u>Publication:</u> Hedger, R. D; F. Martin, D. Hatin, F. Caron, F. G. Whoriskey, and J. J. Dodson. 2008. Active migration of wild Atlantic salmon Salmo salar smolt through a coastal embayment. Marine Ecology Progress Series Vol. 355: 235-246.

<u>Abstract:</u> Migration patterns of wild Atlantic salmon Salmo salar smolt were examined in a coastal embayment in the Gaspe peninsula of Quebec, Canada. Twenty-four smolt in 2005 and 30 in 2006 were tagged with coded ultrasonic transmitters, and their migration throughout the bay was monitored using an array of fixed VR2 hydrophone receivers. Migration patterns were complex, with some smolt taking a direct route through the coastal embayment and others repeatedly changing direction over short spatial and temporal scales. Migration was mainly an active process with an overall outward (seaward) migration in the face of an inward residual circulation. Swimming direction was mainly outward during nocturnal inflowing currents but was more dispersed during daytime and nocturnal outflowing currents; swimming speed was greater during daytime than during nighttime. This pattern was consistent with smolt migrating offshore nocturnally and using daytime for prey detection and predator avoidance. Salinity had a strong effect: exposure to more saline waters caused increased swimming speeds. These observations are consistent with the hypothesis that smolt exploit an innate compass to maintain a preferred bearing and that the speed and direction of swimming is controlled by salinity and the diurnal cycle.

| Party or relevant jurisdiction | Canada (Fisheries and Oceans Canada – Newfoundland Region) | | | |
|---|---|--|--|--|
| Title of project | Estuary acoustic tracking of Atlantic salmon (<i>Salmo salar</i>) smolts | | | |
| The of project | and kelts – Conne River, Little River, and Bay d'Espoir, | | | |
| | Newfoundland | | | |
| Objective of research project | To tag and track migratory behaviour of Atlantic salmon smolts and kelts as they leave the Conne River, Newfoundland; To determine the movements and migration patterns throughout the Bay d'Espoir fjord; To provide insight into the initial survival and residency of | | | |
| Brief description of research project | smolts and kelts migrating through the fjord.The population of Atlantic salmon in the Conne River on the southcoast of Newfoundland has, with few exceptions, been in declinesince the early 1990s and continues to remain at relatively low levelsof adult abundance. Marine survival has fallen from 7 - 10%estimated in the mid-to-late 1980s, to 3-4% during much of the pastdecade. Reasons for the decline in marine survival are not known. | | | |
| | Fifteen (15) kelts and 49 smolts were captured and implanted with the Vemco acoustic tags as they migrated out of the Conne River in the spring of 2006. Twenty-one (21) VR2 Vemco receivers were deployed throughout Bay d'Espoir to track migrating fish. Manual tracking in nearshore areas was also carried out to complement the arrays of acoustic receivers. This project was expanded in 2007 whereby 38 receivers (2 subsequently lost) were placed throughout the Bay d'Espoir fiord, with 30 kelt and 62 smolt tagged and released from Conne River. In addition, the Miawpukek (Conne River) First Nation provided funding and participated with the tagging and tracking of twenty (20) smolts that were released from Little River, another system in the Bay d'Espoir area. | | | |
| Dates during which research took place | 2006 - 2008 | | | |
| Area in which research took place | Conne River, and estuary, Little River, and the Bay d'Espoir fjord, south coast Newfoundland, SFA 11. | | | |
| Estimated number and weight of salmon retained | N/A | | | |
| Resources Estimated cost of the research project | £15,000 per annum. Project funded by Fisheries and Oceans Canada, the Miapukek First Nation, and is also a joint initiative between the Experimental Sciences Section and Salmonid Research Section. | | | |
| Number of participating scientists | This project involved several scientists and technical staff with expertise in salmonid research and telemetry investigations and staff from the Miawpukek First Nation. | | | |
| Name and e-mail address of coordinating scientists in charge of project | J. Brian Dempson dempsonb@dfo-mpo.gc.ca Keith Clarke <u>clarkekd@dfo-mpo.gc.ca</u> | | | |
| Details of research vessels, e.g. name, registration, call | N/A | | | |

Project No. C12 Status: Completed

| sign and description of vessel | |
|---|---|
| Type and amount of gear and other equipment used | Vemco VR2 receivers, V7-2L and V9-6L transmitters |
| Details of any collaborating | N/A |
| countries | |

Summary of Findings

During 2006 – 2008 Atlantic salmon smolts and kelts have been tagged with acoustic transmitters and released during April and May from Conne River, with smolts only being released at Little River in 2007 and 2008. The objectives were to determine movements and migration patterns throughout the Bay d'Espoir fiord, and obtain insight into the initial survival and residency time of both life history stages and compare patterns across years. This past year (2008), an additional 30 smolts and 8 kelt were tagged at Conne River with 20 smolts released from Little River. A total of 28 Vemco VR2 receivers were again positioned at various locations throughout Bay d'Espoir. This year several receivers were located in more distant areas outside of the Bay d'Espoir fiord. Extended areas included Dragon Bay (west of McCallum), Round Harbour (south coast of Long Island) and several positioned along the Connaigre Peninsula past Hermitage that could potentially extend tracking coverage upwards of 65 km from the point of release.

With respect to 2008 results, all Conne River kelt that were tagged and released were subsequently accounted for. Three (3) kelt returned to Conne River after an absence of 57 to 73 days. Several kelt were tracked migrating into the North Bay arm of the Bay d'Espoir fiord. Analysis of data compiled over the past three years indicates that while there some differences in the annual migration route, the differences were not statistically significant. Thus, most kelt (77.4%) migrate out of Bay d'Espoir via Lampidoes Passage.

Regarding Conne River smolts, in 2008 half of the fish tagged and released provided no recovery data. At least one smolt was tracked out to Dragon Bay and several migrate up into the North Bay arm. Similar to the kelt, there were no significant differences in the migration route out of Bay d'Espoir over the past three years with most smolts (54.3%) leaving by way of Lampoides Passage. There was no significant difference in the size of smolt that were successfully tracked versus those for which no data were obtained and thus likely represent mortalities. However, the migration route of Conne River smolt difference significantly from that of out migrating kelt.

Little River smolts differed from the Conne River smolt in that most (78.8%) migrate out through the main channel of the Bay d'Espoir fiord. At least six smolt were tracked out to Dragon Bay and four down along the Connaigre Peninsula (Halfway Point/Western Cove). As observed with Conne River smolt, Little River smolt were also tracked up into the North Bay arm of the fiord. Last year (2007) it was observed that Little River smolt took noticeably longer to migrate to the outer areas of the Bay d'Espoir fiord by comparison with Conne River smolts. In 2008, Conne River smolt were found to have taken about a week longer to reach the outer fiord than the previous year, while Little River smolt timing was similar to 2007.

Collectively, results suggest that the outer areas of the Bay d'Espoir fiord that includes the North Bay arm are important staging areas for smolts and kelts prior to fish undertaking any open sea migrations.

| Project No. C13 | Status: Completed | | |
|--|---|--|--|
| Party or relevant jurisdiction | Canada | | |
| Title of project | Spatio-temporal distribution of Atlantic salmon stocks and the impact of the West Greenland fishery | | |
| Objective of research project | Provide knowledge about the river origin of the salmon catch in the commercial fishery, particularly at West Greenland. | | |
| Brief description of research project | To evaluate the spatio-temporal distribution of North American Atlantic salmon on the coast of West Greenland, tissue samples were obtained as part of the international salmon monitoring initiative. Tissue will be analysed and population origins assigned to reference populations from Québec, the Maritimes and Maine, using 13 microsatellites markers. The impacts of fishing will then be estimated by evaluating the contribution of each of these base populations to the annual landings in Greenland. The project is a research thesis for a Masters program. | | |
| Dates during which research took place | 2006 – 2008 (samples collected in 2006 and 2007). | | |
| Area in which research took | Samples from West Greenland, analysis at Laval University, Quebec, | | |
| place | Canada | | |
| Estimated number and weight of salmon retained | N/A | | |
| Resources | | | |
| Estimated cost of the research project | £15,000 per annum. Project funded by research grants to Université de Laval (Bernatchez). Salaries for a sampler were provided by Quebec MNRF. Travel expenses for samplers to collect data were provided by Fisheries and Oceans Canada. | | |
| Number of participating scientists | 2 | | |
| Name and e-mail address of coordinating scientists in charge of project | Louis Bernatchez (Supervisor); Tim King (Co-supervisor) louis.bernatchez@bio.ulaval.ca | | |
| Details of research vessels, e.g. name, registration, call sign and description of vessel | N/A | | |
| Type and amount of gear and other equipment used | N/A | | |
| Details of any collaborating countries | N/A | | |
| Summary of Findings | | | |

| | Project No. | C13 | Status: | Completed | |
|--|-------------|-----|---------|-----------|--|
|--|-------------|-----|---------|-----------|--|

Summary of Findings

Samples were collected from the West Greenland fishery in August and September, 2006 and 2007 and were compared to historical samples. Analyses for genetic characterization were completed. Results show that the Southern Québec, Labrador and New-Brunswick regions contributed significantly more than the other regions of North America to the West Greenland Fishery. Regional contribution to the fishery was correlated with the regional MSW production.

Publication:

Gauthier-Ouellet M, Dionne M, Caron F, King TL, Bernatchez L. 2009. Spatio-temporal dynamics of the Atlantic salmon Greenland fishery inferred from mixed-stock analysis. Canadian Journal of

Fisheries and Aquatic Sciences, 66 : 2040-2051. The manuscript is available at: <u>http://pubs.nrc-cnrc.gc.ca/rp-ps/inDetail.jsp?jcode=cjfas&lang=eng&vol=66&is=12</u>

| Project No. | C14 | Status: | Completed |
|-------------|-----|---------|-----------|
|-------------|-----|---------|-----------|

| Party or relevant jurisdiction | Canada |
|--------------------------------|---|
| Title of project | Genetic population structure of Atlantic salmon in Eastern |
| | Canada and its implication for conservation |
| Objective of research project | This project aims at elucidating the genetic population structure of |
| | Atlantic salmon from a small (river) to a large (Eastern Atlantic |
| | coast) spatial scale and proposing conservation units for the Canadian |
| | distribution range. |
| Brief description of research | Samples from over 55 rivers in Quebec with additional sampling |
| project | from rivers in the southern Gulf of St. Lawrence and Labrador were |
| | obtained and their characteristics evaluated at multiple microsatellite |
| | loci. Further work was conducted on the variability in major histo- |
| | compatability complexes and its association with exposure to pathogens. |
| Dates during which research | The project began in 2004 - 2008 |
| took place | |
| Area in which research took | Rivers from Québec, Canada |
| place | |
| Estimated number and weight | N/A |
| of salmon to be retained | |
| Resources | |
| Estimated cost of the | £60,000. Project funded by research grants to Université de Laval |
| research project | (Bernatchez and Dionne) with support from Quebec MNRF. |
| | About £20,000 per annum |
| Number of participating | 2 |
| scientists | |
| Name and e-mail address | Louis Bernatchez |
| of coordinating scientists | louis.bernatchez@bio.ulaval.ca |
| in charge of project | Mélanie Dionne |
| | melanie.dionne@giroq.ulaval.ca |
| Details of research vessels, | N/A |
| e.g. name, registration, call | |
| sign and description of | |
| vessel | |
| Type and amount of gear | N/A |
| and other equipment used | |
| Details of any collaborating | N/A |
| countries | |

Summary of Findings

This project aimed at elucidating the genetic population structure of Atlantic salmon from a small (river) to a large spatial scale (Eastern Atlantic coast) and proposing conservation units for the Canadian distribution range. Results showed that most rivers are genetically differentiated from one another (mean $F_{st} = 0.05$, p < 0.001), suggested that in general each river in Eastern Canada represents a distinct population. However, genetic differentiation is also found within certain river systems such as the Moisie, Romaine and Restigouche, suggesting that populations can be identified at the tributary level. At a large spatial scale, seven genetic regions are identified in Eastern Canada. Genetic differentiation is found to be associated with temperature regime conditions, suggesting local adaptation in Atlantic salmon. Results have been published. <u>Publications:</u>

Dionne, M.; Miller, K. M; Dodson, J. J; Caron, F.; Bernatchez, L.; Sunnucks, P. 2007. Clinal variation in mhc diversity with temperature: evidence for the role of host-pathogen interaction on local adaptation in Atlantic salmon. Evolution Vol. 61(9) : 2154-2164.

Dionne. M., F. Caron, J. J. Dodson, and L. Bernatchez. 2008. Landscape genetics and hierarchical genetic structure in Atlantic salmon: the interaction of gene flow and local adaptation. Molecular Ecology 17: 2382–2396.

Dionne. M., F. Caron, J. J. Dodson, and L. Bernatchez. 2009. Comparative survey of within-river genetic structure in Atlantic salmon; relevance for management and conservation. Conserv. Genet. 10: 869–879.

Dionne M, Miller KM, Dodson JJ, Bernatchez L. 2009. MHC standing genetic variation and pathogen resistance in wild Atlantic salmon. *Philosophical Transactions of the Royal Society of London B*, 364: 1555-1565.

| Party or relevant jurisdiction | Canada |
|--|---|
| | |
| Title of project Objective of research project | Pelagic ecosystem survey of the Northwest Atlantic A marine pelagic trawl survey was conducted to sample the upper pelagic ecosystem during the period corresponding to the early postsmolt phase of Atlantic salmon (August and September). The survey design addressed hypotheses of post-smolt distribution (mixing of stocks, mixing of maturing and non-maturing components) and oceanographic features. Catches of post-smolts provided information on distribution and relative abundance of salmon at selected locations and times along the hypothesized ocean migration route. Data on relative abundance of other species, including macroplankton aggregations, provided information on the role of salmon within this larger pelagic ecosystem. Oceanographic |
| Brief description of research project | conditions would be examined relative to smolt catches. A Fisheries and Oceans Canada research vessel was used to the ecosystem components within the upper 20 m of the water column. Surface gillnets were deployed to assess size-selective catchability of the pelagic trawl and to validate trawl catchability. Catches of salmon were examined relative to geographic (latitude, longitude) and oceanographic (fronts, temperature, salinity) characteristics. These data will provide information on preferences and/or selection of the physical characteristics by salmon size / age groups. Catches and relative abundance of other species, including macroplankton aggregations, will provide information on the role of salmon within this larger pelagic ecosystem. |
| Dates during which research will take place | Research surveys were conducted during August 2008 and September 2009. |
| Area in which research will take place | In 2008, in the northwest Atlantic from just south of 49°N to 56°N, 49°W to 55°W. In 2009 in the northwest Atlantic between 56°N to 58°N, 45°W to 60°W |
| Estimated number and weight of salmon to be retained | In 2008, 15 post smolts, total weight = 3.5 kg. In 2009, catch of 63 post smolts and 22 non-maturing salmon, total weight = 85 kg. |
| Resources | |
| Estimated cost of the research project | For 2008:Total estimated cost excluding any analysis: £350,000£230,000. Fisheries and Oceans Canada Research vessel costexcluding science personnel (23 days @ £10,000)Science personnel costs (salary, overtime, operations)£70,000 Fisheries and Oceans Canada£10,000 MRNF Province of Québec (Canada)£40,000 US NOAAFor 2009:Total estimated cost excluding any analysis: £350,000£230,000. Fisheries and Oceans Canada Research vessel costexcluding science personnel (23 days @ £10,000)Science personnel costs (salary, overtime, operations)£70,000 Fisheries and Oceans Canada Research vessel costexcluding science personnel (23 days @ £10,000)Science personnel costs (salary, overtime, operations)£70,000 Fisheries and Oceans Canada |

| Project No. | C15 | Status: | Ongoing |
|-------------|-----|---------|---------|
|-------------|-----|---------|---------|

| | £10,000 MRNF Province of Québec (Canada) |
|------------------------------|---|
| | £40,000 US NOAA |
| | <u>For 2010</u> |
| | Analysis of samples collected in 2008 and 2009. |
| | Costing unknown to date |
| Number of participating | 6 scientists |
| scientists | Five from Atlantic DFO regions (Gulf, Maritimes, Newfoundland |
| XY 1 11 11 | and Labrador), one from US NOAA |
| Name and e-mail address | Gerald Chaput |
| of coordinating scientist | Chaputg@dfo-mpo.gc.ca |
| in charge of project | Dave Reddin |
| | Reddind@dfo-mpo.gc.ca |
| | Tim Sheehan |
| | tsheehan@mercury.wh.whoi.edu |
| Details of research | |
| vessels, e.g. name, | |
| registration, call sign and | |
| description of vessel | |
| Type and amount of gear | |
| and other equipment to be | |
| used | |
| Details of any collaborating | US NOAA |
| countries | |
| C C | |

During August 8 to 21, 2008, 46 stations were sampled with the pelagic surface trawl. The survey covered an area extending from just south of 49° N to 56° N, 49° W to 55° W. Very few (N=15) Atlantic salmon postsmolts were captured. Atlantic salmon were captured at 8 of the 46 stations (17%) and the majority (14 of 15 fish) were captured at stations north of 52° N. The stations with salmon catches were characterized by a wide range of water depths (about 250 m to >3,000m depth) and temperatures (less than 10°C to over 13°C). Salmon were only captured during the daytime. The salmon ranged in size from 23 to 31 cm.

For 2009, 21 sets were made in the Labrador Sea between 55[°] N and 58[°] N. Fourteen tows were made with the surface trawl and eight post smolt salmon were caught with the aquarium attached. No postsmolts were caught during tows without the aquarium. Different fishing techniques including adjustments to warp length, vessel speed, length of tow time and time of fishing were tried. Two night tows were done and 5 postsmolts caught. Two tows and one gillnet set were made in the colder water of the Labrador Current with no salmon caught. Seven drift net sets of 42 to 48 nets of varying mesh size (2.5-5 inch) were completed in the Labrador Sea. Eighty four salmon (61 post smolt, 23 adults) were caught with an average time of each set being approximately 16 hours. CTDs and plankton tows were done at stations where salmon were successfully captured.

In spite of the poor weather for fishing surface trawl and gillnets, the SALSEA program objectives of sampling the ecosystem components within the upper 20 m of the water column were achieved. The salmon that were intensively sampled when analysed will define the characteristics, origin, age, health, and diet of the salmon population in the northern Labrador Sea area. Stable isotope analysis will define the salmon's place trophically in the ecosystem. Other accomplishments were showing that salmon could be caught in the surface trawl at night and the high productivity and species diversity of the upper portion of the water column

in the Labrador Sea. No salmon were caught in sets on the shelf area influenced by the Labrador Current versus fishing sets in mid-Labrador Sea where salmon were commonly caught. Species caught during surface trawling included salmon, lumpfish, myctophids, jellyfish, amphipods, barracudina, squid, redfish, Atlantic saury, redfish and Greenland halibut. Most abundant species were lumpfish, myctophids, redfish, salmon and squid.

For 2010, various activities related to tissue processing and data analysis will be ongoing.

| Party or relevant jurisdiction | Canada |
|---|--|
| | Joint project of the Miramichi Salmon Association, Atlantic Salmon |
| | Federation, with collaboration from the Department of Fisheries and |
| | Oceans |
| Title of project | Miramichi River kelt movements and survival |
| Objective of research project | Document the spring movements and survival of post-spawning kelts |
| | from the Miramichi River system as they return to the sea, and |
| | subsequent return as repeat spawners. Use pressure-sensitive tags to |
| | record the depths used by the kelts. |
| Brief description of research | Sonic telemetry will be used to document the movements and |
| project | survival of salmon kelts as they move back to the ocean and across |
| Deter having addish many add | the Gulf of St. Lawrence. |
| Dates during which research will take place | 1 April 2009 to March 31 2011. |
| Area in which research will | Miramichi River, estuary, and Gulf of St. Lawrence |
| take place | Windmich River, estuary, and Oun of St. Lawrence |
| Estimated number and weight | Up to 25 kelts to be sonically tagged and released in 2009 |
| of salmon to be retained | op to 25 kens to be somethy tagged and released in 2007 |
| Resources | |
| Estimated cost of the | £25,000 |
| research project | direct costs for tags, student salary, operating expenses. Receiver deployment and other costs are covered under other projects. |
| Number of participating | 4 |
| scientists | |
| Name and e-mail address | Dr. F. Whoriskey |
| of coordinating scientist | fwhoriskey@asf.ca |
| in charge of project | |
| Details of research | na |
| vessels | |
| Type and amount of gear | Sonic telemetry arrays and charter/coastal vessels as described in |
| and other equipment to be | Canada ongoing project C2 Atlantic salmon smolt migration and |
| used | survival within Canadian rivers, estuaries and during the marine life |
| Details of any collaborating | stage. |
| countries | |
| Summery of Progress: | 1 |

Project No. C16 Status: Ongoing

Summary of Progress:

In spring 2008, 50 kelts in total from the two principal branches of the Miramichi River were marked with sonic tags. Twenty of the tags carried pressure and temperature sensors. Kelt movements were followed downstream of the freshwater marking point, and out of Miramichi Bay to the open sea. Three of the kelts returned to the river within three months, maturing apparently as consecutive spawners. Twenty two kelts were detected in the Strait of Belle Isle, en route to feeding grounds off Greenland. Three of these fish were additionally detected shortly after crossing the Strait of Belle Isle in a coastal receiver array maintained by Memorial University in Labrador. Tag lives (620 days minimum) should be sufficient to permit us to detect any of these fish should they survive return as alternate year spawners. Acoustic receivers have been overwintered in the river to detect any fish that may return very early in the season.

In 2009, 50 kelts were again tagged. Similar movements to those observed in the first year were

observed. These results are now being analyzed for submission as part of a MSc degree at McGill University, and for submission for publication.

In 2010, 25 kelts are planned to be tagged. For the first time, sonic receivers have been deployed in part of the Cabot Strait (by Dalhousie University's Ocean Tracking Network). These fish will give the first estimate of whether kelts use both the Strait of Belle Isle and the Cabot Strait during their migration.

| Party or relevant jurisdiction | Canada |
|--|---|
| Title of project | Marine survival of Canadian Atlantic salmon stocks: long-term monitoring |
| Objective of research project | Smolt production and adult return estimates are available for many salmon populations in Canada, from rivers (wild) and from hatcheries. In some cases, these time series extend to 30 years. |
| | Spatial and temporal trends in freshwater smolt production and in marine survival are monitored at the following sites: |
| | In DFO's Newfoundland Region, five (5) facilities: Campbellton River; Northwest River (Trepassey) and Rocky River; Conne River; Western Arm Brook, and Sand Hill River (Labrador). |
| | In DFO's Maritimes Region, smolts and return rates are monitored at four locations: Nashwaak River, Mactaquac dam on Saint John River, LaHave River (wild and hatchery), and St. Mary's River. |
| | In DFO's Gulf Region, four (4) facilities: two on the Miramichi River (Northwest and Southwest tributaries), Restigouche River, Margaree River |
| | In Quebec, Ministère des Ressources Naturelles et de la Faune (MRNF) has two (2) facilities on Rivière de la Trinité and Rivière St- Jean (Gaspé); in addition, stocked salmon survival is monitored on three (3) rivers: Rivière aux Rochers, Rivière a Mars, and Rivière Malbaie, the latter two in collaboration with CIRSA. |
| Brief description of research project | <i>Newfoundland:</i> Smolt and adult Atlantic salmon abundance is monitored by fish- counting fences or mark-recapture (Conne River smolts). Survival is determined both for smolt to small (< 63 cm) and MSW adult salmon returns. Biological characteristics (e.g. length, weight, condition, age etc.) of both life-stage components are collected along with additional information on run timing and environmental conditions. These data are periodically examined in relation to patterns of annual variation in marine survival of wild smolts. |
| | <i>Maritimes:</i> Continuation of a 30- and 25-year time series of marine survival for hatchery smolts released to the Saint John (Mactaquac) and LaHave River. Continuation of 6-year data series for wild smolt survival on the Saint John (Nashwaak trib) and LaHave River. |
| | <i>Gulf:</i> Smolt production and adult return estimates are obtained from the two branches of the Miramichi River. Biological characteristics are described and survival rates assessed relative to size of smolts, age, and sex of returning adults. Programme began in 1998 for the Northwest Miramichi and was extended to include the Southwest Miramichi in 2001. Smolt production is obtained from the Restigouche River and Margaree River. Biological characteristics are |

| | described including size of smolts, age, and sex ratios. Programme |
|--|--|
| | began in 2001 in Margaree River and 2002 in the Restigouche River. <i>Quebec:</i> |
| | Smolt trap to estimate smolt run by mark-recapture, counting adult |
| | return in a fishway (de la Trinité) or direct observation (St-Jean), characteristics of adult returns using recreational catch. |
| | For the MRNF projects, stocked smolt returns are determined by scale analysis of all returning adult salmon. This data permits estimation of sea survival of the stocked fish. For the CIRSA project stocked fish returns are determined by scale analysis (smolts) and genetic analysis (fry). Reproductive success is determined by genetic analysis. |
| Dates during which research will take place | April – November, annually |
| Area in which research will take place | On Canadian rivers named in 'objectives' section |
| Estimated number and weight | Generally not applicable, although in some studies a few smolts are |
| of salmon to be retained | retained (less than 500 overall) for biological sampling |
| Resources | |
| Estimated cost of the | Newfoundland (£362,000 sub-total): |
| research project | DFO - £209,000 per year, including overheads NGO Partners - £78,000 per year |
| | Maritimes (£27,000 sub-total): |
| | DFO - £21,500 per year, incl overheads |
| | NGO Partners - £5,500 per year (including Atlantic Salmon Federation for purchase of smolt wheels in Nashwaak River) |
| | Gulf (£109,000 sub-total): DFO - £73,000 per year (includes DFO operating costs, capital investment and salaries, incl overheads) Partners: £36,000 spent in 2001/02 by NGO partners (Atlantic Salmon Federation, Northumberland Salmon Protective Association, Miramichi Salmon Association, First Nations) for capital acquisitions, and O&M for assistance. Same level of support anticipated in 2006-2007 |
| | Quebec (£141,500 sub-total): |
| | MRNF - £41,500 per year, incl overheads Hydro Quebec – £22,200 per year |
| | CIRSA - £77,800 per year |
| | Canada Total - £639,500 per year |
| Number of participating scientists | Newfoundland (5), Maritimes (3), Gulf (3), Quebec (10) |
| Name and e-mail address of coordinating scientist in charge of project | C. Bourgeois (Rocky River), B. Dempson (Conne River; Northeast Brook, Trepassey), G. Veniott (Western Arm Brook), D. Reddin (Campbellton & Sand Hill rivers), T. Goff, R. Jones, J. Gibson |
| | (Maritimes), C. Breau, P. Cameron, G. Chaput (Gulf) |

| | For information, contact: G. Chaput, Chaputg@dfo-mpo.gc.ca |
|------------------------------|---|
| Details of research | N/A |
| vessels | |
| Type and amount of gear | Smolt and adult traps in fishways and fences, trap nets, rotary screw |
| and other equipment to | smolt traps. |
| be used | |
| Details of any collaborating | |
| countries | |

Newfoundland: (Dempson, Reddin, Veinot)

All five monitored rivers were maintained in 2009. Smolt production data and return rates from smolts in 2008 are being compiled.

Maritimes: (J. Gibson)

Simultaneous monitoring of both wild smolt migrations and adult returns was maintained at four locations: the Nashwaak River, the LaHave River, St. Mary's River and the Big Salmon River. Return rates for hatchery smolts are presently being obtained at Mactaquac and on the Big salmon River, although releases of hatchery smolts have been reduced with the increased emphasis on exposure to wild environments. These data together indicate a major downward shift occurring after 1990 that has affected both wild and hatchery salmon. The information collected for these populations provides data for age-structured, life history models, which when combined with information about freshwater productivity, are being used to assess persistence and recovery strategies for this stocks. Values of smolt production in 2009 and return rates from smolts in 2008 are presently being compiled.

Gulf: (G. Chaput)

Smolt production from rivers in the southern Gulf was maintained at four locations, as in previous years. Freshwater production estimates in most rivers indicate that freshwater production rates are not the factor constraining adult salmon abundance in this region. Values for 2009 are presently being compiled.

Quebec: (M. Dionne)

Smolt monitoring continued at the two index rivers in 2009. Smolt production values and return rates from 2008 smolts are presently being compiled.

| Project No. C18 | Status: Ongoing |
|--|---|
| Party or relevant jurisdiction | Canada NGO (Atlantic Salmon Federation), DFO (Gulf and Newfoundland Regions) and Province of Québec collaboration |
| Title of project | Atlantic salmon smolt migration and survival within Canadian rivers, estuaries and during the marine life stage |
| Objective of research project | Provide a time series of stage-specific estimates of mortality rates for smolts and post-smolts at various points of their at-sea migration, including for their transitions through fresh water, the estuary and to various points in the ocean. |
| | Examine the relation between biological characteristics of the fish and survival rates to attempt to isolate mortality causes. |
| | Document the migration pathways and speeds of smolts from different rivers. |
| Brief description of research project | Smolts are captured in smolt wheels in fresh water and fitted with acoustic tags. Acoustic receiving arrays are positioned in rivers, at the head of tide, and at the exit of the estuary and in the Strait of Belle Isle. Additional receivers will be placed at points of opportunity. In 2010 the Cabot Strait from Saint Paul's Island to Cape Breton has been fitted with an acoustic line This line is being funded by the Ocean Tracking Network (OTN) based out of Dalhousie University. |
| Dates during which research will take place | 2003 – present (spring/summer) |
| Area in which research will take place | Miramichi River and estuary; Restigouche River and Baie des Chaleurs; Cascapedia River and estuary; St-Jean (Côte-Nord) River and estuary; Western Arm Brook, Strait of Belle Isle, Cabot Strait, Labrador, West River, Sheet Harbour. |
| Estimated number and weight of salmon to be retained | |
| Resources | |
| Estimated cost of the research project | Approx. £125,000 for operations, salaries and acoustic tags Approx. £75,000 for receiver arrays |
| | Approx. £100,000 for smolt wheels (Partner contribution: 8 wheels and their operation) |
| | Total Approx. £300,000 per annum |
| | Principal Supporting Partners: DFO Miramichi Salmon Association |
| | Bowater US NOAA Fisheries |
| Number of participating scientists | 8 |
| Name and e-mail address | Fred Whoriskey |
| of coordinating scientist | fwhoriskey@asf.ca |

| in charge of project | |
|------------------------------|---|
| Details of research | Small boats (20 feet in length) |
| vessels, | Chartered fishing vessel (approx 35 feet) for gear deployment |
| | |
| Type and amount of gear | Up to 200 VR 2 acoustic receivers |
| and other equipment to | 309 acoustic tags |
| be used | |
| Details of any collaborating | Data sharing underway with US NOAA Fisheries tracking programs. |
| countries | |
| C CD | |

The study now encompasses five rivers spanning a south-to-north latitudinal difference of about 700 km. This provides the opportunity for a test of the hypothesis that early smolt survivals in southern rivers where populations are most depressed are worse than those rivers further north. For the Miramichi and Restigouche Rivers, seven and six years of data respectively have been collected, whereas five or less years of data are available for the other sites. Results for the Miramichi and Restigouche have been consistent among years. In the Miramichi system, smolt survival through freshwater is generally high (about 90%), with about 50% of the tagged smolts surviving to exit the estuary to the sea. In the Restigouche River, mortality in fresh water was higher than in the Miramichi River, and heavy losses occurred in the estuary, resulting in about 30% of the smolts surviving to exit the river and its associated estuary to the sea. Significant fractions of the post-smolts from the Miramichi, Restigouche and Cascapedia Rivers have now been documented using the Strait of Belle Isle to exit the Gulf of St. Lawrence. Margaree River fish also use this pathway.

| Troject No. C19 | Status. Ongoing |
|---|---|
| Party or relevant jurisdiction | Canada, US |
| Title of project | Stable isotope ratios to infer trophic structure and condition of Atlantic salmon during their life at sea |
| Objective of research project | Marine ecology of these fish could be advanced through studies of trophic state and condition. The questions to be addressed include: Are trophic states of 1SW non-maturing fish similar between NAC and NEAC origin salmon? Are trophic states of 1SW non-maturing fish different from that of 1SW maturing of the same cohort? Can this tell us anything about when these different maturity groups separate in the North Atlantic? Has there been a trophic state change between West Greenland and when these fish finally return to home rivers as 2SW salmon? |
| Brief description of research project | A complete cohort of Atlantic salmon will be tracked from the time they leave the rivers to their return to rivers two years later as 2SW salmon. Smolts will be sampled from the broad geographic range of rivers in eastern North America to characterize their stable isotope signatures as they enter the sea. Stable isotope signatures will be characterized from post-smolts from the marine surveys followed by 1SW maturing and non-maturing salmon as they return to rivers or during their feeding migrations at West Greenland. This will be followed by sampling 2SW salmon upon their return to homewaters. The present sampling program at West Greenland includes the purchase of whole fish specifically for disease sampling. Additional tissue sampling of these fish would be conducted including muscle, liver and caudal fin punches. Liver and muscle samples would be analysed for lipid and stable isotope ratios. Caudal punches would be analysed for stable isotope ratios. Caudal punches can be collected without lethal sampling and would therefore be collected from sacrificed fish to permit calibration to the other tissues to allow sampling of survivors of 1SW and 2SW salmon back in home waters. |
| Dates during which research will take place | Tissue samples from smolts collected in spring 2008. Post-smolts were sampled in the Labrador Sea in August 2008. West Greenland samples will be collected in August and September 2009. 1SW maturing samples will be collected in summer 2009. 2SW salmon samples will be collected in summer 2010. |
| Area in which research will take place | Sampling will occur at West Greenland and from salmon returning to the index rivers of eastern Canada |
| Estimated number and weight of salmon to be retained | Sampling program at West Greenland includes the purchase of whole fish specifically for disease sampling. Additional tissue sampling of these fish would be conducted and therefore no additional fish are to be retained. Tissue samples from 1SW and 2SW salmon in the Miramichi will be collected preferentially from First Nations food fisheries. Target sample size for tissue sampling is 50 fish per age group. |

Project No. C19 Status: Ongoing

| Resources | | | | |
|------------------------------|---|--|--|--|
| Estimated cost of the | Purchase of fish at West Greenland accounted for in ongoing project | | | |
| research project | D1 (Denmark) | | | |
| | Laboratory analysis in winter 2010: | | | |
| | Smolt tissue sample analyses: £18,000, funded by International | | | |
| | Atlantic Salmon Research Board | | | |
| | Samples to be processed at cost at U. of Waterloo, Canada | | | |
| Number of participating | Lead scientists: | | | |
| scientists | Gerald Chaput. Brian Dempson (DFO Canada) | | | |
| | Mike Power U. of Waterloo (Canada) | | | |
| | Tim Sheehan (US NOAA) | | | |
| Name and e-mail address | Gerald Chaput : chaputg@dfo-mpo.gc.ca | | | |
| of coordinating scientist | Tim Sheehan : Tim.Sheehan@noaa.gov | | | |
| in charge of project | | | | |
| Details of research | Not applicable | | | |
| vessels | | | | |
| Type and amount of gear | Not applicable | | | |
| and other equipment to be | | | | |
| used | | | | |
| Details of any collaborating | Denmark (in respect of the Faroe Islands and Greenland) | | | |
| countries | | | | |
| Summary of Progress | | | | |

Smolts were collected from 15 index rivers in eastern Canada in May and June 2008 : LaHave, Margaree (Nova Scotia), Nashwaak, Southwest Miramichi, Little Southwest Miramici, Kedgwick, Upsalquitch (New Brunswick), Saint-Jean, de la Trinité (Québec), Conne, Rocky, Campbellton, Exploits, Western Arm Brook (Newfoundland), Sand Hill River (Labrador). Tissues (liver, dorsal muscle, adipose, caudal fin, scales) were collected from 50 fish per river. Tissues have been dried and are awaiting processing at the U. of Waterloo laboratory in winter 2010. Tissues will be analysed for C and N ratios.

Similar tissues from the 15 post-smolts captured in August 2008 have been collected and will be processed as above.

Similar tissues (liver, dorsal muscle, adipose, caudal fin, scales) from the 63 post-smolts and 22 adult salmon captured in September 2009 have been collected.

The extended sampling program at West Greenland collected similar tissues from 450 non-maturing 1SW salmon from West Greenland in 2009.

Scale and adipose fin tissue were collected from up to 30 individual 1SW maturing salmon from 13 rivers in eastern Canada in 2009.

Preliminary results should be available for the Scientific Advisory Group meeting in June 2010.

| Party or relevant jurisdiction | Canada | | | |
|--|---|--|--|--|
| Title of project | Identification of essential habitat for repeat spawning Atlantic salmon of Inner Bay of Fundy origin | | | |
| Objective of research project | To identify the freshwater and marine habitats used by possisteen spawning Atlantic salmon of inner Bay of Fundy (iBoF) origin for reconditioning until their return as repeat spawners, and identify the sites and times of mortality for those that fail to return. | | | |
| Brief description of research project | The project is part of an overall strategy to use telemetry to identify the marine habitat used by iBoF salmon (the most obvious data gap). Satellite tags can be used immediately on large salmon (kelts) to help fill this gap until the Ocean Tracking Network (OTN) establishes monitoring arrays (2009–2011) for acoustic tags that can be used on small salmon (postsmolts). | | | |
| Dates during which research will take place | September, 2008 – December, 2010 | | | |
| Area in which research will take place | Primarily the Big Salmon River but possibly other inner Bay of Fundy rivers (i.e. Stewiacke) as well as the Saint John River + Bay of Fundy. | | | |
| Estimated number and weight of salmon to be retained | None | | | |
| Resources | | | | |
| Estimated cost of the research project | Expenditures to date and for 2009-2010: £30,000 Fisheries and Oceans Canada: personnel, satellite tags, operating costs In-kind contributions from Fort Folly First Nation. | | | |
| Number of participating scientists | 2 | | | |
| Name and e-mail address of coordinating scientist in charge of project | Dr. Gilles Lacroix <u>Gilles.Lacroix@dfo-mpo.gc.ca</u> Ross Jones <u>Ross.A.Jones@dfo-mpo.gc.ca</u> | | | |
| Details of research vessels, e.g. name, registration, call sign and description of vessel | Not applicable | | | |
| Type and amount of gear and other equipment to be used | Seine nets, angling gear and Rotary Screw trap Acoustic receivers and tags (freshwater component) Satellite tags (marine component) | | | |
| Details of any collaborating countries | None to date | | | |

Project No. C20 Status: Ongoing

Atlantic salmon kelts from three different regions of the Bay of Fundy were tagged with pop-up satellite archival tags (PSATs) with 4-month pop-off delay as they left the rivers in the fall and spring for reconditioning at sea. Tags from 15 of 20 kelts tagged in 2008-2009 (75%) reported some data. Kelts from one region migrated thousands of kilometers to the northern edge of the Labrador Sea and as far east as the Flemish Cap, whereas those from the other two regions remained in the Bay of Fundy and Gulf of Maine. Detailed migration tracks were obtained from the archived light data (geo-positioning using sunrise and sunset times and day length). Preliminary examination of the water temperature and depth data archived at 2-15 min intervals revealed some interesting and common behaviour. Although kelts encountered a wide temperature range $(-1^{\circ}C \text{ to } 20^{\circ}C)$ they tended to exploit areas within a narrow range (5-10°C). Kelts spent most of their time near the surface (depth ≤ 2 m) while migrating but there were nevertheless frequent diel periods of repeated diving to 25-50 m, possibly associated with feeding. There were also occurrences of deep diving in the 100-500 m range (maximum depth 700 m). Mortality during migration was high and the archived parameters revealed that predation was a frequent cause. Changes in diving behaviour and temperature also allowed for identification of a common predator (fish with thermoregulation capabilities) for several cases in the Gulf of Maine.

| Project No. C21 Status: Ongoing - New | / Entry |
|---------------------------------------|---------|
|---------------------------------------|---------|

| Party or relevant jurisdiction | Canada | | | | |
|--|--|--|--|--|--|
| Title of project | Genomic basis of adaptive divergence and marine survival | | | | |
| | among Atlantic salmon populations | | | | |
| Objective of research project | Elucidate the genetic basis of adaptive divergence and marine survival in Atlantic salmon populations from eastern Canada. Contribute to the identification of management units. | | | | |
| Brief description of research project | This project aim at creating a genetic database across eastern Canada populations by resolving the genetic structure of populations using the same genetic markers across the study area. Moreover, with the use of recent genomic resources developed for Atlantic salmon, it will identify genes under selection and environmental factors responsible for the genetic divergence between populations. Finally, these ressources will help identify the genetic basis of high marine mortality during the first years at sea. | | | | |
| Dates during which research will take place | 2010-2013 | | | | |
| Area in which research will take place | Eastern Canada: Québec, Maritimes, Newfoundland and Labrador | | | | |
| Estimated number and weight of salmon to be retained | Salmon samples have already been collected through another project | | | | |
| Resources | | | | | |
| Estimated cost of the research project | £193,600. Funded by the Natural Sciences Engineering Research Council of Canada (NSERC), the Ministère des Ressources naturelles et de la Faune (MRNF) and the Réseau Aquaculture Québec (RAQ) | | | | |
| Number of participating scientists | 3 | | | | |
| Name and e-mail address of coordinating scientist in charge of project | Louis Bernatchez, supervisor, Louis.Bernatchez@bio.ulaval.ca Mélanie Dionne, co-supervisor, Melanie.Dionne@mrnf.gouv.qc.ca Patrick O'Reilly, coordinator, OReillyP@mar.dfo-mpo.gc.ca Vincent Bourret, PhD student, vincent.bourret.1@ulaval.ca | | | | |
| Details of research vessels, e.g. name, registration, call sign and description of vessel | | | | | |
| Type and amount of gear and other equipment to be used | | | | | |
| Details of any collaborating countries | Norway: the centre for integrative genetic (CIGENE) developed some of the genomic ressource that will be used in this project USA: tissue samples from Greenland fisheries | | | | |
| Summary of Progress | | | | | |
| New entry. | | | | | |

2. DENMARK (IN RESPECT OF THE FAROE ISLANDS AND GREENLAND)

Faroe Islands

The Faroese Fisheries Laboratory is collaborating in a number of projects detailed in the returns made by other Parties.

Greenland

| Project No. D1 | Status: Ongoing | | |
|--|---|--|--|
| Party or relevant jurisdiction | Greenland West Greenland Salmon Fishery Sampling Programme | | |
| Title of project Objective of research project | Continue the time series of data (1969-2008) on the continent of origin and biological characteristics of the salmon in the West Greenland Fishery; Provide data on mean weight, length and continent of origin for input to the North American and European run-reconstruction models; Collect information on the recovery of internal and external tags; Collect other additional biological samples as required. In addition to the long-term baseline sampling under the West Greenland Fishery Sampling Programme, samples from fresh whole fish are being collected under the SALSEA-West Greenland project (see project U6) | | |
| Brief description of research project | One of the key data inputs to international stock assessments of Atlantic salmon is the origin of Atlantic salmon harvested in mixed stock fisheries. The Parties to the West Greenland Commission of NASCO have, therefore, worked cooperatively over the past three decades to collect biological data on Atlantic salmon harvested at West Greenland. The sampling programme collects biological data, scale and tissue samples, and information on tags and marks from Atlantic salmon caught in the commercial fishery at West Greenland. Under the NASCO 2009 West Greenland Sampling Agreement (WGC(09)5), Parties to the NASCO West Greenland Commission agreed to provide staff to sample catches of Atlantic salmon in the West Greenland fishery during the 2009 fishing season. The sampling programme collects: Biological characteristics data including lengths and weights of landed fish; Information on tags, fin clips and other marks; Scale samples to be used for age and growth analyses; Other biological data requested by the ICES scientists and NASCO co-operators. | | |

| Dates during which research will take place | Annually during the fishing season, usually August – October |
|---|---|
| Area in which research will take place | Sisimiut, Nuuk and Qaqortoq, Greenland |
| Estimated number and weight of salmon to be retained | |
| Resources | |
| Estimated cost of the research project | Greenland - approximately £9,000 per annum (includes salaries, travel, lodging and equipment) Canada - £7,000 per annum (excludes costs of scale sample and data analyses) EU (United Kingdom) - £24,000 per annum (includes staff costs, travel and subsistence, and equipment) EU (Ireland) - £6,200 per annum USA - £42,000 per annum £88,200 |
| Number of participating scientists | 1 technician and 1 scientist from Greenland working with scientists from Canada (1), USA(2), EU-UK (2) and EU-Ireland (1) |
| Name and e-mail address of coordinating scientist in charge of project | Helle Siegstad helle@natur.gl |
| Details of research vessels, e.g. name, registration, call sign and description of vessel | None |
| Type and amount of gear and other equipment to be used | Standard sampling equipment Standard genetics laboratory equipment |
| Details of any collaborating countries | Collaborative project with investigators from US (T. Sheehan), the United Kingdom (T. Potter and J. MacLean), Ireland (N. Ó Maoiléidigh) and Canada (G. Chaput and D. Reddin). The work is coordinated via NASCO and is reported to ICES (Working Group on North Atlantic Salmon). |

In 2009, the sampling programme included sampling teams from Greenland, United States, Canada, Scotland, England and Wales, and Ireland. Teams were in place at the start of the fishery on 1 August and continued until 31 October. In total, approximately 1,660 specimens were sampled for presence of tags, fork length, weight, scales, and tissue samples for DNA analysis. Samples were obtained from three landing sites: Sisimiut (NAFO Division 1B), Nuuk (1D), and Qaqortoq (1F). The sampled salmon were measured, scales were removed for ageing, and gutted weight recorded. Approximately 1,660 scale samples were collected and aged by Canadian collaborators and approximately 1,640 tissue samples were removed for DNA analysis with US collaborators.

3. EUROPEAN UNION

| U | Sutus. Completed | | |
|--|--|--|--|
| Party or relevant jurisdiction | European Union | | |
| Title of project | SALMODEL Concerted Action - A co-ordinated approach towards the development of a scientific basis for management o wild Atlantic salmon in the north-east Atlantic | | |
| Objectives of research project | - To improve our ability to set salmon conservation limits (CLs); addressing transportability and dynamic change issues, also taking into account underlying stock structure, and; | | |
| | - To examine methods of estimating pre-fishery abundance (PFA) for north-east Atlantic (NEAC) salmon stocks and to determine whether and how PFA estimates can be used to give catch advice. | | |
| Brief description of research project (Note: only the PFA/marine side of the project is reported here) | Development of catch advice for NEAC salmon in distant water fisheries depends critically on availability of methods of assessing stock status in advance of fishing and relating this to conservation requirements in rivers of origin. SALMODEL aimed to provide improvements to the existing interim methods of developing catch advice at ICES (which do not have predictive capability for NEAC stocks) and to explore and evaluate options for developing fully predicative PFA models. Two workpackages addressed these areas: | | |
| | Workpackage 4: - examined current models used to estimate PFA, including that used by ICES | | |
| | - valuated the quality of historic data used to run the ICES PFA model | | |
| | - assessed sensitivity of the model to data types and variation, and tested assumptions of incorporation of natural mortality "m" into PFA models | | |
| | -evaluated the basis of the NEAC stock groupings being used in the catch advice process. | | |
| | Workpackage 5: -evaluated options for developing a predictive PFA model from the historic time series employing environmental and other data, producing for the first time forecasts of PFA of southern European stocks at West Greenland | | |
| | -investigated forward-running predictive PFA models based on smolt production estimates/indices for the NEAC area | | |
| | -examined approaches for model validation | | |
| | -examined scales at which the various model types can be applied | | |

Project No. E1 Status: Completed

| Dates during which research | 2000-2002. Project completed 31/12/02, draft final report sent to | | | |
|---|---|--|--|--|
| took place | European Commission March 2003. | | | |
| Area in which research took place | Work was progressed via formal meetings, topic-specific workshop and co-operative studies; no field studies were involved. | | | |
| Estimated number and weight of salmon retained | Not applicable | | | |
| Resources | | | | |
| Estimated cost of the research project | £500,000 in total | | | |
| Number of participating scientists | 17 European members; 2 Canadian participants; + invited external experts | | | |
| Name of coordinating scientist in charge of project | Dr Walter Crozier | | | |
| Details of research vessels, e.g. name, registration, call sign and description of vessel | Not applicable | | | |
| Type and amount of gear and other equipment to be used | Not applicable | | | |
| Details of any collaborating | UK (E&W Scotland, N. Ireland); France; Ireland; Norway; Sweden; | | | |
| countries | Finland; Iceland; Canada | | | |
| Summary of Progress This will be provided as a sep | arate document to NASCO (CNL(03)9). Briefly, SALMODEL has: | | | |
| - examined current mo | dels used to estimate PFA, including that used by ICES | | | |
| | f the ICES model to data types and variation, and tested assumptions of iral mortality "m" into PFA models, this resulting in a change to the used at ICES | | | |
| - SALMODEL also ev advice process | aluated the basis of the NEAC stock groupings being used in the catch | | | |
| employing environm | or developing a predictive PFA model from the historic time series ental and other data, producing for the first time forecasts of PFA of pocks at West Greenland | | | |
| - investigated predictiv | ve PFA models based on smolt production estimates/indices for the | | | |
| - examined approaches | for model validation and examined scales at which the various model | | | |

| Project No. E2 | Status: Ongoing | | |
|--|--|--|--|
| Party or relevant jurisdiction | European Union - (consortium of 20 partners) | | |
| Title of project | SALSEA-Merge - Advancing understanding of Atlantic salmon at sea: Merging genetics and ecology to resolve stock-specific migration and distribution patterns. | | |
| Objective of research project | The overall objective of SALSEA-Merge is, by merging genetic and ecological investigations, to advance understanding of stock specific migration and distribution patterns and overall ecology of the marine life of Atlantic salmon and gain an insight into the factors resulting in recent significant increases in marine mortality. | | |
| Brief description of research project | SALSEA-Merge comprises seven work packages including: development of genetic identification methodology; marine data acquisition through a series of marine surveys in the north-east Atlantic; genetic identification of stock origin of samples collected; biological analysis of samples including analysis of scale samples (historic and contemporary), diet analysis and assessment of condition; merging and analysis of genetic, biological and oceanographic data. | | |
| Dates during which research | April 2008 – October 2011 | | |
| will take place | (marine surveys in 2008 and 2009) | | |
| Area in which research will take place | North- East Atlantic with marine surveys conducted west of Ireland and the UK, around the Faroes, the Norwegian Sea and western Barents Sea. Laboratory analysis of contemporary and historic samples. | | |
| Estimated number and weight of salmon to be retained | All salmon sampled during the marine surveys will be retained. Approximately 900 fish each year, predominantly postsmolts. | | |
| Resources | | | |
| Estimated cost of the research project | Euro 5.5million (£5.5million) over 3 years with Euro 3.5million (£3.5million) funded through the EU Seventh Research Framework Programme (FP7) and Euro 2million (£2million) contributed by the programmes scientific and private sector partners. The Atlantic Salmon Trust is funding the scientific coordinator's post £50,000 (Euro 50,000) per annum and the TOTAL Fondation is contributing Euro 100,000 (£100,000) to the Faroese marine surveys in both 2008 and 2009. | | |
| Number of participating scientists | | | |
| Name and e-mail address of coordinating scientist in charge of project | Scientific Coordinator - Jens Christian Holst jens.christian.holst@imr.no Project Coordinator – Merethe Flatseth merethef@IMR.no | | |
| Details of research vessels, e.g. name, | <i>RV</i> Celtic Explorer, <i>RV</i> Celtic Voyager, <i>RV</i> Magnus Heinason, <i>RV</i> Johan Hjort, <i>FV</i> Eros, <i>FV</i> Libas | | |

| registration, call sign and description of vessel | | | |
|--|--|---|-----------------|
| Type and amount of gear and other equipment to be used | Pelagic trawls, Pelagic Live Capture Trawls (Fish-Lift), CTD, plankton sampling equipment, genetic analysis. | | |
| Details of any collaborating countries | The SALSEA-Me | rge consortium comprises 20 partn | ers as follows: |
| | Participant No. | Organization Name. | Country. |
| | 1 (Co-ordinator). | Institute of Marine Research (IMR). | Norway. |
| | 2. | Marine Institute (MI). | Ireland. |
| | 3. | Fisheries Research Services (FRS) (now Marine Scotland Science). | UK. |
| | 4. | Norwegian Institute for Nature Research (NINA). | Norway. |
| | 5. | University of Exeter (UE). | UK. |
| | 6. | National University of Ireland, Cork (NUIC). | Ireland. |
| | 7. | Queen's University Belfast (QUB). | UK. |
| | 8. | University of Wales, Swansea (UWS). | UK. |
| | 9. | Danish Institute for Fisheries Research (DIFRES). | Denmark. |
| | 10. | Institute of Freshwater Fisheries (IFL). | Iceland. |
| | 11. | University of Turku (UT). | Finland. |
| | 12. | University of Oviedo (UO). | Spain. |
| | 13. | Geneindex (GENI). | France. |
| | 14. | Finnish Game and Fisheries Research Institute (FGFRI). | Finland. |
| | 15. | *Faroese Fisheries Laboratory (FFL). | Faroes. |
| | 16. | *Atlantic Salmon Trust (AST). | UK. |
| | 17. | * NASCO's International Atlantic Salmon Research Board (IASRB). | UK. |
| | 18. | *Total Foundation (TOTAL). | France. |
| | 19. | *Conservatoire National du Saumon Sauvage (CNSS). | France. |
| | 20. | *Loughs Agency. | UK. |
| | * Non-contracting | | |

2008:

SALSEA-Merge as an EU FP-7 project, formally commenced on 1 April 2008, but before that, in February 2008, an international SALSEA-SALMAN II Genetics Symposium and Workshop was arranged by IASRB in Paris with sponsorship from the Total Foundation. The symposium reviewed the state of the art within the field of salmon genetics and the possibilities of developing genetic techniques to support the SALSEA-Merge project. The workshop went into the planning of the project and strategies were developed with regard to the work both on the genetic baseline of European salmon stocks, the construction of a common European genetic salmon database, the optimisation of the standardised set of genetic markers to be used by the labs involved and the first preliminary organising of the seagoing sampling.

In March, the marine data acquisition group met in Copenhagen to plan the marine surveys and sampling strategies in detail. The meeting developed a common plan for the four surveys focusing on intercepting the high concentrations of north-ward migrating post-smolts along the strong currents on

the shelf edge The plan developed in Copenhagen was later followed in detail by the vessels.

RV Celtic Voyager carried out the first survey during May 10-15 and sampled the areas west off Ireland and Scotland between 55°N and 57°N. The survey was very successful with 76 post-smolts caught.

The SALSEA-Merge launch meeting was held in Sligo, Ireland, during 14-15 May. The second survey, by *RV* Celtic Explorer, was launched from Killibegs 16 May which also promoted the official launch of the SALSEA-Merge seagoing activities with participation by the Deputy Prime Minister and broad media coverage. The *RV* Celtic Explorer surveyed the shelf edge current west off the British Isles from 56°N to almost 62° N during the period 16–24 May The total catch was 358 postsmolts.

The Faroese survey by *RV* Magnus Heinason was the third survey, and it took place during the period 2-16 July in the areas around 65°N-69°N along and north of the Vøring plateau in the Norwegian Sea. This is an area of high post-smolt abundance because of a very narrow migration corridor. The vessel caught 363 salmon, further underlining the success of the sampling strategy put out in Copenhagen.

The Norwegian FV Eros left Longyeartown in Spitzbergen on 26 July and surveyed the northern Norwegian Sea from 77°N south to Tromsø at 70°N on 9 August. In these northern areas the concentrated transport migration phase in the shelf edge current is over and the fish spread out over a vast area. This leads to much lower concentrations which are reflected in the lower catch of 88 post-smolts despite a large trawling effort.

In August, a genetic planning and strategy meeting was held at Stansted, London. The meeting focused in particular on choosing the genetic markers to be used in SALSEA-Merge and on different aspects of the future genetic work. The planning of the database was advanced, as was the work on the common European genetic salmon baseline.

In September, a workshop on scale reading was organised in Trondheim, Norway. The focus of the meeting was training and standardising the measuring and reading technique to be used by the SALSEA-Merge partners.

2009:

The 2009 General Assembly was held in Bergen 5-7 March, combined with internal planning meetings for the Genetics and Sea groups.

The survey activities continued in 2009, with 2 Irish, one Faroese and two Norwegian surveys. The first survey was carried out by the RV Celtic Voyager during 9 -12 May on the shelf edge off western Ireland and western Scotland. The survey was severely hampered by bad weather and only 9 post-smolts were caught in 9 hauls.

The second survey by the *RV* Celtic Explorer took place during 23 June - 2 July on the western edge of the Voering plateau at about 67-68°N, 2°E. During a hectic four day period 15 trawl hauls were made and in total 465 salmon were caught under very good weather conditions.

The third survey was carried out by the Faroese *RV* Magnus Heinasson in the Norwegian Sea between 66-69 °N, 1°W to 4 °E during the period 1-5 July. This survey also took place under very favourable conditions and in total 342 salmon were caught.

The fourth and fifth surveys were carried out by the Norwegian vessels FV Libas and FV Eros during the period 15 July - 6 August. Eros made experiments with the 'Continuous video trawl' system (CVT) and did not catch salmon while FV Libas caught 87 salmon in total.

2010:

The Steering Group met in London during 13-15 January 2010 focusing on administrative, financial and practical issues that have a bearing upon the management of the SALSEA-Merge project.

| Party or relevant jurisdiction | European Union – Denmark |
|--|--|
| Title of project | Estuarine migration of smolts in the Rivers Skjern Å (North Sea) and River Guden Å |
| Objective of research project | |
| Brief description of research project | |
| Dates during which research will take place | |
| Area in which research will take place | |
| Estimated number and weight of salmon to be retained | |
| Resources | |
| Estimated cost of the research project | |
| Number of participating scientists | |
| Name of coordinating | Gorm Rasmussen |
| scientist in charge of project | gr@dfu.min.dk |
| Details of research vessels, e.g. name, | |
| registration, call sign and description of vessel | |
| Type and amount of gear and other equipment to | |
| be used | |
| Details of any collaborating countries | |

Project No. De1 Status: Completed

Summary of Findings

In Skjern Å estuary we have demonstrated very high smolt mortalities during two research seasons caused by cormorants (28 and 44%). European rivers and their floodplains are generally severely affected by human activity. As a consequence, both the water and the river habitat quality have been seriously degraded in numerous European rivers during the twentieth century. In Denmark less than 5% of the rivers have been left in a natural physical state. During the 1960s the lower part of River Skjern Å was regulated and adjacent bogs, ponds, marshes and meanders drained. In the beginning of the 1990s the Danish government decided to restore the River Skjern Å and its floodplain and in 2002 the River Skjern Nature Project was implemented. The project consisted of several parts, including returning the straight, regulated river back to its former meanders and introducing better hydraulic interaction between the river and its meadows. Before implementation of the restoration project the causes of mortality of wild salmon Salmo salar and trout Salmo trutta smolts in River Skjern Å and its estuary Ringkøbing Fjord were investigated in 2000. A follow-up comparable study was performed in the spring of 2002 after the majority of the project was implemented, aimed towards assessing the effect of the restoration project on the salmon and trout smolt runs. This study indicated that the river restoration had an indirect slightly negative effect on the smolt run, mediating bird predation within the river system. As also demonstrated in 2000, bird predation in the estuary had a major adverse effect on the smolt run and jointly the smolt mortality in the river and in the estuary may threaten a self-sustaining salmon population in River Skjern Å.

In the River Guden Å and its estuary the migration of salmon smolts was investigated in 2002 and 2003 by acoustic telemetry.

| Project No. De2 | Status: Completed |
|--|--|
| Party or relevant jurisdiction | European Union – Denmark |
| Title of project | Mortality of Atlantic salmon smolts during estuary migration |
| Objective of research project | The main objective of the research is to estimate mortality of salmon smolts during migration through estuaries and to compare the return ratio of wild, stocked ¹ / ₂ - and one-yearlings. |
| Brief description of research project | Since 2001 all salmon stocked (30,000 ¹ / ₂ - and 62,000 1-yearlings annually) in River Skjern Å are microtagged and adipose fin clipped, in order to distinguish between wild and hatchery-reared smolts in a planned study in 2005 (using rotary screw traps). Since 1996, the spawning run has been estimated yearly (mark-recapture method). Thus in the future it will be possible to distinguish between wild and hatchery-reared fish. A similar programme is planned in the River Storå in 2007. |
| | Previously high smolt mortalities during estuarine migration through the Skjern Å estuary have been demonstrated for both sea-trout and salmon by radio telemetry. The total mortality during estuarine migration will be estimated in 2005 by acoustic telemetry. |
| | In Guden Å estuary, a project has been started in 2002 where wild salmon smolts are caught in a trap, and tagged with acoustic transmitters and followed through the estuaries by data-loggers at fixed stations and manual tracking. The preliminary results are promising and the project will be continued and combined with feeding studies of post-smolt and DST (data storage tags) tagging of smolt and/or spent fish. |
| Dates during which research took place | April 2000 to December 2008 |
| Area in which research took place | River Skjern Å and River Stor Å (North Sea) and River Guden Å (Kattegat) and their estuaries. |
| Estimated number and weight of salmon retained | N/A |
| ResourcesEstimated cost of the | River Skjern Å: £143,184 (total in years 2005-08) |
| research project | River Guden Å: £152,594 (total in years 2005-08) |
| | River Stor Å: £104,350 (2008) |
| | Publications (i.e. three rivers): £30,000 (2008) |
| Number of participating scientists | 4 |
| Name of coordinating | Anders Koed (River Skjern Å and River Stor Å) |
| scientist in charge of | ak@difres.dk |
| project | Kim Aarestrup (River Guden Å) kaa@difres.dk |
| Details of research | N/A |
| vessels, e.g. name, | |
| registration, call sign and | |

Project No. De2 Status: Completed

| description of vessel | |
|------------------------------|--|
| Type and amount of gear | Rotary screw traps, radio and acoustic telemetry equipment |
| and other equipment used | |
| Details of any collaborating | None |
| countries | |
| | |

Summary of Findings

Year 2004. Salmon and sea trout smolts and mature eel were trapped and numbered in River Guden Å and tagged with acoustic transmitters and followed during their migration through the estuary to the Kattegat. The migration speed of salmon exceeded the speed of sea trout smolts. The project continues in 2005 when the salmon and sea trout smolt project in River Skjern Å and the Ringkøbing estuary commences.

Year 2005. The project continued in 2005 and the results are being analysed. A report and paper will be published in year 2008. A peer reviewed publication on the results is planned in 2010.

Year 2005 and 2006. In River Skjern Å salmon and sea trout smolts were caught in a rotary screw trap in the river and acoustic tagged and followed on their downstream migration in the river and through the estuary, i.e. the Ringkøbing Fjord. The total mortality of salmon smolts in river and estuary was 54 % and was caused by predation from pike and birds (mostly cormorants) in the river and cormorants in the fjord; that means that 46 % of the salmon smolts entered the North Sea. Because of the low wild salmon population in River Skjern Å, each year ½- and one-year-old parr are stocked (F1 offspring from wild salmon). In 2005 about 27,300 smolts migrated out from the river, of which about 30 % were wild smolts from spawning in the river and 70 % were from stocking. It is concluded that because of bird predation, mostly from cormorants, the natural wild salmon in River Skjern Å is threatened. The data also showed that relatively the ½- and one-year-old parr give the same number of smolts, but the reason is uncertain; maybe it has something to do with a longer stay in hatchery of the one-year-old parr and therefore less adaptability in the river after release.

The results was analyzed and published in 2006 (Research on the smolt run of Atlantic salmon from River Skjern Å and mortality during migration through Ringkøbing Fjord, DFU-rapport nr. 160-06, in Danish). A peer reviewed publication on the results is planned in 2010.

Year 2007. In River Stor Å salmon and sea trout smolts were caught in a rotary screw trap in the river and acoustic tagged and followed on their downstream migration in the river and through the estuary, i.e. the Nissum Fjord.(to the North Sea). The salmon smolt production was about 17,800 smolts. The total mortality of salmon smolts in river and estuary was about 64 % and was caused by predation from pike and birds (mostly cormorants) in the river and cormorants in the fjord; that means that about 36 % of the salmon smolts entered the North Sea. The results was published in 2008 (Smolt run from River Stor Å in 2007 and smolt mortalities during migration through Felsted Kog and Nissum Fjord, DFU-rapport nr. 186-08, in Danish).

| Project No. De3 | Status: Ongoing |
|---|---|
| Party or relevant jurisdiction | European Union - Denmark |
| Title of project | Salmon Rehabilitation Plan: monitoring numbers of spawners, spawning and nursery areas in four Atlantic Salmon rivers |
| Objective of research project | The Danish national salmon rehabilitation plan describes four rivers with natural wild salmon populations. In earlier years monitoring has estimated numbers of smolts and numbers of spawners in the River Skjern Å but the exact spawning areas are not known. In 2008 monitoring took place in River Skjern Å, in 2009 in River Ribe Å, in 2010 in River Storå and in 2011/12 in River Varde Å. In 2013 again in River Skjern Å and so forth. In this way the effect of the rehabilitation plan and the development of the populations is assessed (the goal is at least 1,000 spawners in each river to fulfil the plan). This study will allow estimates of marine mortality of salmon to be made. |
| Brief description of research project | Every year about 100 spawners are radio tagged and a number of spawners are PIT tagged and followed by boat and listening stations during the spawning period. Spawning areas are determined and numbers of spawners estimated from tagged and untagged salmon caught by electro fishing and reports from anglers. From identified spawning areas salmon fry are collected and genetically analyzed (20 – 25 micro satellites) to identify numbers of families on the spawning areas. High numbers of fry and families indicate better areas versus few fry and spawners. |
| Dates during which research will take place | Annually. Started in autumn 2008 (tagging) and fry collection during summer 2009 and so on. |
| Area in which research will take place | River Skjern Å, River Ribe Å, River Storå and Varde Å. The rivers flow into the North Sea. |
| Estimated number and weight of salmon to be retained | N/A |
| Resources | |
| Estimated cost of the research project Details of the full | Annually about £14,000 for running costs (tags and chemicals). The amount is indexed. |
| economic costs of each study are requested, including staff costs, equipment and overheads. For collaborative projects, a breakdown of costs between public and private partners is requested. Number of participating | Annually about 510 scientist hours and 720 technical assistant hours Two (2) |
| scientists | |

| Name and e-mail address of coordinating scientist in charge of project | Anders Koed, <u>ak@aqua.dtu.dk</u> Einar Eg Nielsen, <u>én@aqua.dtu.dk</u> | |
|--|---|--|
| Details of research vessels, e.g. name, registration, call sign and description of vessel | N/A | |
| Type and amount of gear and other equipment to be used | Pit and radio tags, lab equipments | |
| Details of any collaborating countries | | |
| Summary of progress The spawning run in Skjern Å river in 2008 was estimated to c. 3,100 of which about 30 % were wild | | |

The spawning run in Skjern A river in 2008 was estimated to c. 3,100 of which about 30 % were wild fish and the rest from stocked fish of the Skjern Å strain; and in Ribe Å 2009 c. 726 spawners, most of them from stocked fish of the Ribe Å strain. In 2010 the spawning run will be estimated in the Stor Å river system.

| Project No. | Fi1 | Status: | Ongoing |
|-------------|-----|---------|---------|
| | | | |

| Party or relevant | European Union - Finland |
|---|--|
| jurisdiction Title of project | Long-term variation in population dynamics, life history characteristics, sea growth and origin (wild/reared) of salmon in the rivers Teno (Tana) and Näätämöjoki (Neidenelva) |
| Objective of research project | Collect long-term data on variation in the stock components, life histories, sea growth and abundance of escaped farmed salmon in the salmon stocks of the rivers Teno and Näätämöjoki. Relate the population dynamics of the juvenile salmon and returning |
| Brief description of research project | adult salmon in preceding and subsequent generations. The wild Atlantic salmon stocks of the Rivers Teno (Tana) and Näätämöjoki (Neidenelva) have been subject to long-term monitoring programme since the 1970s in cooperation between Finnish and Norwegian research institutes and authorities. Catch statistics and samples have been collected in the freshwater salmon fisheries since 1972 covering all user groups, seasons and gear types. Typically, some 2,000-8,000 adult salmon scales have been collected yearly. Long-term electrofishing at permanent sampling sites has been carried out in the Teno since 1979 and in the Näätämöjoki since 1990. |
| Dates during which research will take place | Long-term ongoing programme |
| Area in which research will take place | Northern Finland and Norway |
| Estimated number and weight of salmon to be retained | N/A |
| Resources | |
| Estimated cost of the research project | £275,000 per annum |
| Number of participating scientists | 5 |
| Name/e-mail of coordinating scientist in charge of project | Dr. Jaakko Erkinaro jaakko.erkinaro@rktl.fi |
| Details of research vessels, e.g. name, registration, call sign and description of vessel | N/A |
| Type and amount of gear and other equipment to be used | N/A |
| Details of any collaborating countries | Norway |

Long-term monitoring programmes. Analyses have indicated relationships between the yearly stock fluctuation and the environmental conditions, especially the Barents Sea temperatures. In addition, positive correlations between the catch fluctuations and the preceding and subsequent juvenile salmon production have been documented. Special emphasis has been allocated to the monitoring of possible escaped farmed salmon in the river catches of the Rivers Teno and Näätämöjoki.

| Party or relevant jurisdiction | European Union - Finland |
|--|---|
| Title of project | Joint use of high-throughput SNP assay infrastructure in Atlantic salmon |
| Objective of research project | The key aims of the project include: I) A concerted effort to identify genomic regions that affect ecologically and economically important phenotypic traits in domesticated and wild Atlantic salmon; II)efficient joint utilization of a state-of-the-art Nordic genomics infrastructure to generate large-scale salmon SNP datasets; |
| Brief description of research project | Atlantic salmon is one of the most economically and scientifically important fish species world-wide and especially in the Nordic countries Atlantic salmon can be seen as a "flagship" species because of their vulnerability, attractiveness and broad influence in conservation biology as well as evolutionary, ecological and genomic research. In recent years, the ability to study biological processes from a whole genome perspective have opened unforeseen directions and opportunities but at the same time the resources required for high-throughput genomic projects are becoming prohibitively large for single research groups. Hence, there is an urgent need for collaborative effort for utilizing the latest genomic developments and it provides an ideal ground for joint use of Nordic infrastructures in merging evolutionary, ecological and genomic perspectives. |
| Dates during which research will take place | 2009 -2010 |
| Area in which research will take place | Norway and Finland |
| Estimated number and weight of salmon to be retained | - |
| Resources | |
| Estimated cost of the research project | Staff costs: - Travel: £2,000 Laboratory expenses: £98,000 Overheads: Total 2009-2010: £100,000 i.e. approximately £50,000 per annum |
| Number of participating scientists | 4 |
| Name and e-mail address of coordinating scientist in charge of project | Craig Primmer craig.primmer@utu.fi |
| Details of research vessels, e.g. name, registration, call sign and description of vessel | - |
| Type and amount of gear and other equipment to be used | - |
| Details of any collaborating countries | Department of Biology, University of Turku, Finland Center for Integrative Genomics, Norwegian University of Life Sciences, Aas, Norway |

| Frequenciation of the status. Ongoing - New entry | Project No. | Fi2 | Status: (| Ongoing - New entry |
|---|-------------|-----|-----------|---------------------|
|---|-------------|-----|-----------|---------------------|

Initial testing and optimisation of the SNP chip for use with a range of salmon populations and DNA extraction methods has commenced.

| Party or relevant jurisdiction | European Union - France |
|--|--|
| Title of project | Evolution of biological characteristics in Atlantic salmon from all the Armorican massif rivers (Brittany and Low-Normandy, France) |
| Objective of research project | Relationships between the cumulative effects of climate warming and other anthropogenic stresses and changes in biological features in populations in the southern part of the European distribution range of the species. |
| Brief description of research project | This project focused on the analysis of biological data (biometric and demographic) from rod catches and other information (catches by trapping, dead fish, etc.) to identify the biological changes in salmon populations. A long-term data series (biological and catches statistics) since the beginning of the 1970's (more than 30 years) is available for all the Armorican massif rivers. Furthermore, the sampling effort has been improving in space and time since 1987 with the obligatory registration of salmon catches and an extension of the fishing season towards the summer and autumn periods. Moreover, we have a lot of additional information from smolt and adult trapping on two index rivers, the Oir River in Low-Normandy and the Scorff River in Brittany. At the same time, a climatological and freshwater quality time series (temperature and rainfall mainly) might be analysed. The joint analysis of the different data series might allow better understanding of the natural and anthropogenic factors responsible for the biological changes in Atlantic salmon stocks. The project was operated jointly by the National Institute for Agronomical Research (INRA) and the Conseil supérieur de la pêche (CSP). |
| Dates during which research took place | 1972 - 2005 |
| Area in which research took place | All salmon rivers in the Armorican Massif (about 25-30). |
| Estimated number and weight of salmon retained | No fish are retained; all fish come from the rod fishery and all individuals trapped are released. |
| Resources Estimated cost of the research project Details of the full economic costs of each study are requested, including staff costs, equipment and overheads. | N/A, part of a larger long-term monitoring programme |
| Number of participating scientists | 2 scientists + 2 technicians |
| Name of coordinating scientist in charge of project | Dr Jean-Luc Baglinière |
| Details of research vessels, e.g. name, registration, call sign and | N/A |

Project No. Fr1 Status: Completed

| description of vessel | |
|------------------------------|--------------------------------|
| Type and amount of gear | Adult and smolt counting fence |
| and other equipment used | |
| Details of any | None |
| collaborating countries | |
| Summony of Drogross/Findings | |

Summary of Progress/Findings

First results confirmed at a multi-regional scale the decrease in the two-sea-winter component in stocks. Furthermore, they showed a decrease in the freshwater age, a strengthening of the semelpare character of the species (strong decrease in the multi-spawner population) and the near extinction of the large multi-sea-winter salmon (three years at sea). All the modifications seem to lead to a shorter turn-over in populations and so to their greater sensitivity to environmental factors.

| Project No. Fr2 | Status: Ongoing |
|--|---|
| Party or relevant jurisdiction | European Union - France |
| Title of project | The sea survival of Atlantic salmon from the River Scorff, Brittany |
| Objective of research project | Estimation and long-term monitoring of survival at sea in the southern part of the European distribution range of the species |
| Brief description of research project | This project centres on quantifying smolt production and adult returns, by means of trapping and mark-recapture techniques, to enable estimation of sea survival. The Scorff is an index river which provides management-oriented scientific information at the regional (Brittany) and international (ICES) levels. It is the only stock in the Southern European part of the species distribution range (France and Spain) for which both smolts and adults are enumerated at the mouth of the river. In addition, no coastal or estuarine commercial fishery targeting Atlantic salmon is currently operating. Thus, the Scorff provides a unique opportunity for assessing marine survival of salmon in an area for which such information is virtually lacking. The project is operated jointly by the National Institute for Agronomical Research (INRA), and Angling Associations. |
| Dates during which research | 1994 onwards |
| will take place | |
| Area in which research will take place | The River Scorff (Southern Brittany) |
| Estimated number and weight | No fish are retained, all animals trapped for tagging or mark control |
| of salmon to be retained | are released |
| Resources | |
| Estimated cost of the research project | £165,000 per annum |
| Number of participating scientists | 2 scientists + 2 technicians |
| Name and e-mail address | Etienne Prévost |
| of coordinating scientist in | eprevost@st-pee.inra.fr |
| charge of project | |
| Details of research vessels, | N/A |
| e.g. name, registration, call | |
| sign and description of | |
| vessel | |
| Type and amount of gear and other equipment to be used | Adult and smolt trapping facilities specially designed to minimize impacts on wild fish due to handling |
| Details of any collaborating | None |
| countries | |
| Summary of progress | |

First estimates of sea survival are indicative of higher marine mortality than for more northern stocks (UK, Scandinavia, Iceland). Combined with information on freshwater survival, they reveal the precarious status of the stock. The stock is still able to maintain itself at a reasonably high level of abundance, but may not stand any additional increase in fishing or marine mortality. Recent years have shown an increase in marine mortality (reduction by half of the smolt to adult survival). In addition there is a constant decline in the size combined with a later date of freshwater entry of the adults returning in the Scorff.

| Party or relevant jurisdiction | European Union - France | | |
|--|--|--|--|
| Title of project | Atlantic salmon metapopulation investigation in Normandy rivers | | |
| Objective of research project | Estimate exchanges between rivers flowing into the Mont-Saint- Michel-Bay and impact on the management of salmon populations | | |
| Brief description of research project | Straying salmon and river proximity lead to individual exchanges and genes flow between populations and can result in a metapopulation structure. Moreover, stocking of Atlantic salmon populations with non-native and hatchery-reared fish can have important consequences on metapopulations by increasing gene flow. Inversely, the river proximity could increase straying of released fish. A good example for such study is the salmon populations in four neighbouring rivers flowing into from the Mont-Saint-Michel Bay (Couesnon, Sélune, Sée, and Sienne) in Lower Normandy and were stocking has been settled since 1989 using non-native salmon coming from two French hatcheries. We propose to explore 1- the functioning of the metapopulation by investigating salmon and gene flows between the four rivers 2- the genetic impact of stocking 3- the consequences for management, including habitat, stocking, and exploitation. We are coupling three approaches: Molecular genetics using microsatellite markers Otoliths microchemistry Modelling the two types of data with capture-recapture | | |
| Dates during which research will take place | informations 2007 to 2010 | | |
| Area in which research will take place | 5 rivers flowing into the Mont-Saint-Michel Bay, Normandy, France | | |
| Estimated number and weight of salmon to be retained | t No adult fish are retained; all fish trapped are released. Genetic analyses are performed mainly from scales of adult salmon caught by angling. 100 juveniles have been caught and killed for removing otoliths and. for microchemistry analysis. | | |
| Resources | | | |
| Estimated cost of the research project | £150,000 (Euro150,000) i.e. £50,000 per annum | | |
| Number of participating scientists | 1 PHD, 8 scientists, 2 technicians | | |
| Name and e-mail address of coordinating scientist in charge of project | Jean-Luc Baglinière Jean-Luc.Bagliniere@rennes.inra.fr | | |
| Details of research vessels, e.g. name, registration, call sign and description of vessel | none | | |
| Type and amount of gear | Standard sampling equipment | | |

Project No. Fr3 Status: Ongoing

| and other equipment to be | Standard genetics laboratory equipment | | |
|------------------------------|---|--|--|
| used | LAICPMS (Laser Ablation Inductively Coupled Plasma-Mass | | |
| | Spectrometer) for microchemistry analysis | | |
| | Trapping | | |
| Details of any collaborating | none | | |
| countries | | | |
| C 8D | · | | |

Molecular analyses showed very low and not significant differentiation between populations from the Mont-Saint-Michel Bay. Furthermore, the comparison with others wild stocks (Brittany populations (west side) and Upper Normandy (north side)), and with hatchery-reared strains, showed large genetic differences. These results also show relatively high genetic introgression of Normandy populations following stocking.

LAICPMS analysis discriminated juveniles from the four rivers with 85% accuracy and also allowed to discriminate juvenile from hatchery.

Overall, coupling genetic and microchemistry analyses showed high straying rates of wild and released hatchery-reared adults salmon among the rivers of Normandy and successfull reproduction of stocked fish in the wild.

Further investigations are needed to quantify the natural exchange rate between the four populations, and the impact of stocking, by using statistical models and a more complete analysis of otolith microchemistry.

| - | - | |
|--|---|--|
| Party or relevant jurisdiction | European Union – Ireland | |
| Title of project | Assessment of the levels of the parasite Lepeophtheirus salmonis onAtlantic salmon post-smolts in salmon aquaculture bays along | |
| | Ireland's western seaboard. | |
| Objective of research | Determine whether sea lice from marine salmon farms are | |
| project | contributory factor in increased marine mortality of salmon pos smolts migrating from bays with salmon aquaculture. A furthe objective was to gather information on salmon post-smolt migratic patterns. | |
| Brief description of research | Trawling was undertaken using the Fishlift live aquarium to capture | |
| project | salmon post-smolts in selected bays along Ireland's Western seaboard. Salmon post-smolts were examined for sea lice and data was collected on post-smolt diet, growth and migration. Trawling further off-shore has provided information on post-smolt migration patterns. | |
| Dates during which research took place | First week in May, 2002. | |
| Area in which research took | South-West Coast (Kenmare Bay), West Coast (Killary Harbour | |
| place | Bertraghboy Bay, Clew Bay), North-West Coast (Inver Bay) | |
| Estimated number and | | |
| weight of salmon retained | Up to 250 post-smolts | |
| Resources | | |
| Estimated cost of the research project | £20,000 | |
| Number of participating scientists | Two | |
| Name of coordinating | Dr. Patrick Gargan, Central Fisheries Board | |
| scientist in charge of project | paddy.gargan@cfb.ie | |
| Details of research | Naomh Jude, based in Rossaveel, Connemara, Co Galway. | |
| vessels, e.g. name, | 85 ft pelagic trawler, 850 HP. | |
| registration, call sign | | |
| and description of | | |
| vessel | | |
| Type and amount of | Salmon smolt surface trawl with Spectra ropes. Fishlift live aquarium | |
| gear and other | separator frame and cod-end. | |
| equipment used | | |
| Details of any collaborating | | |
| countries | | |
| Summary of findings | 1 | |

| Project No. Ir1 Status: Completed | Project No. | Ir1 | Status: | Completed | |
|-----------------------------------|-------------|-----|---------|-----------|--|
|-----------------------------------|-------------|-----|---------|-----------|--|

Summary of findings

This work has now been submitted for publication. Eight experimental releases of tagged, hatcheryreared salmon smolts were released in river systems draining into 3 salmon aquaculture bays over a 3year period. For each experiment, groups of smolts were fed untreated pellets or were treated prophylactically with pellets including an in-feed sea louse treatment (SliceTM; emamectin benzoate) prior to their release. Analysis of tag recaptures showed that Slice-treated smolts experienced increased survivorship over un-treated controls in six of the seven releases when farm net-pens were in production. The present experimental results suggest that sea lice larvae released from overwintering farmed salmon may influence the survivorship and conservation status of wild salmon in these river systems.

| Party or relevant jurisdiction | European Union – Ireland | |
|---|--|--|
| Title of project | Oceanic factors influencing marine survival of Irish salmon stocks | |
| | The programme was initiated in 1999 to: | |
| Objective of research | | |
| project | Provide information on marine survival at various stages of ocean migration. | |
| Brief description of research project | Marine Institute have funded a fellowship for an entry level scientist to enter a PhD programme in the University of Massachusetts. The fellowship enabled the researcher to avail of the extensive information sets on oceanographic parameters relevant to survival of salmonids at sea. The long-term objective was to examine the relationships between marine survival indices available for Irish salmon stocks with corresponding marine environmental data sets. | |
| Dates during which research took place | August 2001 – 2005 | |
| Area in which research took place | Oceanic datawas examined for:Post-smoltsNorwegian Sea, Wyville Thompson Ridge, North of Scotland, North of FaroesGrilseWest Greenland, Irish coastMSWNorth of Faroes, Irish coast | |
| Estimated number and | N/A | |
| weight of salmon retained | | |
| Resources | | |
| Estimated cost of the research project | £25,000 per annum (Phase 1 – studentship) | |
| Number of participating scientists | 5 | |
| Name/e-mail of coordinating scientist in charge of project | Dr Niall O' Maoileidigh (Ireland), niall.omaoileidigh@marine.ie Dr Kevin Friedland (US), friedlandk@forwild.umas.edu | |
| Details of research vessels, e.g. name, registration, call sign and description of vessel | N/A | |
| Type and amount of gear and other equipment used | N/A | |
| Details of any collaborating countries | USA | |
| Summary of Findings | | |

Completed

Project No.

Ir2

Status:

Evidence was found that the level of marine recruitment of 1SW salmon is linked to growth during the marine residency, and that decreasing growth over the last 30 years explains the observed decrease in salmon recruitment. Furthermore, the work concludes that changes in climate in the northeast Atlantic have affected the salmon via bottom-up effect, by affecting the abundance, distribution and phenology of key zooplankton species in the northern North Sea and southern Norwegian Sea.

| Party or relevant jurisdiction | European Union – Ireland | |
|---|--|--|
| Title of project | Sustainable management of interactions between aquaculture and wild salmonid fish (EU SUMBAWS project – Irish component of project only) | |
| Objectives of research | To assess efficacy of prophylactic treatments for salmon smolts | |
| project | migrating through aquaculture bays | |
| Brief description of research project | Two treated and control fish groups, differentially micro-tagged (5,000 fish in each group), released from two freshwater river systems' fisheries, in three years, 2002 to 2005. Survivors in experimental groups were recaptured in commercial fisheries and freshwater traps. | |
| Dates during which research took place | 3 year programme 2003-2006. Final release groups returned summer 2006. | |
| Area in which research took place | Kilkerrin Bay, Bertraghbouy Bay, Connemara | |
| Estimated number and weight of salmon retained | | |
| Resources | | |
| Estimated cost of the research project | £143,000 | |
| Number of participating scientists | 2 | |
| Name of coordinating scientist in charge of project | Paddy Gargan, Central Fisheries Board. paddy.gargan@cfb.ie Niall O'Maoileidigh, Marine Institute (microtagging and tag recovery in commercial fisheries) niall.omaoileidigh@marine.ie | |
| Details of research vessels, e.g. name, registration, call sign and description of vessel | | |
| Type and amount of gear and other equipment used | Traps, Microtagging, Commercial fishery | |
| Details of any collaborating countries | UK (Neil Hazon, Scotland); Norway (Bengt Finstad) | |
| Summary of Findings | | |

Completed

Status:

Project No. Ir3

Preliminary results – prophylactic-treated fish had statistically higher returns compared to non-treated controls.

| 110ject No. 114 | Status. Completeu | |
|--|---|--|
| Party or relevant jurisdiction | European Union - Ireland | |
| Title of project | Early distribution and migration of Atlantic salmon smolts off the west of Ireland. | |
| Objective of research project | To test a new pelagic trawl in open waters off the Irish coast; To train and familiarise technical and support staff on the operation and deployment of the trawl for further surveys in 2008 and 2009; To obtain samples of post-smolts for biological and genetic analyses; To relate run timing, timing of migration, swimming speed, growth etc to oceanographic parameters. | |
| Brief description of research project Dates during which research | A single pelagic trawl was deployed from the Celtic Voyager off the west of Ireland to intercept out-migrating salmon smolts. | |
| took place | 7 May and 16 May 2007. | |
| Area in which research took place | North-west coast of Ireland | |
| Estimated number and weight of salmon retained | Depending on survey success but probably no more than 100 individual salmon smolts. | |
| Resources Estimated cost of the | Trawl = approximately £11,700 (Atlantic Salmon Trust - AST) | |
| research project | Vessel = $\pounds 62,000$ (Marine Institute – MI) Staff = $\pounds 3,500$ (MI), $\pounds 1,400$ (AST), $\pounds 1,000$ (University College Cork - UCC), $\pounds 1,000$ (Central Fisheries Board – CFB) Samples = $\pounds 3,500$ (UCC) Approximate overheads @ 50% = $\pounds 42,000$ | |
| | $Total = \pounds 126,100$ | |
| Number of participating scientists | MI = 3 $UCC = 1$ $AST = 1 or 2$ $CFB = 1$ | |
| Name and e-mail address of coordinating scientist in charge of project | N Ó Maoiléidigh niall.omaoileidigh@marine.ie | |
| Details of research vessels, e.g. name, registration, call sign and description of vessel | RV Celtic Voyager General Description 31.4m length, 8.5 beam Gross tonnage 340 Fishery, acoustic, oceanography, buoy handling, environmental sampling, geological and hydrographic research vessel Lloyd's Classification: Δ100A1 Research Vessel, LMC | |
| Type and amount of gear and other equipment used | Pelagic trawl with smolt cod-end, CTD and Water sampling rosette mounted with Fluorometer and transmissometer, thermosalinograph, Fluorometer, Weather Station, Data Acquisition System | |

| Details of any collaborating | UK | | |
|--|----|--|--|
| countries | | | |
| Summary of findings | | | |
| | | | |
| A summary of the cruise and the catches of post-smolts was provided to NASCO in document | | | |
| CNL(07)35. | | | |

| | Status. Completed | | |
|--|---|--|--|
| Party or relevant jurisdiction | EU – Ireland | | |
| Title of project | Migration of salmon in estuarine and coastal waters | | |
| Objective of research project | Investigate the timing, route of migration and aspects of the biology of migrating ranched salmon smolts in comparison to the native wild smolt migration. | | |
| Brief description of research project | There were three main elements to the project: <i>a)</i> Timing of wild smolt migration The downstream traps were monitored for the wild salmon smolt migration and this was related to environmental, lunar and tidal conditions. | | |
| | b) Tracking of wild smolts by acoustic sounding and ranched smolts by acoustic pinger tags and remote receivers Wild and ranched smolts were tracked using acoustic echo- sounders to ascertain migration patterns within fresh water and the upper estuary. Acoustic Vemco V8SC-6L-4K pingers were inserted into 40 ranched smolts. A series of 13 automatic listening stations installed throughout the estuary and Clew Bay monitored the seaward movements of these fish, recording timing, direction of movement, temperature and tide. | | |
| | <i>Biological Sampling</i> Samples of migrating smolts were collected in the coastal waters by gill net and surface otter trawling. Analysis included scales (growth), diet and parasite load (internal and external). | | |
| Dates during which research took place | 2005-2008 | | |
| Area in which research took place | The Burrishoole Catchment, Newport, and Clew Bay, Co. Mayo | | |
| Estimated number and weight of salmon retained | N/A | | |
| Resources | | | |
| Estimated cost of the research project | £24,000 per annum | | |
| Number of participating scientists | 3 Marine Institute (Irl), 2 CEFAS (UK) | | |
| Name and e-mail address | Russell Poole | | |
| of coordinating scientist | russell.poole@marine.ie | | |
| in charge of project | Deirdre Cotter | | |
| | deirdre.cotter@marine.ie | | |
| | Niall O'Maoileidigh | | |
| Details of research | niall.omaoileidigh@marine.ie N/A | | |
| vessels, e.g. name, | | | |
| registration, call sign and description of vessel | | | |
| Type and amount of gear | 40 Acoustic Vemco V8SC-6L-4K pingers. A series of 13 automatic | | |

| Project No. | Ir5 | Status: | Completed |
|-------------|-----|---------|-----------|
|-------------|-----|---------|-----------|

| and other equipment used | listening stations. Echo sounders. |
|------------------------------|------------------------------------|
| Details of any collaborating | UK (Andrew Moore, CEFAS) |
| countries | |
| Summony of Drogroup | |

54 ranched salmon smolts were tagged using Vemco acoustic pingers. These were released in late April into L. Furnace. Detection was good and 70% of the fish were recorded in the middle of Clew Bay and 65% were recorded at Clare Island, some 25km out to sea. Some fish not detected in the middle bay were detected at Clare Island, making minimum survival through the estuary and inner bay of >80%. Fish moved through the main channels and tidal flows and movement was influenced by outgoing tidal flows. Analysis of the data is continuing. Equipment will be upgraded in 2006 for application in 2007.

| Party or relevant jurisdiction | EU - Ireland | |
|--|---|--|
| Title of project | National Development Plan - National Genetic Stock Identification | |
| The of project | Project | |
| Objectives of research project | To identify and map discrete spawning areas within tributaries of the salmon-bearing rivers in Ireland (approximately 149) and to collect juvenile Atlantic salmon from these rivers at locations close to the principal spawning areas for establishment of genetic baseline for mixed sample analysis. | |
| | To undertake the molecular genetic analysis (genotyping) of juvenile salmon tissue samples and adult salmon scales using a pre-determined panel of microsatellite markers. To use the genotype data obtained above, using appropriate statistical packages to identify and characterise river populations as a basis for determining the relative contributions of different baseline river populations within mixed samples. | |
| Brief description of research project | Genetic Stock Identification (GSI), the use of genetic markers for identifying the proportions of different contributing populations in salmon fisheries and new developments in GSI such as individual assignment (IA) methodologies, have been demonstrated to be powerful and valuable tools for the management of fisheries. | |
| | As part of ongoing efforts to improve the salmon stock assessment programme, the Marine Institute commenced, in addition to the microtag recovery programme, a genetic stock identification (GSI) project in 2005. | |
| Dates during which research | | |
| took place | Data analysis only in 2008 | |
| Area in which research took place | Comprehensive survey of all Irish salmon rivers | |
| Estimated number and weight of salmon retained | None. | |
| Resources | | |
| Estimated cost of the research project | £270,000 per annum in 2006 and 2007 provided under Ireland's National Development Plan. Analysis of results in 2008. | |
| Number of participating scientists | 2 project scientists and 1 technical staff, 2 field staff | |
| Name and e-mail address of coordinating | Tom Cross t.cross@ucc.ie | |
| scientist in charge of | Paddy Gargan | |
| project | paddy.gargan@cfb.ie Philip McGinnity, Chairman of Scientific Steering Committee) phil.mcginnity@marine.ie | |
| Details of research vessels, e.g. name, | N/A | |
| registration, call sign | | |
| and description of vessel | | |
| 105501 | | |

Project No. Ir6 Status: Completed

| Type and amount of | Instream electrofishing equipment |
|------------------------------|---|
| gear and other | |
| equipment used | |
| Details of any collaborating | Links to ASAP Interreg Programme UK and Spain |
| countries | |
| C CD | |

The report of this project The National (Ireland) Atlantic Salmon Genetic Stock Identification Project (ST-05-002 Final report is now available. This report was produced by University College Cork, Central Fisheries Board and the Marine Institute.

Preliminary results for both "offshore" and "inshore" confirmed the results using other tagging methods over the years and showed the highly mixed stock nature of the marine fisheries whether some distance offshore or even within estuaries and bays. These fisheries, despite being restricted to specific geographic districts and fishing season (June and July), will comprise of salmon destined not just for that particular district but also comprise salmon from neighbouring and even distant districts, sometimes in high proportions relative to the proportion of "own district" salmon. Also, the fisheries are indiscriminate in that they will not exclusively target only those stocks which are above Conservation Limits.

In general, the original objectives of the programme were achieved and several important spin-offs in relation to the development of markers and other techniques (Single Nucleotide Polymorphisms SNPS) are now under investigation.

| Project No. 177 Status: Complete | Project No. | Ir7 | Status: | Completed |
|----------------------------------|-------------|-----|---------|-----------|
|----------------------------------|-------------|-----|---------|-----------|

| Party or relevant jurisdiction | EU - Ireland |
|---|--|
| Title of project | Interactions between aquaculture and wild salmonid fish |
| Objectives of research | To assess efficacy of prophylactic treatments for salmon smolts |
| project | migrating through aquaculture bays |
| Brief description of research | Two treated and control fish groups of salmon, differentially micro- |
| project | tagged (5,000 fish in each group), were released from several |
| | freshwater river systems' fisheries, between 2002 to 2006 |
| | (Burrishoole, Shannon, Lee, Delphi, Screebe). Survivors in |
| | experimental groups were recaptured in commercial fisheries and |
| | freshwater traps. |
| Dates during which research | 2003-2009: |
| took place | Final release groups due back summer 2007. |
| Area in which research took | Burrishoole, Shannon River, Lee River, Screebe and associated |
| place | interceptory drift net fisheries around the Irish coast |
| Estimated number and | N/A. Hatchery-reared only |
| weight of salmon retained | |
| Resources Estimated cost of the | 650,000 |
| | £50,000 approx. |
| research project Number of participating | 3 |
| scientists | 5 |
| Name and e-mail | D. Jackson |
| address of coordinating | dave.jackson@marine.ie |
| scientist in charge of | dave.jackson@marme.ie |
| project | |
| Details of research | |
| vessels, e.g. name, | |
| registration, call sign | |
| and description of | |
| vessel | |
| Type and amount of | Traps, Microtagging, Commercial fishery |
| gear and other | |
| equipment used | |
| Details of any collaborating | |
| countries | |
| | |

Two treated and control fish groups of salmon, differentially micro-tagged (5,000 fish in each group), released from several freshwater river systems' fisheries, between 2002 to 2006 (Burrishoole, Shannon, Lee, Delphi, Screebe). Survivors in experimental groups being recaptured in commercial fisheries and freshwater traps.

Project commenced October 2003 and is now complete with recovery of final release groups in 2008. Preliminary results indicate that in nearly all instances the treated groups showed a higher survivorship than the untreated controls but these were not always significant differences. There it would appear that there was variable levels of resistance between treated and untreated fish. Final analyses are being carried on brood stock returns collected from October 2007 to January 2008. These results are in preparation for scientific publication. Further releases may be made from the Burrishoole research facility on Newport, Ireland.

| Party or relevant jurisdiction | EU – Ireland | |
|--------------------------------|---|--|
| Title of project | Marine survival of wild and hatchery reared salmon | |
| | National coded wire tagging and tag recovery programme and | |
| Ohiosting of geograph angle of | Burrishoole wild salmon census | |
| Objective of research project | The National Coded Wire Tagging and Tag Recovery Programs was initiated in 1980 to: | |
| | Provide information on marine survival and exploitation rates by | |
| | commercial fisheries; | |
| | Estimate the contribution of individual river stocks to catches; | |
| | Examine the performance of selected experimental groups; | |
| | Evaluate the potential of a salmon ranching industry in Ireland. | |
| | The Burrishoole salmon census began in the 1960's to investigate | |
| | factors influencing the survival at sea of salmon smolts migrating | |
| | from the Burrishoole river until their returns as adult salmon | |
| Brief description of research | Up to 500,000 salmon smolts are tagged with coded wire tags and | |
| project | released from 9 Irish rivers annually. Tag recovery takes place in | |
| | scanning programmes in Greenland and Faroes (during any | |
| | experimental fishing) and in experimental trawling for post-smolts in | |
| | the Norwegian Sea and north of Scotland. Subsequently, tags are recovered from homewater fisheries at over 40 locations in Ireland. | |
| | Between 40 and 50% of the total declared catch of salmon is | |
| | examined for tags. With the imposition of the carcass tagging | |
| | scheme, and the district quotas tag recovery has dropped to about | |
| | 35% of the total catch. With the closure of the Irish mixed stock | |
| | salmon fishery, returns are now being generated principally from | |
| | river catches (commercial and recreational) and broodstock returns. | |
| | This Burrishoole wild salmon census long-term project centres or enumerating numbers of migrating wild smolts and returning adults | |
| | | |
| | to the Burrishoole river, by means of trapping facilities, in order to | |
| | assess return rates and maturation schedules. Return rates to Irish | |
| | homewaters, which provides an index of natural survival at sea. | |
| Dates during which research | Coded Wire tagging since 1980 | |
| will take place | Tagging November to April | |
| | TaggingNovember to April.RecoveryPost-smolts - May to July (Norwegian Sea), | |
| | September to November (Faroes) | |
| | Grilse – May to November | |
| | MSW – January to November | |
| | Wild salmon census in the Burrishoole are monitored 24/t both | |
| Area in which research will | upstream and downstream migrating since the 1960's | |
| take place | Tag recoveryPost-smoltsNorwegian Sea, Wyville Thompson Ridge, North of | |
| | Scotland, North of Faroes | |
| | Grilse: West Greenland, Irish estuarine and river fisheries, Irish | |
| | rivers. | |

Project No. Ir8 Status: Ongoing

| | MSW: North of Faroes, Irish estuarine and river fisheries, Irish rivers Salmon Census Facility, Newport Co. Mayo Ireland |
|--|--|
| Estimated number and weight of salmon to be retained | Up to 200,000 adults may be examined and cored to retrieve tags. Approximately 40,000 in recent years with mixed stock fisheries and approximately 10,000 in 2007 in the absence of MSF. Up to 40 post-smolts may be recovered in high-seas experimental fisheries of Faroes and Norwegian Sea |
| Resources | |
| Estimated cost of the research project | £300,000 per annum nationally funded (does not include sampling in experimental fisheries in high seas, etc.) Staff approx. £200,000 Equipment (including tags) £100,00 |
| | Burrishoole salmon census - £72,000 per annum mainly staff costs |
| Number of participating scientists | National Coded Wire tagging and Tag Recovery programme = 5 Burrishoole salmon census = 6 |
| Name and e-mail address | Niall O' Maoileidigh |
| of coordinating scientist in charge of project | niall.omaoileidigh@marine.ie |
| | Russell Poole |
| | russell.poole@marine.ie |
| Details of research vessels, e.g. name, registration, call sign and description of vessel | None |
| Type and amount of gear and other equipment to be used | None |
| Details of any collaborating countries | Norway, UK, Faroes, France, Spain, Germany, Denmark |

National Coded Wire Tagging and Tag Recovery Programme – This tagging programme takes place in up to 8 locations nationally, with recovery centres in commercial fisheries, recreational fisheries and hatchery broodstock collections. Up to 500,000 smolts have been tagged and released since 1980 with approximately 250,000 being tagged presently. The data are reported to ICES annually and are incorporated in the Reports of the Working group on North Atlantic Salmon. Returns of tagged adult salmon and the distribution of Irish and international tagged salmon in the drift net fisheries from 1980 to 2006 clearly demonstrated the mixed stock nature of these fisheries and has been a key element in the Irish government's decision to close this fishery on the precautionary principle in 2007. Subsequent genetic stock identification confirmed the highly mixed stock nature of this fishery. In the absence of the landings of salmon at many major ports, the tag recovery programme will concentrate on key areas with remaining single stock fisheries in estuaries, bays and rivers and the information will continue to be used for the management of the individual and district river stocks. Following the closure of the Irish Mixed Stock salmon fishery in 2006, tag returns from commercial fisheries were as anticipated extremely low relative to other years but there was a significant increase in the recovery of tags in riverine brood stock collections in both years as more fish escaped to enter freshwater. In 2009 approximately, 4,000 individual tag recoveries were generated from a release in 2008 of approximately 260,000 smolts. Survival was again low in 2009 for most groups returning to the coast and rivers confirming that conditions at sea for salmon survival are not yet improving.

Burrishoole wild salmon census - Long-term monitoring programme reflecting the decline in marine survival of European salmon stocks. This site is one of only three facilities in NEAC area with total census capabilities (i.e. upstream adult and downstream adult and juvenile trapping and monitoring).

| Party or relevant jurisdiction | European Union – Sweden |
|--|--|
| Title of project | Long-term variation in population dynamics, life history and exploitation of salmon stocks in monitored rivers |
| Objective of research project | The objective is to estimate long-term variation of survival in different life stages, life history characteristics and growth of wild salmon in the River Ätran with its major tributary Högvadsån. Estimates of sea survival, growth and exploitation are provided from annual Carlin taggings of wild fish in River Ätran and fish from reared stocks in the Rivers Lagan and Nissan. |
| Brief description of research project | The wild salmon stock in River Ätran has been subject to monitoring since the 1950s with annual recording of the number of ascending fish in the tributary Högvadsån since 1954 and partial smolt trapping since 1959. Present monitoring programmes include electrofishing surveys, smolt trapping, adult counters in the main stem of River Ätran and in Högvadsån, catch sampling and scale reading, Carlin tagging and collection of catch statistics. As the river Ätran is infected by <i>Gyrodactylus salaris</i> , there is an annual monitoring of the parasite infection. In addition to the major programme in River Ätran there is a tagging programme for the reared stocks in the rivers Lagan and Nissan. This gives data on sea survival and exploitation of reared stocks. |
| Dates during which research will take place | Long-term ongoing project (subject to annual review). |
| Area in which research will take place | Sweden |
| Estimated number and weight of salmon to be retained | No adult fish are retained. Up to 100 parr/smolt are retained in sampling programmes. |
| Resources | |
| Estimated cost of the research project | £8,500 in 2009 dedicated to the project. Other parts of project in larger monitoring programmes or part of compensatory programme after hydro-electric power development. |
| Number of participating scientists | 2-4 (also participating in other projects) |
| Name and e-mail address of coordinating scientist in charge of project | Lars Karlsson lars.karlsson@fiskeriverket.se |
| Details of research vessels, e.g. name, registration, call sign and description of vessel | N/A |
| Type and amount of gear and other equipment to be used | Adult and smolt trapping facilities. |
| Details of any collaborating countries | N/A |

Project No. Sw1 Status: Ongoing

Although River Ätran was infected by *Gyrodactylus salaris* somewhere around 1990, this river still supports the most substantial salmon angling of any of the wild salmon rivers on the Swedish west coast. An analysis of the effect of the parasite on all wild salmon stocks indicated a negative influence, as the densities of parr were lower in infected rivers. The decrease in densities of older parr was particularly pronounced in River Ätran. Within a Gyrodactylus monitoring programme a significant correlation was found between high infection rates with parasites and low survival of older salmon parr. The partial smolt trapping in River Ätran indicate a quite stable smolt production level in the last 10 years, but it is on a substantially lower level than it was in the 1970s. There are signs of an increase in sea trout production in the last 10 years. This may fit in with negative effects of parasites on salmon that partly compete with sea trout for space. All monitoring programs continue.

River Ätran is one of the European projects in The Interreg IVB North Sea Region Programme and granted 0,7 million euro. In 2010 a hydropower plant will be eliminated in River Ätran. Salmon can pass the plant using a fishway (Denile type) since 1945, but elimination of the plant will further enhance the spawning run and also the smolt migration and of course the migration of eel. Earlier spawning areas (15 000 m²) will also be restored. The estimated cost is Euro 1.8 million. In the Interreg project a new liming project will also be carried out.

| Party or relevant jurisdiction | EU - UK (England and Wales) |
|---|--|
| Title of project | Salmonid migration and climate change |
| Objective of research project | The main objective of the research is to describe and model the environmental factors affecting the migration of salmonids and to predict the effects of climate change on salmonid migration and survival in the sea. |
| Brief description of research project | Telemetry studies at CEFAS on the movements of post-smolts in coastal waters have provided information on the importance of water currents and tidal streams to the speed and direction of migration. The research project further developed the migration studies to examine the movements and distribution of salmon and sea trout smolts in the marine environment. Models were developed to describe the migration routes of post-smolts in relation to marine currents and sea surface temperature and the results used to predict the impact of oceanographic and climatic conditions on distribution and migration of salmonids in the marine environment. |
| Dates during which research | 1 April 1999 - 31 March 2004 |
| took place | |
| Area in which research took place | Coastal waters around the UK and extending to salmon feeding grounds in Faroes and Greenland seas |
| Estimated number and weight of salmon retained | 250 salmon smolts |
| Resources | |
| Estimated cost of the research project | £140,000 per annum |
| Number of participating scientists | 5 CEFAS scientists |
| Name of coordinating scientist in charge of project | Dr Andrew Moore |
| Details of research vessels, e.g. name, registration, call sign and description of vessel | N/A |
| Type and amount of gear and other equipment used | Acoustic transmitters and automated acoustic receiver systems |
| Details of any collaborating countries | N/A |
| | |

Completed

Status:

Project No. Ew1

Summary of Findings

The key objectives of the research were to describe and model the environmental factors affecting the migration of salmonids and to investigate the effects of climate change on salmonid migration and survival both in fresh water and the sea.

The main findings of the research are as follows:

Migratory behaviour of salmonid smolts and post-smolts

- The migratory behaviour of the sea trout smolts in the River Fowey was similar to populations of both salmon and sea trout in other river systems in England and Wales.
- Smolt emigration in the freshwater section of the river was correlated with increasing water temperature and increasing river flows although no particular threshold was evident for either environmental parameter.
- There was a seasonal difference in the time that tagged smolts spent in the freshwater section of the river before entering the estuary. Fish released later in the season spent less time in the river before emigrating into coastal waters. As a result a significant proportion of the sea trout smolts migrated out of the estuary and into coastal waters during a 10-day period that coincided with a spring tide.
- Migration through the estuary was principally on a spring ebb tide and in the region of the water column with the highest flows. This is energetically the most advantageous strategy for migration and resulted in the fish being moved rapidly out into coastal waters.
- The smolts were pre-adapted in fresh water to the marine environment and as a result there was no requirement to spend long periods acclimating within the estuary during one of the most critical periods in the life-cycle of the sea trout.
- A physiological requirement for smolts to leave fresh water and to enter the marine environment is likely to be the major stimulus initiating the emigration of sea trout smolts in spring.
- In coastal waters salmon and sea trout post-smolts demonstrated active, directed swimming. Migratory behaviour was initiated when the direction of the prevailing tidal currents was suitable to assist the fish in rapid movement away from the estuary mouth and in the case of the salmon in the general direction of the principal feeding grounds in the Norwegian Sea.
- The speed of migrating salmon over the ground was within the range 18-23 cm sec⁻¹, which is similar to the migratory speeds recorded in studies on other salmon populations in UK river systems.
- The physiological transformation of the emigrating fish to full smolt status was necessary for successful migration within the marine environment. Therefore any factors that operate within the freshwater environment to inhibit smoltification (e.g. contaminants or high water temperatures) or delay migration (e.g. estuarine barrages, amenity constructions) will reduce the survival of the post-smolts in the marine environment.

Migratory behaviour of sea trout kelts

- The post-spawning survival of the sea trout was relatively high and over 60% of the tagged kelts emigrated from fresh water and into the coastal zone.
- Seaward migration within fresh water was predominantly nocturnal and generally occurred in conjunction with increasing river discharge and rising water temperature. Post-spawning residency within the freshwater zone was highly variable between individuals, ranging from 4 days to over 2 months.
- Measurements of gill ATPase activity in fish sampled soon after spawning indicated that the fish were not yet physiologically adapted to migrate into saline conditions. However, the subsequent movement through the estuary and into coastal waters was rapid and the fish showed no evidence of a requirement to adapt to the increasing salinities. Physiological adaptation after spawning would therefore appear to be rapid prior to the onset of emigration.
- Migration through the estuary was predominantly nocturnal and occurred during an ebbing tide. This ebb tide form of transport is energetically the most favourable method of movement and migration at night would reduce the level of mortality from visual predators.
- Tagged trout were recorded returning to the river after a period at sea and, in the case of one individual, successfully spawned whilst still retaining the tag in the body cavity.
- The high return rates of tagged sea trout suggests that similar techniques using electronic data storage tags would permit longer-term studies such as the thermal habitat requirements of the sea trout in the marine environment.

Distribution of salmon in the sea

- Attachment methods have been developed to allow data storage tags (DSTs) to be used as part of large-scale studies to determine the distribution of salmon in relation to marine environmental conditions. Existing DSTs can be placed within the body cavities of adult salmon for long-term monitoring of marine environmental conditions although the exteriorisation of the light sensor to permit the geographical position of the fish to be calculated would be necessary.
- A non-invasive technique for monitoring cortisol levels in tagged fish was developed in order to quantify the effect of electronic tag attachment to fish and their subsequent recovery. The technique measures the level of cortisol excreted into the water by individual tagged fish and allows the recovery rate of the fish to be assessed. The technique will be used to quantify the effects of tags on salmon prior to the long-term studies on the distribution and behaviour of salmon in the sea.
- Collaborative links have been developed with international organisations through the NASCO Working Group on International Cooperative Research held in Norway to study the factors regulating populations of salmon in the sea.
- CEFAS contributed to *SALSEA A marine research strategy to determine key factors affecting salmon survival at sea* presented to the EU in 2004 for funding.
- Other opportunities have continued to be investigated for applying DSTs to salmon in the sea and a variety of approaches have been pursued through this project and related work programmes. These have included membership of the Lotek Wireless Ocean Technology Fund Committee (funded by Lotek Wireless) and participation in the Census of Marine Life Pacific Ocean Salmon Tracking Program.
- However, the cost of research programmes has been the main factor in preventing large-scale studies on salmon in the sea.

The impact of climate change on salmonids

- A literature review was completed using the available models and scenarios of climate change and organised into a framework with which to predict the impact on the freshwater and marine environments and subsequent effects on populations of salmon and sea trout over the next 20 and 50 years.
- The climatic information on which the study was based was taken principally from the UK Climatic Impacts Programme (UKCIP) Technical Report 1 and from the NOAA-CIRES Climatic Diagnostics Center and the work on the North Atlantic Oscillation (NAO) by CEFAS, Lowestoft.
- In fresh water, the expected increases in winter temperature and precipitation will be greatest in NW England and in Wales; the highest increase in summer temperatures will occur in SE England where there will be a corresponding reduction in summer and annual rainfall. Warming of rivers should be less than the 1-2°C anticipated for annual mean air temperatures. However, the warming of rivers in winter will probably be more significant for salmonids than increases at other seasons. The frequency of extreme events such as droughts and floods will increase. Increasing abstraction and reduced precipitation will increase the contaminant loading in many rivers and exacerbate their impact on salmonid populations.
- The warming of rivers by 1-2°C will accelerate embryonic and alevin development during the winter, and lead to earlier emergence of fry from the gravels.
- The consequential effects on survival and growth of later stages will depend on a synchronous phenological advancement of food organisms, plant growth and other requirements.
- Survival of eggs and alevins in upland rivers could be reduced should expected higher winter rainfall generate more frequent river spates resulting in wash-out of the embryos.
- Growth rates of salmonid parr will increase significantly as the result of a temperature rise of 1-2°C providing that there is a commensurate increase in their food resources.
- Faster growth could lower the mean age at which parr reach the smolt stage by about 1 year, increasing smolt production for a particular year-class. However, density-dependent regulation would regulate overall smolt production.
- Reduced river flows and lower water temperatures would inhibit or delay the emigration of smolts and their entry into coastal waters. Modification to the timing of the entry of smolts into the marine environment has been shown to affect survival and the return of spawning adults.
- Reduced flows will inhibit and delay the movement of adult spawning salmon into the freshwater environment. Increased temperatures will reduce the amount of suitable thermal habitat for returning salmon. Reproductive success and fecundity may be reduced at higher water temperatures.
- Increases in river flow will facilitate upstream spawning migration and assist the movement around obstacles such as weirs and barrages.
- There are major uncertainties regarding the impact of changes in climate within the marine environment. The various models and predictions indicate either small gradual rises in sea surface temperature, no significant changes, or even slight cooling in those regions occupied by salmon.
- Changes to sea surface temperature and oceanographic features such as currents may modify the distribution and abundance of key prey items of the post-smolts and adult salmon. A mis-match in prey availability during entry into the marine environment may reduce post-smolt survival and growth.
- Changes in sea surface temperatures (SST) will reduce the amount of suitable thermal habitat required for the suitable growth and development of salmon in the sea.
- Changes in oceanographic features such as shelf edge currents may compromise the bio-energetic requirements of the migrating fish and lower survival.

| Project No. Ew2 | Status: Completed |
|---|--|
| Party or relevant jurisdiction | EU (UK - England and Wales) |
| Title of project | Impacts of agricultural contaminants on wild salmonids |
| Objective of research project | The main objective of the research was to describe the nature and extent of the impact of aquatic contaminants derived from agriculture (e.g. pesticides) on migration and marine survival of salmonid smolts and post-smolts. |
| Brief description of research project | Recent research has demonstrated that the freshwater and the marine environments cannot be considered in isolation and that the conditions within the freshwater zone experienced by Atlantic salmon may be critical to their subsequent survival within the sea. In particular, exposure of juvenile salmon to a range of sub-lethal concentrations of freshwater contaminants such as pesticides and endocrine-disrupting chemicals (EDCs) may operate to reduce survival in fish once they have emigrated to sea. The research project described how freshwater contaminants such as the pesticide atrazine can interfere with the parr- smolt transformation and reduce the ability of the fish to physiologically adapt to saline conditions. Laboratory studies have indicated that smolts exposed in freshwater to environmental levels of the pesticide atrazine have reduced levels of gill Na+K+ATPase activity and plasma ion concentrations. Subsequent exposure to seawater resulted in poor hypo-osmoregulatory performance and mortality. In addition, modification of the physiological processes involved during smoltification by pesticides may also delay or inhibit smolt migration. The results of the studies have been incorporated into existing life-cycle models to determine the impact of freshwater contaminants on salmon at the stock and population level. |
| Dates during which research took place | April 1999 - April 2004 |
| Area in which research took | England and Wales |
| place | |
| Estimated number and | N/A |
| weight of salmon retained | |
| Resources Estimated cost of the research project | £425,000 (over 5 years) |
| Number of participating scientists | 6 |
| Name of coordinating scientist in charge of project | Dr Andy Moore |
| Details of research vessels, e.g. name, registration, call sign and description of vessel | N/A |
| Type and amount of gear and other equipment used | N/A |

| Details of any collaborating | Sweden and Canada |
|------------------------------|-------------------|
| countries | |
| Summary of Findings | |

The key objectives of the research were to identify and describe the effects of environmental levels of agricultural pesticides on salmonid embryo survival, smolt emigration and marine survival and to model their potential impacts at the population level. In addition, the role of pheromones in sea trout biology was investigated in order to predict the effects of water quality on sea trout reproduction.

The main findings of the research are as follows:

- Exposure of juvenile salmon during the parr-smolt transformation to environmentally relevant levels of the herbicide atrazine inhibited smoltification and reduced the ability of the fish to adapt to salt water conditions. Smolts exposed in fresh water to atrazine demonstrated low survival when transferred to seawater.
- Exposure of juvenile salmon during the parr-smolt transformation to environmentally relevant levels of the herbicide atrazine inhibited or delayed downstream migratory behaviour during the spring.
- Exposure of juvenile salmon during the parr-smolt transformation to mixtures of environmentally relevant levels of the herbicide atrazine and the endocrine-disrupting chemical 4-nonylphenol inhibited smoltification and reduced the ability of the fish to adapt to salt water conditions. Mixtures of the two contaminants operated synergistically to reduce survival when the fish were transferred to seawater.
- Exposure of juvenile salmon during the parr-smolt transformation to mixtures of environmentally relevant levels of the sheep dip insecticides diazinon and cypermethrin had no significant effect on smoltification or reduced the ability of the fish to adapt to salt water conditions.
- Exposure of juvenile salmon during the parr-smolt transformation to environmentally relevant levels of the brominated flame retardant PBDE inhibited smoltification and reduced the ability of the fish to adapt to salt water conditions. Smolts exposed in fresh water to PBDE demonstrated low survival when transferred to seawater.
- The freshwater environment cannot be considered in isolation from the marine environment. The contaminants that juvenile salmon are exposed to within the freshwater environment can have a direct impact on their subsequent survival within the sea.
- Exposure to environmentally relevant levels of the sheep dip insecticides diazinon and cypermethrin for a brief period during fertilisation inhibits or delays the timing of emergence of fry from the spawning gravel. Exposure to the insecticides also reduces the subsequent survival and development of salmonid fry.
- Exposure of fertilised salmon and sea trout embryos to sediments containing environmentally relevant levels of the sheep dip insecticides diazinon and cypermethrin reduces survival and inhibits or delays the timing of emergence of fry from the spawning gravel.

- The sea trout has a similar reproductive pheromone system to the Atlantic salmon and is likely to be affected by environmental contaminants in the same way and that has been previously shown for Atlantic salmon. The shared reproductive pheromone system may further explain the occurrence of hybridisation in certain sympatric populations.
- Exposure of mature male trout to mixtures of the pesticides diazinon and cypermethrin inhibited the ability of the fish to detect and respond to the reproductive priming pheromone Prostaglandin $F_{2\alpha}$. As a result there was no significant increase in the levels of milt that are required for successful reproduction.
- The life-cycle model developed in order to predict the potential effects of environmental contaminants on Atlantic salmon at the population level predicted that exposure to contaminants during fertilisation, smoltification and reproduction result in a significant decline in the number of returning adult fish, particularly in exploited stocks.

| Project No. Ew3 | Status: | Completed |
|--|--|--|
| Party or relevant jurisdiction | EU (UK – Engl | and and Wales) |
| Title of project | Impact of inte | nsive in-river aquaculture on wild salmonids |
| Objective of research project | The main object of the impact of aquaculture (effective reproduction ar | tive of the research was to describe the nature and extent f aquatic contaminants derived from intensive freshwater effluents, pesticides, antibiotics and hormones) on ad migration of wild salmonids. |
| Brief description of research project | agricultural pess reproduction, e marine environ be released wi and these inclu and bacterial di farmed fish. hormones/phere reproductive sta clear to what e affect reproduct whether they c aim of the press environmentall salmonid repro- relevant contain the freshwater the effects of th of post-smolts The results were to increase of | es have demonstrated that sublethal concentrations of tricides and contaminants may significantly affect salmon mbryo survival and the ability of smolts to adapt to the ment. A similar variety of compounds are also known to thin the effluents from freshwater aquaculture facilities de pesticides and antibiotics for the control of parasitic iseases, and hormones and hormone metabolites from the Recent studies have also indicated that these omones have an important role in increasing the atus of wild salmon prior to spawning. However, it is not extent the contaminants within fish farm effluents may ction, migration and survival of wild salmonids and ould result in serious declines in salmonid stocks. The sent research programme was to describe the impact of y relevant concentrations of fish farm contaminants on duction and migration. Firstly, the concentrations of ninants (pesticides and hormone/pheromones) entering environment were determined and described. Secondly, uese contaminants on reproduction/spawning and survival in the marine environment was assessed and described. re incorporated into salmonid life-cycle models, in order our understanding of the impacts of aquaculture n stocks of salmonids. |
| Dates during which research took place | November 200 | |
| | England and W | ales |
| Estimated number and weight of salmon retained Resources | N/A | |
| Estimated cost of the research project Details of the full economic costs of each study are requested, including staff costs, | £325,000 (ove £72,000 per at | |
| <i>equipment and overheads.</i> Number of participating scientists | 4 | |

| Name of coordinating scientist in charge of project | Dr Andy Moore andy.moore@cefas.co.uk |
|--|---|
| Details of research vessels, e.g. name, registration, call sign and description of vessel | N/A |
| Type and amount of gear and other equipment used | N/A |
| Details of any collaborating countries | N/A |
| Summary of findings | |

Summary of findings

The study investigated the effects of trout farms (both rainbow trout farms and brown trout) on both reproduction and smoltification in Atlantic salmon. The research involved laboratory-based studies on the impacts of identified contaminants within the fish farm effluents on salmon reproduction, smoltification and the ability of smolts to adapt to sea water. In addition, field-based studies were carried out where both male salmon and salmon smolts were caged upstream and downstream of rainbow and brown trout fish farms to investigate the impact of the effluents on physiology and survival. The majority of the research was undertaken at an intensive rainbow trout farm on the River Test at Romsey and a brown trout farm at Netheravon on the River Avon. Additional studies were undertaken at a mixed rainbow/brown trout farm at Stockbridge on the River Test. The research has indicated that the effluents from fish farms can have significant impacts on Atlantic salmon particularly during sensitive life-history stages such as reproduction and smoltification. In addition, effluents from rainbow trout farms may also have a deleterious effect on the macro-invertebrate populations, which include many of the prey items of juvenile salmonids.

| Project No. Ew4 | Status: Completed |
|---|---|
| Party or relevant jurisdiction | EU - UK (England and Wales) |
| Title of project | Modelling the bioenergetics of salmon migration |
| Objective of research | The principal objectives of the research was to model the energetic |
| project | requirements of salmon during their marine migrations and predict the effects of environmental and oceanographic changes on smolt growth and survival. |
| Brief description of research project | Successful migration of salmon within the marine environment requires that sufficient energy stores are either available prior to, or replenished throughout, migration. Therefore, the overall energy budget of a smolt may be an extremely important factor contributing to the migratory success, growth and survival in the sea. The project developed a model to describe the basic energy requirements of salmon and how it is utilised for movement, maintenance and growth in the marine environment. The model was used to predict the effects of environmental and oceanographic changes (e.g. sea surface temperature, ocean currents, food availability) on smolt growth and survival in the sea. |
| Dates during which research took place | April 2002 – April 2005 |
| Area in which research took | The research will model the migrations of selected stocks of salmon |
| place | from English and Welsh rivers. |
| Estimated number and weight of salmon retained | N/A |
| Resources | |
| Estimated cost of the research project | £40,000 per annum |
| Number of participating scientists | 2 CEFAS scientists |
| Name/e-mail of | Dr Andrew Moore |
| coordinating scientist in charge of project | a.moore@cefas.co.uk |
| Details of research vessels, e.g. name, registration, call sign and description of vessel | N/A |
| Type and amount of gear and other equipment used | N/A |
| Details of any collaborating countries | N/A |

Summary of findings

The aim of the research was to develop a numerical model for investigating potential changes in the growth and survival of Atlantic salmon during the marine phase arising from changes in smolt condition or oceanic conditions. A numerical model was designed to calculate growth and survival resulting from spatial and temporal patterns of physical oceanographic conditions, specifically ocean currents, sea surface temperature and prey availability. The results of the different modelling scenarios suggest that, during their oceanic phase, salmon may be capable of adapting to future climate change provided that their migration routes are not inherited and guided by cues other than temperature (e.g. celestial or wave patterns). However, the ability to predict the effects of climate change on salmon populations is limited by a lack of knowledge about migration behaviour, which in turn is due to the paucity of observations of salmon movements and growth in the open sea.

| Party or relevant jurisdiction | EU – UK (England and Wales) |
|---|--|
| Title of project | Cardiff Bay Fisheries Monitoring Programme |
| Objective of research | Assess the impact of Cardiff Bay Barrage on salmon and sea trout |
| project | stocks in rivers Taff and Ely |
| Brief description of research | 1. Tracking movements of adult salmon up to and past barrage and |
| project | through impoundment using contained acoustic and radio tags. |
| | 2. Tracking movements of smolts through impoundment and past |
| | barrage. |
| | 3. Monitoring changes in the return rates of microtagged smolts (hotohom) origin) before during and after construction |
| Datas during which research | (hatchery origin) before, during and after construction. |
| Dates during which research | Through years 1990-2006 |
| took place Area in which research took | Cardiff Day at mouth of rivers Toff Ely, South Walso, UK |
| | Cardiff Bay at mouth of rivers Taff, Ely, South Wales, UK |
| place Estimated number and | Up to 20 per year |
| weight of salmon retained | Op to 20 per year |
| Resources | |
| Estimated cost of the | c. £250,000 per annum |
| research project | |
| Number of participating | 5/6 per annum |
| scientists | |
| Name of coordinating | Peter Gough |
| scientist in charge of | peter.gough@environment-agency.wales.gov.uk |
| project | |
| Details of research | 'Challanger' |
| vessels, e.g. name, | |
| registration, call sign | M00WB70085 |
| and description of | |
| vessel | 7-4 Metres long |
| Type and amount of | <60 C.A.R.T tags pa. |
| gear and other | |
| equipment used | 40-50 smolt tags pa. |
| | |
| | 10,000 - 70,000 micro-tagged and/or fin-clipped smolts stocked each |
| | year. |
| Details of any collaborating | None |
| countries | |
| Summary of Progress | |
| | |
| | |

Completed

Status:

Project No. Ew5

| Project No. Ew6 | Status: Completed |
|--|---|
| Party or relevant jurisdiction | EU (UK – England and Wales) |
| Title of project | Atlantic Salmon Arc Project, ASAP |
| Objective of research project | Define exploitation at sea on a regional basis using genetic tools. Create a long-term database for these studies and create an international management tool to inform decision-making. |
| Brief description of research project | A Europe wide collaboration to define tools for genetic metapopulation studies culminating in a Europe wide effort that collected samples from all the regions and genotyped using defined methods and took first steps to assess proportional stock exploitation at sea. Microsatellite analysis was the method used. The genetic laboratories directly involved were Exeter University and Oviedo University. |
| | There were many associated partners in the study helping to collect salmon samples from the rives of the North Atlantic; however, the funded partners in the study are: Central Fisheries Board of Ireland Westcountry Rivers Trust (Lead partner) Association of West Coast Fisheries Trusts Oviedo University Asturias government Galician Government Exeter University. |
| Dates during which research took place | May 2004 – July 2008 |
| Area in which research took place | Europe, North Atlantic |
| Estimated number and weight of salmon retained | N/A |
| Resources | |
| Estimated cost of the | £2.2 million |
| research project | Approximately £550,000 per annum |
| Number of participating scientists | 12 |
| Name/e-mail address of | Dr Dylan Bright |
| coordinating scientist in charge of project | dylan@wrt.org.uk |
| Details of research vessels, e.g. name, registration, call sign and description of vessel | N/A |
| Type and amount of gear and other equipment used | N/A |
| Details of any collaborating countries | Spain, France, Ireland, Scotland, USA, Iceland |
| Summary of Progress | |

The ASAP project has successfully completed its first phase. A database of salmon population genotypes has been defined for Spain, France the UK and Ireland. The database

has been blind tested and shows a very good level of discrimination in assigning salmon from different regions to their correct population of origin and destination. The database has been tested with samples from small inshore net fisheries in the UK and it has been demonstrated that in most cases these fisheries are exploiting multiple populations. The database has been used in collaboration with the Marine Institute to examine the destination and origin salmon represented by an extensive suite samples from Irish Inshore and Offshore fisheries. The findings from this study are in press. Details of each population used in the database and the details of each of the rivers of origin are available online in an interactive, multilingual web based GIS. Data is only partially uploaded to the data base at present.

| Project No. Ew7 | Status: Completed |
|---|---|
| Party or relevant jurisdiction | EU (UK – England and Wales) |
| Title of project | Diffuse pollution and freshwater fish populations |
| Objective of research project | The main objective of the research was to investigate the role of diffuse aquatic contaminants in regulating populations of freshwater fish with particular reference to salmonid stocks and fisheries. |
| Brief description of research project | There is increasing evidence from studies carried out in Europe and North America that contaminants derived principally from intensive agriculture and in-river aquaculture may have significant effects on salmonids at specific periods during the life cycle (e.g. spawning and reproduction, embryo development, migration, parr-smolt transformation and/or entry into saltwater) at concentrations frequently found in the environment. Initial modelling from these laboratory-based studies has indicated that exposure at these critical stages may affect productivity at the population level. The present research programme had two principal aims. Firstly, to validate the results from the laboratory based studies carried out under SF0228 – <i>Impacts of agricultural contaminants on wild salmonids</i> , and determine whether exposure to these contaminants within river systems in England and Wales are affecting populations in the wild. The research tested the conclusions made about the effects on populations of wild salmon by the retrospective analyses of the relationship between specific declining stocks and land management changes resulting in the occurrence of target contaminants in the aquatic environment. Secondly, recent monitoring of the aquatic environment has highlighted the presence of novel contaminants whose chemical structure and toxic mechanisms are known to target important biological processes in fish and which may significantly compromise and regulate populations. These contaminants include specific pharmaceuticals, antibiotics from intensive agriculture and aquaculture and brominated flame retardants from industry. The research therefore determined the potential impacts of these contaminants on fish at both the individual and population level in order to support both the advice on the regulation of contaminants within aquatic ecosystems and the conservation and management of fish populations. |
| Dates during which research took place | April 2005 – March 2010 |
| Area in which research took | England and Wales |
| place | |
| Estimated number and weight | |
| of salmon retained | N/A |
| Resources | |
| Estimated cost of the research project | £694,680 (over 5 years) of which £68,500 was added to research on salmon at sea. |
| Number of participating scientists | ىى |

| Name/e-mail address of | Dr Andrew Moore |
|------------------------------|---------------------|
| coordinating scientist in | a.moore@cefas.co.uk |
| charge of project | |
| Details of research | N/A |
| vessels, e.g. name, | |
| registration, call sign and | |
| description of vessel | |
| Type and amount of gear | N/A |
| and other equipment to | |
| be used | |
| Details of any collaborating | N/A |
| countries | |
| Details of research | N/A |
| vessels, e.g. name, | |
| registration, call sign and | |
| description of vessel | |
| Type and amount of gear | N/A |
| and other equipment to | |
| be used | |
| Details of any collaborating | N/A |
| countries | |
| Summary of Progress | |

There is now evidence from stud

There is now evidence from studies carried out in Europe and North America that contaminants derived principally from intensive agriculture may have significant effects on salmonids at specific periods during the life cycle, often at concentrations frequently found in the environment. In particular, research carried out at the Cefas, Lowestoft Laboratory has indicated that a range of pesticides may compromise Atlantic salmon (*Salmo salar* L.) sense of smell, reproduction, embryo development and the parr-smolt transformation and/or entry into saltwater. This research has highlighted that in terms of the life cycle of the Atlantic salmon, the freshwater and marine environments cannot be considered in isolation and that exposure to poor water quality in freshwater may be a key factor influencing survival of the fish once they migrate into the sea. However, the majority of this research was based on laboratory experiments and there is a requirement to determine whether exposure to environmentally relevant contaminants within river systems in England and Wales are indeed affecting populations in the wild.

Therefore, the present research programme had two principal aims. Firstly, to validate the results from the laboratory based studies carried out under a previous Defra funded research programme SF0228 – *Impacts of agricultural contaminants on wild salmonids*, and determine whether exposure to these contaminants within river systems in England and Wales are affecting populations in the wild. Secondly, recent monitoring of the aquatic environment has highlighted the presence of novel contaminants whose chemical structure and toxic mechanisms are known to target important biological processes in fish and which may significantly compromise and regulate populations. These contaminants include specific pharmaceuticals, antibiotics from intensive agriculture and aquaculture and brominated flame retardants from industry. The present research examined the potential impacts of these contaminants on fish at both the individual and population level in order to support the advice to the Policy Customer on the regulation of contaminants within aquatic ecosystems and the conservation and management of fish populations.

The specific objectives of the research programme were:

1. To determine the impact of novel diffuse contaminants on juvenile salmon with specific reference to development, olfactory imprinting, run-timing and behaviour within the marine environment.

2. To determine the impact of novel diffuse contaminants on adult salmon with specific reference to freshwater entry, homing, and fecundity in female salmonids.

3. Determine the relationship between specific declining salmon stocks, land management changes and occurrence of target contaminants in the aquatic environment.

4. To assess the effects of diffuse contaminants on the biology of salmon within wild populations.

5. To provide recommendations to Policy Division for any required remedial action to reduce the impacts on diffuse contaminants on fish populations.

Laboratory and field based experiments have formed the basis of the research to determine the impact of contaminants on juvenile and adult salmon. The contaminants that were selected for study are known to routinely occur in rivers during the period of the parr-smolt transformation and seaward migration of the smolts and during the spawning season. The concentrations of the contaminants studied also reflect the levels that may occur routinely in the rivers and tributaries and so are therefore relevant to many salmonid populations. Extensive literature and data based investigations formed the basis for the studies examining the relationship between the decline in salmonid stocks and the occurrence of specific agriculture derived contaminants within river catchments.

The major findings of the research were that contaminants such as the brominated flame retardants, which are known to mimic thyroid hormones, significantly disrupt the parr-smolt transformation process whereby the juvenile salmon undergo a number of physiological and behavioural changes that adapt them to a life in the ocean. Specifically, hexabromocyclododecane reduces the olfactory ability of the fish to detect odours that are considered important during the imprinting process during which the emigrating fish remember the "smell" of their home river and subsequently use this to home to their natal tributaries as spawning adults. Exposure of salmon smolts to hexabromocyclododecane was also shown to reduce the survival of the fish during the transition from freshwater and into the sea. Exposure of salmon smolts in freshwater to environmental levels of the imprinting period. The results clearly demonstrate that exposure of salmon smolts to environmental levels of a range of diffuse contaminants inhibits olfactory function, which is known to play a pivotal role in the imprinting process and the subsequent homing of adult salmon to their natal river.

Diffuse contaminants were also demonstrated to interfere with female salmonid reproduction and the subsequent survival of the eggs and embryos. Eggs exposed to atrazine during fertilisation had a 66% higher risk of mortality compared to control eggs for every microgram per litre of atrazine in the water. Comet assays also indicated that in those surviving eyed eggs, 30 days after fertilisation, DNA damage was higher in the eggs that had been fertilised in the water containing both $0.5\mu g/l$ or $2.0\mu g/l$ atrazine. Exposure to polycyclic aromatic hydrocarbons (PAH) produced modifications to the kidney structure of the female fish, as well as lower levels of intestine Na⁺K⁺ ATPase activity. This may indicate that the female fish are under physiological stress as a result of PAH exposure. There was also a significant difference in the subsequent survival of the eggs after 50 days, which had been fertilised in PAH water compared to the controls. Once again exposure of eggs to contaminants during fertilisation have a poorer survival rate than those fertilised in "clean" water.

It proved difficult to obtain suitable data with which to investigate relationships between pesticide concentrations in the catchments and variations in salmon stocks. However, in the River Avon rod catches of salmon were lower in years when the atrazine levels were high, and similar correlations were shown between the level of another triazine herbicide (simazine) rod catch in this river. Such results may be informative, but must be interpreted with great care.

The incorporation of the laboratory and field-based experimental data into the life cycle model of the salmon demonstrated that low levels of environmental contaminants can have a serious impact on both individuals and populations of salmonids. As more data is gathered, both from laboratory and field-based research programmes the models and the predictions will become more robust.

| Project No. Ew8 | Status: Completed |
|--|---|
| Party or relevant jurisdiction | EU (UK – England and Wales) |
| Title of project | The influence of the freshwater environment on salmonid populations |
| Objective of research project | This is a large research project examining the impact of environmental change on juvenile salmon production and ecology |
| Brief description of research project | One aspect of the research that is directly related to marine survival examines the potential role of assessment techniques in influencing marine survival of salmonid smolts. Assessment methodologies such as trapping, anaesthetisation and tagging of wild/hatchery fish could affect the ability of smolts to adapt and survive in fresh or saline water and there is a need to identify any such effects in order to ensure best possible practice in assessment programmes. The proposed research will critically assess the techniques routinely used as the tools for population assessments and that provide the basis for the provision of advice to managers on biological reference points, the status of stocks and management measures for specific fisheries. |
| Dates during which research took place | April 2005 – March 2010 |
| Area in which research took place | England and Wales |
| Estimated number and weight of salmon retained | N/A |
| Resources | |
| Estimated cost of the research project | £615,350 (over 5 years) of which £72,700 was added to research on salmon at sea |
| Number of participating scientists | 3 |
| Name/e-mail address of coordinating scientist in charge of project | Dr Andrew Moore a.moore@cefas.co.uk |
| Details of research vessels, e.g. name, registration, call sign and description of vessel | N/A |
| Type and amount of gear and other equipment used | N/A |
| Details of any collaborating countries Summary of Findings: | N/A |

Summary of Findings:

In recent years declines in salmon catches and shifts in population structure involving a diminishing of the multi-seawinter fish component have given concern for many salmon populations throughout the NE Atlantic. Although there has been much recent concern regarding the factors influencing and regulating populations of salmon in the sea, it is now accepted that conditions within freshwater also play a pivotal role to a juveniles salmons subsequent survival within the marine environment. However, human pressures on freshwater environments continue to mount and the effects of these are likely to be exacerbated by climate change. There is, therefore, a requirement to understand how the predicted changes in river flow may modify wild populations of juvenile salmonids.

There is increasing evidence that juvenile salmon migrate downstream in the autumn in a wide range of river systems throughout the NE Atlantic. However, the extent and range of movement of these fish and their distribution and habitat requirements during the winter and prior to the spring smolt migration are not known. If such movements are widespread in UK rivers, it could have significant effects on our approaches to stock monitoring and assessment, the evaluation of factors affecting stocks, particularly during the critical transition between freshwater and marine environments and the development of management strategies.

Assessment methodologies such as trapping, anaesthetisation and tagging of wild/ hatchery juvenile salmon could subsequently affect the ability of the fish to adapt and survive in fresh or saline water and there is a need to identify any such effects in order to ensure best possible practice in assessment programmes.

There is also increasing concern regarding the potential impact on ecosystems of increasing levels of artificial light throughout the northern hemisphere. Much of our inland waters are now affected by light pollution, which has the potential to affect salmon at a number of stages throughout their life cycle.

Therefore, the main objectives of the research were to:

Investigate the impact of changes in freshwater river flows expected to result from the predicted climate change scenarios on juvenile salmon production in rivers in England and Wales and determine how these should be managed.

Determine the abundance and distribution of the autumn migrant component of salmonid populations in rivers and estuaries in order to assess their relative contribution to smolt production and determine the effects on current stock assessment and management practices;

Critically assess the techniques routinely used for population assessments in the development of advice to managers on stock assessments, biological reference points and management measures for specific fisheries and propose appropriate improvements.

Review the known information on the impact of diffuse artificial light pollution on freshwater fish populations in order to assess the potential problem and provide recommendations on appropriate research.

Objective 1. Investigate the impact of changes in river flows expected to result from the predicted climate change scenarios on juvenile salmon production in rivers and determine how these should be managed.

The effects of managed severe low summer flow events on habitat use, displacement and survival of wild populations of juvenile salmon, trout and grayling were investigated in a small chalk stream. Significant changes in habitat use and range of movement were identified, many associated with the loss of the stream margins under low flow. However, with no net downstream movement of any species under low flow, displacement was spatially limited. There was an increase in the mortality rate in first year salmon, trout and grayling. This may be related to their small size and increased vulnerability to predation under low flow conditions due to the reduction in depth and loss of the stream margins that are their preferred habitat under normal flow. The findings have implications for the management of chalk streams. In particular, they underline the importance of the stream margins as juvenile salmonid habitat, and suggest that a flow management strategy is required to combat drought conditions.

Conversely, subsequent investigations suggested that low spring flow at the same study site in 2007 had little, or no, impact on the migratory behaviour of wild salmon smolts.

Objective 2. Determine the abundance and distribution of the autumn migrant component of salmon populations in rivers and estuaries in order to assess their relative contribution to smolt

production and determine the effects on current stock assessment and management practices.

The autumn juvenile salmon migration on the R. Frome was monitored between 2005-2007, in collaboration with Centre for Ecology and Hydrology (CEH). The results found the size of the autumn migration to be significant. Subsequent investigations have confirmed a contribution by autumn migrating part to the returning adult stock.

Integrated laboratory and field investigations were carried out to determine whether autumn migrants are physiologically adapted for migration into saline water. The results showed that the juvenile salmon migrating downstream on the R. Frome in autumn, and those fish that were subsequently found in the tidal reaches during the winter, were not sufficiently physiologically adapted to survive entry to seawater. Therefore, this autumn migration of parr represents a habitat shift to the lower freshwater reaches of the river.

If such findings are generic to salmon populations, it would have important implications for fisheries managers, and catchment scale management plans, which should now take account of the tidal reaches as important juvenile salmon habitat. Further, stock-monitoring programmes that do not account for autumn migrations to the lower river, or any inter-annual variation in their abundance, will under-estimate total smolt output, with a consequential under-estimation of marine mortality, and confound the interpretation and comparison of marine mortality and adult return rates.

Objective 3. Critically assess the techniques routinely used for population assessments in the development of advice to managers on stock assessments, biological reference points and management measures for specific fisheries and propose appropriate improvements.

Integrated field and laboratory investigations found that both the migratory behaviour and ability survive in saline water of some salmon smolts is affected following tagging. Previous studies have suggested that natural smolt migration patterns are a predator avoidance tactic and also ensure that the fish enter the marine environment at the optimum time. Therefore, any such disruption may increase the rate of predation on these fish or impact on their fitness to survive at sea.

Differences in adult return rates between wild salmon tagged as smolts and a control population are currently being determined on the River Frome, in collaboration with CEH. At present the number of returns is too small for useful statistical comparison, however this study is ongoing, with more returns expected from the 2007, 2008 and 2009 smolt migrations. Applying the precautionary approach until the results of this large-scale field based investigation are known, we provisionally recommend that fisheries scientists carefully consider the costs/ benefits of the capture, handling and tagging of salmon smolts and ensure that they can account for any potential bias these commonly used marking methodologies may have on their experimental results before commissioning programmes which involve handling smolts. **Objective 4. Review the known information on the impact of diffuse artificial light pollution on freshwater fish populations in order to assess the potential problem and provide recommendations on appropriate research.**

Our extensive literature review revealed large gaps in our knowledge on this subject. Indeed, detailed case studies on the impact to wild freshwater fish were noticeable only by their absence. As a consequence, we strongly recommend that research programmes on this subject be commissioned.

| Project No. Ew9 | Status: Completed |
|--|---|
| Party or relevant jurisdiction | EU (UK - England and Wales) |
| Title of project | Factors affecting the distribution and behaviour of salmonid populations |
| Objective of research project | The main objective of the research is to investigate the habitat requirements of adult salmonids within the estuarine and freshwater environments. However, one key element of the study is to investigate how changes in prey availability within the marine environment may influence recruitment of stocks between years. |
| Brief description of research project | Potential changes in the marine environment such as suitable water temperature and changes in oceanographic circulation patterns may influence the migration routes, growth, run-timing and survival of salmon in the sea and these changes will be influenced further by modifications to the climate. It has also been hypothesised that these changes in marine conditions may regulate salmon populations through modifying the distribution and abundance of key prey items. Therefore, variations in the numbers of returning adults may be directly correlated to previous feeding conditions in the open sea. One potential method to test this hypothesis is to retrospectively measure the stable isotopic composition of salmon scales, which reflect the isotopic composition of the prey items. Changes in the abundance or availability of specific food items may show up as changes in the stable isotopes within salmon scales. The purpose of the research is to investigate using this method whether "poor" years in terms of adult recruitment can be related to changes in productivity and the availability and quality of key prey species within the marine environment. This study will also form part of the programme of research on salmon in the sea being co- ordinated by NASCO. |
| Dates during which research took place | April 2005 – March 2010 |
| Area in which research took place | |
| Estimated number and weight of salmon to be retained Resources | N/A |
| Estimated cost of the research project Number of participating scientists | £721,830 (over 5 years) of which £67,000 is related to research on salmon at sea. |
| Name/e-mail address of coordinating scientist in charge of project | Dr Andrew Moore a.moore@cefas.co.uk |
| Details of research vessels, e.g. name, registration, call sign and description of vessel | N/A |

| Type and amount of gear | N/A |
|------------------------------|-----|
| and other equipment used | |
| Details of any collaborating | N/A |
| countries | |
| Summony of Findings | |

Summary of Findings:

This programme had three parallel themes addressing the factors that might affect the distribution and behaviour of adult salmon in the sea, estuaries and freshwater.

Although there has been a substantial amount of research on the habitat requirements of juvenile salmonids and the factors controlling the emigration and behaviour of smolts, there has been very little understanding of the environmental mechanisms controlling the entry, migration and the habitat requirements of adults within estuaries. In many river estuaries returning salmon congregate in holding areas for variable periods waiting for suitable freshwater conditions before continuing their spawning migration. This may make salmon stocks very susceptible to adverse conditions but losses may often go unnoticed. However, there is little information on the physical and water quality characteristics of these areas, their temporal and spatial distribution or the environmental and anthropogenic factors that may affect them. The purpose of the research is to describe the behaviour of adult salmon in estuary systems prior to freshwater entry and of salmon kelts as they return to sea. One of the potential causes of the decline in salmon stocks may be modification to the freshwater environment that result in changes to the thermal regime, thereby reducing the habitat available to salmon and affecting their survival and reproductive success. Such changes could be due to general climate warming and/or changes in flow regimes due to agricultural and other land-management

practices, such as groundwater abstraction. The purpose of the research is to establish whether or not the freshwater thermal environment in rivers in England and Wales impacts on the migratory behaviour, and reproductive success of adult salmonids.

Potential changes in the marine environment such as suitable water temperature and changes in oceanographic circulation patterns may influence the migration routes, growth, run-timing and survival of salmon in the sea and these changes will be influenced further by modifications to the climate. It has also been hypothesised that these changes in marine conditions may regulate salmon populations through modifying the distribution and abundance of key prey items. Therefore, variations in the numbers of returning adults may be directly correlated to previous feeding conditions in the open sea. The purpose of the research is to investigate using this method whether "poor" years in terms of adult recruitment can be related to changes in productivity and the availability and quality of key prey species within the marine environment.

The research was conducted using an integrated approach of field-based telemetry studies and laboratory investigations. Much of the telemetry work was conducted on the River Tyne, north east England. Returning salmon and sea trout were caught in the lower estuary and their subsequent movements monitored using an acoustic telemetry system consisting of individually coded transmitters and an array of submersed receivers. Data was obtained of the patterns of behaviour through the estuary, into freshwater and, for those fish that survived the ordeal of the spawning migration, their emigration back out to sea. Smaller studies were also conducted on other river systems. Data from this aspect of the programme revealed detailed and novel information on many aspects of migratory behaviour, including; swimming depth behaviour of returning salmon and emigrating kelts, impacts of seal predation and previously unreported data on the behaviour of salmon in freshwater holding pools. The findings of this work provide practically useful information that will aid the protection of adult salmon in estuaries and rivers and open up new areas of research into thermal refuging, predation, energy dynamics, olfactory response and the impacts of estuarine engineering projects (e.g. pile driving and tidal barrages).

The laboratory studies had two objectives. The first, focused on investigating the effect of temperatures within the range experienced by wild salmonids, on gonad investment, egg production and reproductive success in hatchery reared fish. This was achieved by holding adult and juvenile salmonids in climate controlled tank facilities under various thermal conditions at specific stages in their life cycle. The results suggest that water temperatures can influence the level of gonad investment, timing of ovulation and the trade-off between the number and size of eggs produced by migratory salmonids. These findings have implications for population models that do not take account of the variation in egg numbers, reproductive success and subsequent offspring fitness of spawning anadromous salmonids. The second objective was to investigate the relationship between marine prey consumption and recruitment of adult salmon. This was achieved by retrospective measurement of the stable isotopic composition of salmon scales. Scales reflect the isotopic composition of the prey items and therefore changes in the abundance or availability of specific food items may show up as changes in the composition of salmon scales. The results revealed cyclical patterns in the level of carbon isotope that are likely to reflect cyclical variations in the North Atlantic Oscillation (NAO). These patterns explained a large proportion of variation in the numbers of adult salmon returning to regional waters. This implies that there will be greater returns of adult salmon (relative to the number of juveniles entering the ocean) following higher levels of primary production. It also suggests that high winter temperatures leading to smaller phytoplankton blooms, less enriched δ^{13} C values and therefore less favourable trophic conditions for salmon at sea, may increase mortality perhaps by nutritional stress. Techniques developed within this programme provide a wide range of future research opportunities, including further investigations on the influence of ocean productivity on regulating fish populations

The research has continued to examine salmon scale microchemistry in order to determine the potential role of climate/environmental change in regulating populations within the marine environment.

| Project No. Ew10 | Status: Ongoing |
|---|---|
| Party or relevant jurisdiction | European Union – United Kingdom (England, Wales, Northern Ireland and Scotland) |
| Title of project | Genetic sampling to type British salmon stocks |
| Objective of research project | Coordinate and support the establishment of baseline information on the genetic character of breeding populations within and among rivers in Britain. |
| Brief description of research project | The initial aim will be to provide the basis for identifying salmon to specific rivers or regions to assist in a range of stock assessment and management scenarios (e.g. management of mixed stock fisheries). Subsequently it may be possible to answer a range of additional questions relating to the size and structure of breeding populations, levels of exploitation, and the contribution of stocked fish. The study will also provide a tool that may be used in a variety of other scientific investigations. |
| | The project will complement the work already undertaken to characterise genetically salmon river stocks in Ireland, and for optimum benefit will build on the sample collection and analysis currently budgeted for under the SALSEA MERGE programme. Sampling of fry and parr will be conducted in the main spawning areas of a range of rivers in Scotland, England and Wales as required to supplement sampling that has already been undertaken or is planned under other contracts (e.g. ASAP and SALSEA MERGE). Genetic analyses will be undertaken using the same techniques and markers (micro-satellites) as in those other studies. |
| | The project will be overseen by a Steering Group which will coordinate and support the establishment of the baseline genetic information. In additional, a Technical Working Group will: Determine how best to achieve the overall objective Provide technical advice Coordinate methodologies |
| | Participants in the programme will include Environment Agency, AFBNI, Defra/Cefas, Marine Institute, Scottish Government, Association of River Trusts, FRS, AFTS / DSFBS |
| Dates during which research will take place | 1 April 2008 - 31 March 2010 |
| Area in which research will take place | England, Wales, Northern Ireland and Scotland. |

| Estimated months and second the | 50 f |
|--|---|
| Estimated number and weight of salmon to be retained | 50 fry and 50 part per population sampled. |
| of samon to be retained | No adults will be killed specifically for this project but samples will be taken from fish coucht in the red and not fishering |
| D | be taken from fish caught in the rod and net fisheries. |
| Resources | |
| Estimated cost of the | £120 k (total) |
| research project | |
| | £20 k (staff costs includes overheads) |
| Number of participating | 10 |
| scientists | |
| Name and e-mail address | Miran Aprahamian |
| of coordinating scientist in | 1 |
| charge of project | Miran.aprahamian@environment-agency.gov.uk |
| | |
| Details of research | No RVs involved |
| vessels, e.g. name, | |
| registration, call sign and | |
| description of vessel | |
| Type and amount of gear | |
| and other equipment to be | N/A |
| used | N/A |
| ubou | |
| Details of any collaborating | England and Wales, Scotland |
| countries | |
| countries | |
| S f D | |
| Summary of Progress | |

Summary of Progress:

Juvenile salmon samples have been collected from 65 sites on 24 rivers in North East and North West England, and from South West Wales. These have been sent to Exeter University and FRS Pitlochry for analysis. Sampling in summer 2010 will target the few remaining rivers that have so far not been sampled in North Wales and South West England. In addition, samples will be sought from the net fisheries that we regulate.

| Deriving estimates of marine survival for monitored river stocks in England and Wales |
|---|
| in England and Wales |
| |
| The objective of this programme is to establish 'monitored' rivers in |
| England and Wales where estimates of marine survival can be |
| derived for comparison with other North Atlantic stocks. For a number of indicator stocks around the North Atlantic there is |
| For a number of indicator stocks around the North Atlantic there is evidence that the marine survival of salmon is highly variable and is currently well below previous levels. However, until recently, there were no long-term data sets for stocks in England and Wales. The project seeks to collect data in a consistent manner from year to year in order to provide a reliable time series and to allow trends to be identified. In order to provide data for different regions and thus allow for possible spatial differences, two monitored stocks have been established: the River Dee (North Wales) and the River Tamar (SW England). Both these stocks have a reasonable proportion of MSW salmon. |
| Smolt tagging programmes have been carried out at both sites for a number of years using rotary screw traps. This has enabled the trapping and tagging of wild fish on the main stems of these two rivers. Both rivers also have facilities (counters/traps) close to the tidal limit for monitoring returning adult fish and for estimating the return rate of the tagged fish. Models have been developed which provide confidence limits around the return rate estimates; the results are reported annually to the ICES North Atlantic Salmon Working Group. The investigations are run on a collaborative basis by the Environment Agency and the Centre for Environment, Fisheries and Aquaculture Science (Cefas). |
| Ongoing annual monitoring programme (subject to annual review). |
| River Dee (North Wales) |
| River Tamar (SW England) |
| N/A |
| |
| Approximately £120,000 per appur |
| Approximately £120,000 per annum |
| ~10 – involves staff from the Environment Agency's Fisheries Science Teams and regional offices, and personnel from the Cefas Salmon & Freshwater Fisheries Team. |
| Ian Davidson (Environment Agency – Dee) |
| ian.davidson@environment-agency.gov.uk |
| Rob Hillman (Environment Agency – Tamar) |
| rob.hillman@environment-agency.gov.uk Ian Russell (Cefas) |
| ian.russell@cefas.co.uk |
| |

Project No. Ew11 Status Ongoing

| Details of research | N/A |
|------------------------------|--|
| vessels, e.g. name, | |
| registration, call sign | |
| and description of | |
| vessel | |
| Type and amount of | Rotary screw fish traps, coded wire microtagging equipment, adult fish |
| gear and other | traps and fish counters. |
| equipment to be used | |
| Details of any collaborating | N/A |
| countries | |
| Summany of Dragnage | |

Summary of Progress

The Environment Agency and Cefas have continued the programmes on the Rivers Dee (North Wales) and Tamar (SW England) to monitor marine survival of these salmon stocks. Smolt trapping with rotary screw traps has continued, with over 3,200 and 7,500 salmon smolts tagged in 2009 on the Dee and Tamar respectively; additional sea trout smolts were also tagged at both sites (with different management objectives). The Environment Agency have continued to operate upstream traps on both rivers throughout the year to monitor the run of adult fish and allow return rates of tagged fish to be estimated. The traps are also used to collect additional biological information, such as the size and age of the returning fish.

| Ŭ | |
|--|--|
| Party or relevant jurisdiction | European Union – United Kingdom (England and Wales) |
| Title of project | The marine life of Atlantic salmon: evidence from the |
| Objective of research project | microchemistry of scales To identify existing Atlantic salmon scale libraries in England and Wales. Refine and improve existing methods to stable isotope ratios and trace elements in salmon scales. Measure the stable isotope composition (C and N) from salmon scales in relation to variations in the marine environment. Measure trace element compositions from salmon scales in relation to variations in the marine environment. Develop a model to predict the impact of changes in the marine environment (e.g. productivity) on return rates of salmon from specific populations. Assess the suitability of stable isotope and trace element analysis to understand the distribution of other keystone fish species (e.g. European eel). |
| Brief description of research project | The research will focus on scale microchemistry using scales from existing libraries together with scales taken from grilse and MSW salmon sampled in the ocean to develop a model to predict the impact of changes in the marine environment (e.g. productivity) on return rates of salmon from specific populations using scale microchemistry. |
| Dates during which research will take place | 1 April 2007 – 31 March 2010 |
| Area in which research will take place | England and Wales |
| Estimated number and weight of salmon to be retained | N/A |
| Resources | |
| Estimated cost of the research project | £66,709 over 3 years |
| Number of participating scientists | 3 |
| Name and e-mail address of coordinating scientist in charge of project | Dr Clive Trueman School of Ocean and Earth Sciences, University of Southampton National Oceanography Centre, Southampton European Way Southampton SO14 3ZH |
| | trueman@noc.soton.ac.uk |
| Details of research vessels, e.g. name, registration, call sign and description of vessel | N/A |
| Type and amount of gear and other equipment to be used | N/A |

| Details of any collaborating | N/A |
|------------------------------|-----|
| countries | |
| | |

Summary of Progress

To date, 613 fish have been analysed for stable isotope composition, 289 fish from the North Sea driftnet archive and 324 fish from the River Frome archive. Several interesting observations can be made:

1) δ^{13} C values and temporal patterns differ between grilse and MSW fish from the Frome and between the Frome data and the North Sea data. This demonstrates that these populations feed in separate areas of the North Atlantic – and thus form discrete, consistent feeding populations.

2) The North Sea archive shows clear systematic variation in carbon isotope composition, reflecting decadal-scale changes in ocean conditions at the location of feeding. Interestingly, carbon isotope signals in the North Sea data correlate with modelled numbers of returning fish, suggesting that fluctuations in ocean conditions at the feeding location influence marine mortality. If this pattern is repeated with additional data, it will have very significant implications for understanding marine survival in salmon. In contrast, the Frome archive shows no such systematic variation, indicating relatively stable conditions in the feeding areas – and thus that factors other than variations in ocean feeding conditions may have greater influence over marine survival for this population.

3) We have developed a method to predict marine location from carbon isotope data. Applying this method to the salmon archive dataset yields maps showing most likely regions for marine feeding areas. The North Sea stock is predicted to feed in the Norwegian sea, with MSW returning fish feeding at more northerly latitudes. By contrast, MSW returning fish from the Frome stock are most likely to feed either south west of Iceland, or in the West Greenland fishery area. This method clearly has potential to identify stocks with common feeding areas, and to explore marine effects on salmon mortality. Our methodology can be applied to any tissue archive, and we are extending the project to consider migration routes and feeding areas for other salmon stocks.

4) There is no evidence for a long term, directional trend in nitrogen isotope values in either the Frome or North Sea archive, and therefore no evidence for long term change in trophic level as an influence on marine survival.

| Project No. Ew15 | Status: Ongoing - New entry |
|--|---|
| Party or relevant jurisdiction | European Union – United Kingdom (England and Wales) |
| Title of project | Development and application of salmonid life cycle models |
| Objective of research project | 1. Undertake a review of available salmonid life cycle models to assess their suitability to apply to migratory salmonid populations in England and Wales; |
| | 2. Build on existing models and/or develop new models of salmon and sea trout life-histories to permit: Prioritisation of factors affecting stocks in freshwater Scaling of impacts on individuals to populations Comparison of marine and freshwater factors affecting stocks Comparison of the impacts of factors on stocks with different life-cycle characteristics (e.g. grilse v MSW stocks) Comparison of anthropogenic and environmental impacts on stocks; Comparison of management regimes for salmon and sea trout. |
| Brief description of research project | The general objectives of the project are to develop tools to assist with the interpretation of results from a range of experimental studies on salmonids and advise policy on the prioritisation of management decisions relating to the protection, conservation, restoration and enhancement of salmonid populations and related research activities. |
| Dates during which research will take place | April 2009 – March 2013 |
| Area in which research will take place | England and Wales |
| Estimated number and weight of salmon to be retained | N/A |
| Resources | |
| Estimated cost of the research project | £210,000 over 4 years ie £52,500 per annum |
| Number of participating scientists | 4 |
| Name and e-mail address of coordinating scientist in charge of project | Ted Potter: ted.potter @cefas.co.uk |
| Details of research vessels, e.g. name, registration, call sign and description of vessel | N/A |

Project No. Ew13 Status: Ongoing - New entry

| Type and amount of gear and other equipment to be used | N/A |
|--|-----|
| Details of any collaborating countries | N/A |
| Summary of Progress: | |
| New entry | |

| Party or relevant jurisdiction | European Union – United Kingdom (England and Wales) |
|--|--|
| Title of project | The impacts of contaminants and temperature on freshwater fish |
| | populations |
| Objective of research project | The main objectives of the research are to undertake further studies of the impacts of contaminants derived from intensive agriculture and aquaculture facilities on wild salmonids and investigate the implications of predicted climate change scenarios on the impacts of different sources of diffuse and point source pollution on wild fish populations. |
| Brief description of research project | The research will further investigate contaminants derived from or associated with freshwater aquaculture facilities and determine their effects on critical salmonid life stages particularly the transition of smolts from the freshwater to marine environments. In addition, the work will investigate the impact of the changes in flows and temperatures that may be expected under different climate change scenarios on the impacts of environmental levels of specific contaminants on biological processes regulating fish populations (e.g. reproduction and survival of diadromous fish between fresh and marine environments). Finally, the results of the work will be used to model the impact of different climate change scenarios on the impacts of specific contaminants on wild salmonid populations. |
| Dates during which research will take place | April 2009 - March 2014 |
| Area in which research will take place | England and Wales |
| Estimated number and weight of salmon to be retained | N/A |
| Resources | |
| Estimated cost of the research project | £795,000 over 5 years ie £159,000 per annum |
| Number of participating scientists | 5 |
| Name and e-mail address of coordinating scientist in charge of project | Andy Moore: andy.moore@cefas.co.uk |
| Details of research vessels, e.g. name, registration, call sign and description of vessel | N/A |
| Type and amount of gear and other equipment to be used | N/A |
| Details of any collaborating countries | N/A |
| Summary of Progress: New entry | |

Project No. Ew14 Status: Ongoing - New entry

| 110jeet 110. Ew15 | Status. Orgoing - New entry |
|--|---|
| Party or relevant jurisdiction | European Union – United Kingdom (England and Wales) |
| Title of project | Impacts on juvenile salmonid populations from a changing freshwater environment. |
| Objective of research project | The overall objective of the research programme is to investigate how predicted changes within the freshwater environment might impact upon juvenile salmonid populations and how changing conditions during the early life history stages of the fish may influence their behaviour and subsequent survival within the marine environment. The research will be carried out within the context of the revised climate change scenarios for England and Wales (UKCP09). The overall aim will be to better understand the potential changes to the characteristics of salmonid populations in order to better manage and conserve stocks within a dynamic environment. The research will principally focus on specific factors within the freshwater environment that are considered to directly impact upon particular life-history strategies of juvenile salmonids, regulate production and modify the fitness of emigrating smolts. |
| Brief description of research project | The research project will examine the following areas of concern to salmonid populations: |
| | 1. Determine the ecological drivers within freshwater that affect the propensity for wild juvenile salmon to migrate downstream in the autumn. |
| | 2. Determine whether there are changes in the relative number of adult returns derived from autumn and spring migrating juveniles over time, and the geographic significance of the autumn migration. |
| | 3. Determine the impact of assessment techniques on wild salmon smolt physiology and subsequent adult return rates. |
| | 4. Assess the impact of changes within the freshwater environment on smolt "quality", biological characteristics and survival in the marine environment. |
| | 5. Determine the impact of diffuse artificial light pollution on salmonid fry emergence and smolt migratory behaviour. |
| Dates during which research will take place | April 2009 - March 2014 |
| Area in which research will take place | England and Wales |
| Estimated number and weight of salmon to be retained | N/A |
| Resources | |
| Estimated cost of the research | £903,000 over 5 years ie £180,600 per annum |

Project No. Ew15 Status: Ongoing - New entry

| project | |
|---|---------------------------------------|
| Number of participating scientists | 12 |
| Name and e-mail address of coordinating scientist in charge of project | Bill Riley: bill.riley@cefas.co.uk |
| Details of research vessels, e.g. name, registration, call sign and description of vessel | N/A |
| Type and amount of gear and other equipment to be used | N/A |
| Details of any collaborating countries | N/A |
| Summary of Progress: | |
| New entry | |

| Project No. Ni1 | Status: Completed |
|--|--|
| Party or relevant jurisdiction | European Union – United Kingdom (Northern Ireland) and Republic of Ireland (Loughs Agency is a statutory cross-border body). |
| Title of project | Development of conservation limits, pre-fishery abundance and |
| | management of the Foyle salmon fishery |
| Objective of research project | To build upon the existing Foyle salmon management system, to develop it into a precautionary catch advice framework that fully takes account of biological data on stock abundance and which fulfils all the main requirements of the Precautionary Approach. |
| Brief description of research project | To strengthen the basis of the existing in-season management system, by revising the conservation requirements, estimating abundance of cohorts before any fishing takes place and by providing explicit assessment of the uncertainties and risks involved in management decisions on safe levels of catches. |
| Dates during which research took place | October 2005-October 2008 |
| Area in which research took place | Foyle area, Ireland |
| Estimated number and weight of salmon retained | N/A |
| Resources | |
| Estimated cost of the research project | £125,000 over three years (£41,700 per annum) Staff £110,000 Equipment £15,000 (funded by Loughs Agency) |
| Number of participating scientists | 10 |
| Name and e-mail address of coordinating scientist in charge of project | Dr. Patrick Boylan p.boylan@loughs-agency.org |
| Details of research vessels, e.g. name, registration, call sign and description of vessel | N/A |
| Type and amount of gear and other equipment used | N/A |
| Details of any collaborating countries | This is a collaborative project between Loughs Agency (ROI and N Ireland – cross-border Agency), AFBNI (N Ireland), Marine Institute (ROI), Institute National de la Recherche Agronomique (INRA) (France) and the University of Glasgow (Scotland) |
| Summary of Progress | |

Preliminary models have been developed. Conclusions not yet available.

| Project No. | Ni2 | Status: Ongoing |
|--|--|---|
| Party or relevant | nt jurisdiction | European Union – United Kingdom (Northern Ireland) |
| Title of project | | The marine survival of Atlantic salmon from the River Bush, Northern Ireland |
| Objective of re | search project | Investigate factors influencing the survival at sea of salmon smolts migrating from the River Bush until their return as adult salmon |
| Brief description project | on of research | This long-term project centres on enumerating numbers of migrating wild smolts and returning adults to the River Bush, by means of trapping facilities, in order to assess return rates and maturation schedules. A programme of microtagging wild and hatchery-origin smolts provides detailed information on exploitation levels and patterns in coastal and distant-water fisheries. Run-reconstruction modelling provides information on return rates to Irish homewaters, which provides an index of natural survival at sea. |
| Dates during w will take place | hich research | Started in 1973. Project ongoing 2010. |
| Area in which take place | research will | River Bush, N. Irish/Irish coastal waters and distant-water fisheries. |
| Estimated num of salmon to be | • | None retained, as tag recovery based on already-captured fish. Tagged adults at River Bush retained alive as broodstock for hatchery programme. |
| Resources | | |
| Estimated c research pro | | Total annual cost:£60,000Breakdown:Staff£49,000Consumables£8,000Travel and Subsistence£2,000 |
| Number of scientists | participating | 2 project scientists and 3 technical staff |
| | -mail address ting scientist in roject | Richard Kennedy <u>Richard.kennedy@afbini.gov.uk</u> |
| Details of reversels, e.g. registration, description | name, , call sign and | Not applicable |
| • 1 | nount of gear quipment to be | Not applicable |
| Details of any of countries | collaborating | Ireland (tag recovery programme) |
| Summary of P | rogress. | |

Summary of Progress:

The marine survival project continues to provide annual metrics on marine performance of R. Bush wild and hatchery-origin salmon. These data are made available to ICES. The River Bush programme involves the microtagging of wild and hatchery-origin smolts and provides detailed annual information on exploitation levels and patterns in coastal and distant-water fisheries. Focus has recently been given to the timing of smolt migration, in relation to environmental parameters and subsequent marine survival.

| Project No. Sc1 | Status: Completed |
|---------------------------------------|---|
| Party or relevant jurisdiction | European Union – United Kingdom (Scotland) |
| | in collaboration with Norway and the Atlantic Salmon Trust |
| Title of project | Testing and development of Institute of Marine Research (IMR) Bergen, Norway, salmon trawl gear |
| Objective of research project | Test a prototype trawl developed by IMR, Bergen, Norway, which, rather than capturing post-smolts, records, by use of CCTV, their passage as they pass through an open-ended trawl net. A supplementary objective, dependent on the success of the gear trials, was to conduct a post-smolt survey at the shelf edge. |
| Brief description of research project | |
| Dates during which research | |
| took place | |
| Area in which research took | |
| place | |
| Estimated number and weight | |
| of salmon retained | |
| Resources | |
| Estimated cost of the | |
| research project | |
| Number of participating scientists | |
| Name and e-mail address | Julian MacLean (Fishery Research Services) |
| of coordinating scientist | j.c.maclean@marlab.ac.uk |
| in charge of project | Jens Christian Holst (IMR) |
| | jens.christian.holst@imr.no |
| | Dick Shelton (Atlantic Salmon Trust) |
| | freda.shelton@btopenworld.com |
| Details of research | |
| vessels, e.g. name, | |
| registration, call sign and | |
| description of vessel | |
| Type and amount of gear | |
| and other equipment used | |
| Details of any collaborating | |
| countries | |

Summary of Findings

The trial of the modified pelagic trawl gear was a success with real-time footage of fish passing through the net being obtained and recorded. In total 178 post-smolts, one wild adult and one farmed adult salmon were observed. In addition, the supplementary aim of undertaking survey trawls on the shelf edge and collecting ancillary hydrographical information was also achieved.

The successful survey along the shelf edge has shown that the trawl gear is a practical tool for investigating post-smolt distribution at sea. This is extremely relevant with respect to the SALSEA proposal. In summary there are three major advantages of the new gear. First, it is much more cost-effective than using normal pelagic trawls with cod ends. The new trawl can be towed for almost unlimited periods and the fish passing through the net can be observed via the camera link, negating the need to shoot and haul the net every hour or so. Thus, a much greater area of sea can be covered, greatly increasing the efficiency of collecting distribution information. Second, the new trawl provides a non-destructive way in which to observe the distribution of post-smolts. This is a major breakthrough given the high sea mortality rates currently impacting upon salmon in the sea. Third, it is now possible to link the distribution of individual, or shoals of, post-smolts, much more closely to the prevailing hydrographical conditions as the precise location of each observation can be recorded. This was not the case previously when normal pelagic trawls were used and the location of capture could only be recorded relative to the entire area of the particular trawl.

While the trial was an undoubted success, there are some areas of development that need to be considered further in order to obtain the maximum benefits from the new trawl system. In particular, the conditions under which the gear was deployed were relatively calm (gale force 3 - 4) and thus the stability of the trawl requires testing under more testing conditions. In addition to a short FRS Internal Report by Julian MacLean, outlining the findings, an article written by Dr Richard Shelton has also been published in the Atlantic Salmon Trust Journal, Winter 2005-06.

| Party or relevant jurisdiction | EU – UK (Scotland) |
|--------------------------------|--|
| Title of project | Protecting salmonid fisheries from seal damage |
| Objective of research project | 1. Develop and apply new molecular tools for discriminating |
| | among species of fish in the diets of seals from their remains in scats. |
| | Test the possibility of using molecular tools to quantify the |
| | occurrence of diet components. |
| | Develop and deploy cetacean-friendly seal-scarer. Identify factors influencing the in-shore migration routes of |
| | 3. Identify factors influencing the in-shore migration routes of salmon. |
| | 4. Characterise behavioural interactions between salmon and their |
| | predators and seals and their prey. 5. Investigate the digestion of salmonid otoliths during passage |
| | 5. Investigate the digestion of salmonid otoliths during passage through a seal's gut. |
| Brief description of research | 1. A project funded by the Atlantic Salmon Trust (undertaken by |
| project | Dr Kim Parsons) has developed a molecular tool for detecting the |
| | presence of salmon DNA. The tool will be further developed and tested. |
| | 2. There is concern that seal-scarers may adversely affect |
| | cetaceans. Recent work by Dr Vincent Janik of St Andrews |
| | University suggests potential for natural calls of marine mammals to |
| | modify behaviour of sound recipients. This will be tested at the |
| | Shieldaig research facility in north-west Scotland with the aim of |
| | developing a cetacean-friendly seal-scarer for fixed deployment in |
| | rivers/estuaries, and/or for use as a hand-held deterrent. The final |
| | scope of the project is to some extent dependent upon final level of funding. |
| | 3. Salmon were fitted with acoustic transmitters and followed |
| | using active (manned boats) and passive (acoustic receiver buoys) |
| | tracking systems. Migration routes were mapped in relation to |
| | topographical features and distributions of predators. Salmon and sea |
| | trout smolts will also be examined. Work will be concentrated in the |
| | Cromarty Firth in north-east Scotland, and at Shieldaig. |
| | 4. Detailed examination of behavioural interactions between |
| | predators and prey were made using acoustic observations, visual |
| | observations and side-scan sonar. |
| | 5. Captive feeding trials were used to determine the proportion of |
| | otoliths that pass through a seal, and the degree to which these |
| | otoliths are eroded. |
| Dates during which research | April 2003-March 2008 |
| took place | |
| Area in which research took | Principally north-west Scotland (Shieldaig) and north-east Scotland |
| place | (Cromarty Firth). Possible work in other estuaries as required. |
| | Captive work to be undertaken at Sea Mammal Research Unit, St Andrews. |
| Estimated number and weight | |
| of salmon retained | |
| of samon retained | |

Project No. Sc2 Status: Completed

| Resources | |
|---|---|
| Estimated cost of the research project Details of the full economic costs of each study are requested, including staff costs, equipment and overheads. | 2003/04 - £166,000 2004/05 - £142,000 2005/06 - £100,000 |
| Number of participating scientists | Multi-disciplinary work will involve scientists from a number of teams within Fisheries Research Services. Feeding experiments undertaken in conjunction with staff at the Sea Mammal Research Unit, University of St Andrews. |
| Name of coordinating scientist in charge of project | Dr John Armstrong |
| Details of research vessels, e.g. name, registration, call sign and description of vessel | N/A |
| Type and amount of gear and other equipment used | Laboratory –DNA analysis Field work - Acoustic tags and receivers, inflatable craft, seal-scarers, side-scan sonar Feeding experiment - Home Office licensed captive facility |
| Details of any collaborating countries | |

Summary of Findings

1. Seal diet.

Occurrence of salmon and sea trout in the diets of seals has usually been estimated by quantifying hard part remains of the fish in seal scats. However, there is concern that this method underestimates consumption due to either seals discarding heads of the fish, which contain the principle diagnostic hard parts, called otoliths, or the otoliths nor surviving digestion. Furthermore, it is not possible to differentiate between salmon and sea trout from the morphologies of their otoliths. The use of DNA remains in scats potentially has some advantages over the conventional techniques because it does not depend on the consumption of and recovery of hard parts. A quantitative PCR (qPCR) assay was therefore developed for detecting and providing a semi-quantitative measure of the occurrence of salmon and sea trout DNA in seal scats. The qPCR assay was shown to be consistent in detecting salmonids in scats, and was found to be more sensitive than conventional analysis of hard-parts. Nevertheless, the results confirmed findings from previous studies indicating that salmon and sea trout are not common prey for seals in Scottish estuaries.

In addition to the molecular work was undertaken in developing a seal- mounted detector that can record each time a seal consumes a sea trout post smolt fitted with as passive integrated transponder (PIT tag). The aim was to try and quantify the consumption of smolts by seals, which has not proved to be possible using other means. Major advances have been made through collaboration with WyreMicro and SMRU to miniaturise the device and test it on captive seals. The Mk III version

currently in final stages of testing uses a SMRU mobile phone transmitter to relay information to shore. The expected outcome is the development of a state-of-the-art electronic device that will provide an insight into consumption of sea trout post-smolts by seals that could not be achieved by any other means.

2. Identify factors influencing the in-shore migration routes of salmon.

If the benefits of non-lethal scaring techniques are to be maximised, then they need to be targeted at areas where salmon and sea trout congregate. Acoustic tracking was used to examine the habitat use of salmon and sea trout in coastal areas. Adult salmon tagged in the Cromarty Firth did not follow common migration routes through the firth nor were there areas in which they were shown to congregate. This finding led to the outcome that protection should best be concentrated at river mouths. Similarly, tracking of sea trout in Loch Torridon suggested that best value would be to offer protection to the fish around the river mouths during the period of smolt migration. Sea trout largely remained near their natal river over the first 20-day period after sea entry, during which the population experienced a loss rate of c. 50%. This combination of high loss and localised distribution provides a clear management target time and area.

The tracking programmes also allowed losses of salmon and sea trout to be quantified. Losses of salmon in the Upper Cromarty Firth were roughly ten percent, with half being possibly attributable to seals and half to net and coble fisheries. No difference in mortality of sea trout was detected between two areas contrasting seal abundance. Neither study provided evidence that seals were the main cause of fish mortality.

3. Recommend strategies for the most effective deployment of methods for protecting salmonid stocks in inshore waters.

The rationale behind this aim was to translate the findings of this project into management advice. Balancing SG's obligations to conserve salmon and seals while maintaining economically sustainable fisheries is a considerable challenge, particularly when both spring-running salmon and common seals on the East Coast are declining.

In the past, seal management has focussed on populations of seals around the coastline, particularly in the estuaries of salmon rivers. However, in view of the decline in numbers of common seals and the need to conserve their stocks, it is becoming increasingly important to control only those seals that are actually causing damage to salmonid stocks. The work undertaken during this project supports a policy of concentrating management efforts at river mouths for the following reasons. First, there is no evidence that all seals present in estuaries consume salmon and sea trout and therefore shooting in estuaries is unlikely to be effective at targeting those seals that are consuming salmonids. Second, there is no evidence of high losses of salmon in estuaries. Third, there is no evidence that there are specific areas in which salmon congregate within estuaries or on the high sea and where they can be protected by localised scaring of seals.

A modelling exercise was undertaken to examine the benefits to the salmon populations of removing seals. This work emphasised that targeting management on small rivers, and on larger rivers during key periods (eg during spring), is likely to have most value. The outcome of such action is a capacity for increasing the efficiency of protection of fish stocks. The aim was further supported through diversion of resources into directly supporting the Moray Firth Management Project and undertaking counts of seals in 2006 and 2008.

| Party or relevant jurisdiction European Union – United Kingdom (Scotland) Title of project Post-smolt mortality of Atlantic salmon Objective of research project Assess post-smolt mortality rates of Atlantic salmon from the rivers North Esk, Aberdeenshire Dee (two tributaries) and Conon (a river harnessed for hydro-electricity generation) and their contribution to fisheries that exploit them. Brief description of research project North Esk: Project started in 1964. Annual smolt production estimates are made using stratified mark-recapture models. Fish are tagged using coded-wire microtags or modified Carlin tags. An alternative method using river flow characteristics is currently being developed. Age distribution and sex ratio data are collected by sampling rap catches of smolts. Analysis of recapture data yields information on post-smolt mortality levels and contribution of North Esk salmon to fisheries. River Dee: Juvenile surveys by electro-fishing and traps have been operated in the Girnock Burn since 1966, and in the Baddoch Burn since 1989. Fish are tagged using coded-wire microtags. Salmon and grilse entering the tributaries to spawn are trapped and age and length distribution data are collected. Stock-recruitment relationships are investigated. Analysis of recapture data yields information on post- smolt mortality levels and contribution of carly-running grilse. Neturn rates have declined markedly in recent years. Smolt production from the streams has altered qualitatively, as a result, with a shift to younger smolt age. Statistical analysis strongly associates return rates of adults to the traps with the size of the annual spring fishery in the main River Dee, suggesting that the monitored sites typify a wider area of production. The Dee fishery, in turn, is strongly corre | Project No. Sc3 | Status: Ongoing | | |
|--|----------------------|--|--|--|
| Title of project Post-smolt mortality of Atlantic salmon Objective of research project Assess post-smolt mortality rates of Atlantic salmon from the rivers harnessed for hydro-electricity generation) and their contribution to fisheries that exploit them. Brief description of research project North Esk, Project started in 1964. Annual smolt production estimates are made using stratified mark-recapture models. Fish are tagged using coded-wire microtags or modified Carlin tags. An alternative method using river flow characteristics is currently being developed. Age distribution and sex ratio data are collected by sampling trap catches of smolts. Analysis of recapture data yields information on post-smolt mortality levels and contribution of North Esk salmon to fisheries. River Dee: Juvenile surveys by electro-fishing and traps have been operated in the Girnock Burn since 1966, and in the Baddoch Burn since 1989. Fish are tagged using coded-wire microtags. Salmon and grilse entering the tributaries to spawn are trapped and age and length distribution data are collected. Stock-recruitment relationships are investigated. Analysis of recapture data yields information on post- smolt mortality levels and contribution of Upper Dee salmon to fisheries. Both tributary populations are driven by early-running salmon (2SW plus a minor proportion of early-running grilse). Return rates have declined markedly in recent years. Smolt production from the streams has altered qualitatively, as a result, with a shift to younger smolt age. Statistical analysis strongly associates return rates of adults to the traps with the size of the annual spring fishery in the main River Dee, suggesting that the monitored sites typify a wider area of production. The Dee fishery, in turn, is strongly correlated with the Scottish fishery as a whole, indicating generalised | • | European Union – United Kingdom (Scotland) | | |
| projectNorth Esk, Aberdeenshire Dee (two tributaries) and Conon (a river harnessed for hydro-electricity generation) and their contribution to fisheries that exploit them.Brief description of research projectNorth Esk: Project started in 1964. Annual smolt production estimates are made using stratified mark-recapture models. Fish are tagged using coded-wire microtags or modified Carlin tags. An alternative method using river flow characteristics is currently being developed. Age distribution and sex ratio data are collected by sampling trap catches of smolts. Analysis of recapture data yields information on post-smolt mortality levels and contribution of North Esk salmon to fisheries.River Dee: Juvenile surveys by electro-fishing and traps have been operated in the Gimock Burn since 1966, and in the Baddoch Burn since 1989. Fish are tagged using coded-wire microtags. Salmon and grilse entering the tributaries to spawn are trapped and age and length distribution data are collected. Stock-recruitment relationships are investigated. Analysis of recapture data yields information on post- smolt mortality levels and contribution of Upper Dee salmon to fisheries. Both tributary populations are driven by early-running salmon (2SW plus a minor proportion of early-running grilse). Return rates have declined markedly in recent years. Smolt production from the streams has altered qualitatively, as a result, with a shift to younger smolt age. Statistical analysis strongly associates return rates of adults to the traps with the size of the annual spring fishery in the main River Dee, suggesting that the monitored sites typify a wider area of production. The Dee fishery, in turn, is strongly correlated with the Scottish fishery as a whole, indicating generalised effects of marine mortality across river catchments.River Conon: Collaborative p | 5 | Post-smolt mortality of Atlantic salmon | | |
| research project are made using stratified mark-recapture models. Fish are tagged using coded-wire microtags or modified Carlin tags. An alternative method using river flow characteristics is currently being developed. Age distribution and sex ratio data are collected by sampling trap catches of smolts. Analysis of recapture data yields information on post-smolt mortality levels and contribution of North Esk salmon to fisheries. River Dee: Juvenile surveys by electro-fishing and traps have been operated in the Girnock Burn since 1966, and in the Baddoch Burn since 1989. Fish are tagged using coded-wire microtags. Salmon and grilse entering the tributaries to spawn are trapped and age and length distribution data are collected. Stock-recruitment relationships are investigated. Analysis of recapture data yields information on post- smolt mortality levels and contribution of tupper Dee salmon to fisheries. Both tributary populations are driven by early-running salmon (2SW plus a minor proportion of early-running grilse). Return rates have declined markedly in recent years. Smolt production from the streams has altered qualitatively, as a result, with a shift to younger smolt age. Statistical analysis strongly associates return rates of adults to the traps with the size of the annual spring fishery in the main River Dee, suggesting that the monitored sites typify a wider area of production. The Dee fishery, in turn, is strongly correlated with the Scottish fishery as a whole, indicating generalised effects of marine mortality across river catchments. River Conon: Collaborative project with Conon District Salmon Fishery Board and Scottish and Southern Energy started in 1996. Juvenile salmon are captured by electro-fishing and trapping exercises in selected parts of the River Conon catchment. The fish are tagged using a variety of tags including coded-wire microtags (occasionally) and PIT tags (annually). Returning adults are registered automatically as wreys and trapping exercises have recorded the proportion of tag | | North Esk, Aberdeenshire Dee (two tributaries) and Conon (a river harnessed for hydro-electricity generation) and their contribution to fisheries that exploit them. | | |
| operated in the Girnock Burn since 1966, and in the Baddoch Burn since 1989. Fish are tagged using coded-wire microtags. Salmon and grilse entering the tributaries to spawn are trapped and age and length distribution data are collected. Stock-recruitment relationships are investigated. Analysis of recapture data yields information on post-smolt mortality levels and contribution of Upper Dee salmon to fisheries. Both tributary populations are driven by early-running salmon (2SW plus a minor proportion of early-running grilse). Return rates have declined markedly in recent years. Smolt production from the streams has altered qualitatively, as a result, with a shift to younger smolt age. Statistical analysis strongly associates return rates of adults to the traps with the size of the annual spring fishery in the main River Dee, suggesting that the monitored sites typify a wider area of production. The Dee fishery, in turn, is strongly correlated with the Scottish fishery as a whole, indicating generalised effects of marine mortality across river catchments. River Conon: Collaborative project with Conon District Salmon Fishery Board and Scottish and Southern Energy started in 1996. Juvenile salmon are captured by electro-fishing and trapping exercises in selected parts of the River Conon catchment. The fish are tagged using a variety of tags including coded-wire microtags (occasionally) and PIT tags (annually). Returning adults are registered automatically as they pass through a Borland lift in Torr Achilty Dam. Occasional | | are made using stratified mark-recapture models. Fish are tagged using coded-wire microtags or modified Carlin tags. An alternative method using river flow characteristics is currently being developed. Age distribution and sex ratio data are collected by sampling trap catches of smolts. Analysis of recapture data yields information on post-smolt | | |
| Fishery Board and Scottish and Southern Energy started in 1996. Juvenile salmon are captured by electro-fishing and trapping exercises in selected parts of the River Conon catchment. The fish are tagged using a variety of tags including coded-wire microtags (occasionally) and PIT tags (annually). Returning adults are registered automatically as they pass through a Borland lift in Torr Achilty Dam. Occasional surveys and trapping exercises have recorded the proportion of tagged | | operated in the Girnock Burn since 1966, and in the Baddoch Burn since 1989. Fish are tagged using coded-wire microtags. Salmon and grilse entering the tributaries to spawn are trapped and age and length distribution data are collected. Stock-recruitment relationships are investigated. Analysis of recapture data yields information on post- smolt mortality levels and contribution of Upper Dee salmon to fisheries. Both tributary populations are driven by early-running salmon (2SW plus a minor proportion of early-running grilse). Return rates have declined markedly in recent years. Smolt production from the streams has altered qualitatively, as a result, with a shift to younger smolt age. Statistical analysis strongly associates return rates of adults to the traps with the size of the annual spring fishery in the main River Dee, suggesting that the monitored sites typify a wider area of production. The Dee fishery, in turn, is strongly correlated with the Scottish fishery as a whole, indicating generalised effects of marine | | |
| fish in the net-and-coble and rod-and-line fisheries. Work has been undertaken to provide information on the contribution of seals to the marine mortality of Conon salmon | | Fishery Board and Scottish and Southern Energy started in 1996. Juvenile salmon are captured by electro-fishing and trapping exercises in selected parts of the River Conon catchment. The fish are tagged using a variety of tags including coded-wire microtags (occasionally) and PIT tags (annually). Returning adults are registered automatically as they pass through a Borland lift in Torr Achilty Dam. Occasional surveys and trapping exercises have recorded the proportion of tagged fish in the net-and-coble and rod-and-line fisheries. Work has been undertaken to provide information on the contribution of seals to the | | |
| Dates during which Ongoing | - | Ongoing | | |
| research will take place | | North Data Wardow and the set of D' D D' C 1 | | |
| Area in which research will take placeNorth Esk, Western catchment of River Dee, River Conon salmon fishery district | | | | |
| | Estimated number and | N/A | | |

| weight of salmon to be | |
|--|--|
| retained | |
| Resources | |
| Estimated cost of the research project | Approximately £50,000 per annum |
| Number of participating | North Esk - 7 (also employed on other projects) |
| scientists | River Dee - 5 (also employed on other projects) |
| | River Conon - 6 (includes non-FRS staff, and all are also employed on |
| | other projects) |
| Name and e-mail | North Esk and Dee - Julian MacLean |
| address of coordinating | j.c.maclean@marlab.ac.uk |
| scientist in charge of | River Conon - John Armstrong |
| project | j.armstrong@marlab.ac.uk |
| Details of research | N/A |
| vessels, e.g. name, | |
| registration, call sign | |
| and description of | |
| vessel | |
| Type and amount of gear and other | North Esk - Purpose-built smolt trap and resistivity counter on the lower reaches of the North Esk. One additional resistivity counter and |
| equipment to be used | two rotary screw traps deployed to assess trends in sub-catchment populations. Electrofishing gear used for juvenile surveys. |
| | River Dee - Purpose-built traps, electro-fishing. |
| | River Conon - Electro-fishing gear, traps, PIT tagging equipment and |
| | detectors. |
| Details of any collaborating countries | N/A |
| Summary of Progress | |
| | |

Results from the surveillance monitoring continue to be provided to the Working Group for consideration in their on-going modelling work.

| Dontry on valoriant inviadiation | European Union United Kingdom (Sectiond) |
|--|---|
| Party or relevant jurisdiction Title of project | European Union – United Kingdom (Scotland) Analysis of post-smolt life history by scale reading |
| little of project | |
| Objective of research project | Investigate the relationship between growth and mortality in Atlantic salmon, particularly during the marine phase, by analysis of scale |
| | growth patterns |
| Brief description of research | Scale samples of fish of known age (recaptures from smolt tagging |
| project | operations) and from salmon catches generally are examined to |
| | assess growth characteristics. Associations between growth performance and independent measures of mortality are examined |
| N 1 1 1 1 1 | with the aim of identifying the periods crucial to survival. |
| Dates during which research will take place | Continuing project under longer-term remit. |
| Area in which research will | Samples from around Scotland and from the North Esk and Girnock |
| take place | Burn (Aberdeenshire Dee) in particular |
| Estimated number and weight | N/A |
| of salmon to be retained | |
| Resources | |
| Estimated cost of the research project | Approximately £10,000 per annum |
| Number of participating scientists | 3 (also employed on other projects) |
| Name and e-mail address | Julian MacLean |
| of coordinating scientist in charge of project | j.c.maclean@marlab.ac.uk |
| Details of research vessels, e.g. name, | N/A |
| registration, call sign and | |
| description of vessel | |
| Type and amount of gear | N/A |
| and other equipment to | |
| be used | |
| Details of any collaborating | USA and Canada |
| countries | |
| Summary of Progress | |
| | |

Ongoing

Status:

Project No. Sc4

| Factors affecting early marine mortality and its possible causes continue to be investigated. Growth |
|--|
| patterns across Europe are being examined in collaboration with colleagues from other organisations. |
| Fine scale data relating to growth checks have been collected for further analysis. |

| Project No. Sc5 | Status: | Ongoing |
|----------------------------|--|---|
| Party or relevant jurisdie | ction European Union – U | nited Kingdom (Scotland) and Ireland |
| Title of project | Fisheries-induced e | volution |
| Objective of research pr | Evolution will analy induced adaptive cha This objective will empirical phenotyp adaptive genetic va quantitative models management options | eted Research Project on Fisheries-induced ze the prevalence and consequence of fisheries- inges in exploited salmon (and other fish) stocks. be realized through a carefully selected set of ic case studies, the investigation of salient riation, and through the development of new s for understanding trends and evaluating s. The FinE project will deliver insights and for addressing the overlooked evolutionary n fisheries. |
| Brief description of re | population genetics population dynamics project will ensure theoretical lines of d processes in exploit provide the scientit implementing manag- induced adaptive cha | ns at combining fields of expertise as diverse as and quantitative genetics, life-history theory, e, evolutionary theory, and fisheries science. The a close integration of both empirical and evelopment in our understanding of evolutionary ed populations. The FinE project will thereby fic basis required for designing policies and gement measures that can cope with fisheries- inges. I objective can be broken down into three main |
| project | Phenotypic case trends in life-histor productivity of exp maturation, reproduct ubiquity of fisherie stocks from Europ investigated. The st field data, mostly h fish stock assessmen general principle of component of obs underlying evolution reversibility of the fit tailored statistical r norms, will be critica 2) Genetics analyse fisheries-induced eva analysis. The wor thereby developing t genetic changes affe selection will be assisterms of quantitat biological tissues (fisheries-induced sel | studies will aim at documenting phenotypic by traits relevant for the demography and ploited salmon populations, thus focusing on ctive effort, and growth. In order to assess the s-induced adaptive changes, various exploited bean and North American waters will be rudies will be based on long-term time series of osted by national organizations responsible for nt and advising for fisheries management. The the analyses will be to disentangle the plastic erved phenotypic trends from a potentially hary component, in order to assess the degree of sheries-induced changes. The use of specifically methods, like probabilistic maturation reaction al in this respect. es will aim to elucidate the genetic basis of volutionary changes suggested by phenotypic k will be based on a two-pronged approach, wo complementary lines of research: (i) adaptive ecting life-history traits under fisheries-induced essed at the DNA level (candidate genes) and in ive genetics using historical collections of (otoliths) sampled in the field; (ii) artificial ection experiments on a model species (<i>Poecilia</i>) will be set up in order to corroborate molecular |

| | and quantitative genetic results in the wild. These studies will rely on the development of innovative molecular and statistical methodologies allowing tackling temporal adaptive genetic changes, instead of only investigating the neutral genetic differentiation that customarily was at the focus of previous genetics work. 3) Eco-genetic models will be designed for evaluating alternative hypotheses advanced to explain observed data; for assessing the ecological consequences of fisheries-induced evolution in terms of exploited stock dynamics, viability and recovery, as well as fisheries yield; and for comparing various management scenarios. These analyses will address features and dimensions that are particularly difficult to cover in empirical analyses: multi-trait evolution, sex- specific fisheries-induced evolution, and economic drivers of fishery dynamics. Models will be constructed by carefully integrating relevant genetic, ecological, and environmental details, so as to attain sufficient degrees of realism for predicting the speed of evolutionary changes, while also properly describing population dynamics and fishery dynamics. The following specific topics will be addressed: • Evolutionary determination of maturation reaction norms • Fisheries-induced multi-trait evolution • Evolutionary vulnerability of prototypical life histories • Sex-specific dimensions of fisheries-induced evolution • Fisheries-induced evolution of neutral and selected genetic markers • Fisheries-induced evolution of neutral and selected genetic markers • Fisheries-induced evolution of specific stocks • Implications for stock stability and recovery potential • Economic models of fisheries-induced evolution • Evolutionarily enlightened stock management |
|--|--|
| Dates during which research will take place | 2007-2010 |
| Area in which research will take place | FRS will focus on Scottish and Irish salmon stocks; however, fisheries data will be collected from across Europe, including along marine migration routes. |
| Estimated number and weight of salmon to be retained | N/A |
| Resources | |
| Estimated cost of the research project Number of participating | Scotland: FRS cost: £155,000 Ireland: £10,000 (Travel and subsistence for project meetings only) FRS: 6 |
| scientistsName and e-mail address of coordinating scientist in charge of project | Total: 40+ <i>EU Project co-ordinator:</i> Ulf Dieckman dieckman@iiasa.ac.at |
| | Scotland: FRS project leader: John Gilbey J.Gilbey@marlab.ac.uk |
| | <i>Ireland</i> : Marine Institute project leader: Philip McGinnity |

| | P.McGinnity@ucc.ie |
|--------------------------------|---|
| Details of research vessels, | N/A |
| e.g. name, registration, call | |
| sign and description of vessel | |
| Type and amount of gear and | N/A |
| other equipment to be used | |
| Details of any collaborating | Austria: International Institute for Applied Systems Analysis |
| countries | (IIASA); Norway: Institute of Marine Research (IMR); France: |
| | French Research Institute for the Sustainable Exploitation of the Sea |
| | (Ifremer); Denmark: Danish Institute for Fisheries Research |
| | (DIFRES); Belgium: Catholic University of Leuven (KUL); UK: |
| | University of Wales (UW); UK: Fisheries Research Services (FRS); |
| | Norway: University of Tromsø (UT); Netherlands: Netherlands |
| | Institute for Fisheries Research (RIVO); Norway: University of Oslo |
| | (UO); Spain: Spanish National Research Council (CSIC); Finland: |
| | Finnish Game and Fisheries Research Institute (FGFRI); Germany: |
| | Johann Heinrich von Thünen-Institut (vTI), Federal Research |
| | Institute for Rural Areas, Forestry and Fisheries |
| | |

The first meeting of the FinE project was held near Bergen, Norway in September 2007. A follow-up meeting dedicated to salmon issues was held at Pitlochry, Scotland in March, 2008. This second meeting was devoted to mustering data sets, discussing preliminary analyses and planning the way forward for the main data analyses. Since this meeting data relating to Scottish salmon populations has been collated and analysis is ongoing. A meeting was held at IIASA in June 2008 where the details of the Atlantic salmon eco-genetic models were defined and a plan developed to build and use such models. The second annual project meeting was held at Biarritz in October 2008 where the progress of all tasks was presented and future directions discussed.

Work is underway in fitting specific life history models to Irish and Scottish datasets, and in running simulations using the eco-genetic models. A further technical meeting was held in Newport, Ireland in February 2009. Further collaborative work has been undertaken during 2009 with a view to completing updating of data series and further developments of the models. Further meeting to finalise the analyses and reports will be held in 2010.

| U | 0 0 |
|--|--|
| Party or relevant jurisdiction | European Union – United Kingdom (Scotland) |
| Title of project | Size and condition of returning grilse (1SW) and MSW salmon |
| Objective of research project | Investigate decacal trends in the size (length, weight) and condition (weight/length ³) of adult salmon returning to Scotland. |
| Brief description of research project | Biometric data spanning a forty year period at the North Esk, and shorter periods for 5 other sites, are being analysed to document fluctuations in the size and condition of age at return to breed. Complicated trends are evident, which differ between 1SW and MSW fish. |
| Dates during which research will take place | June 2007 – ongoing. |
| Area in which research will take place | Six locations in Scotland, in particular the North Esk |
| Estimated number and weight of salmon to be retained | N/A |
| Resources | |
| Estimated cost of the research project | £30,000 per annum |
| Number of participating scientists | 4 (also employed on other projects) |
| Name and e-mail address | Philip Bacon |
| of coordinating scientist in charge of project | P.J.Bacon@MarLab.ac.uk |
| Details of research vessels, e.g. name, registration, call sign and description of vessel | N/A |
| Type and amount of gear and other equipment to be used | N/A |
| Details of any collaborating countries | Atlantic Salmon Trust |
| Summary of Progress | |

Project No. Sc6 Status: Ongoing

Summary of Progress

Data from the North Esk show that recent reports by anglers of high proportions of thin grilse (1SW salmon) in their catches were an extreme of a longer term (five year) trend (*see also Smith et al 2007; Todd et al 2008*). However, the situation for MSW fish is dissimilar, and for both sea age classes, the trends since 2000 need interpreting in the light of former, decadal, fluctuations. The work is currently being extended to five other Scottish sites (with less complete data sets) to investigate the generality of the findings. Very weak correlations, probably indicating only indirect effects, are apparent with a variety of marine environmental data. Analysis of long term data is continuing.

Smith, G.W., MacLean, J.C. and Whyte, B.D.M. (2007). The presence of "small grilse" in the 2006 Scottish salmon catches: a historical perspective. ICES Working Group on North Atlantic Salmon. Working Paper No. 30/2007. Copenhagen 11th to 20th April 2007.

Todd, C.D., Hughes, S.L., Marshall, C.T., MacLean, J.C., Lonergan, M.E. and Biuw, E.M. 2008. Detrimental effects of recent ocean surface warming on growth condition of Atlantic salmon. Global Change Biology (2008) 14, 1–13 (pages refer to online version only).

| Party or relevant jurisdiction | European Union – United Kingdom (Scotland) | |
|--|--|--|
| Title of project | Development of a General Spatial Model of within river | |
| The of project | population structuring in Scottish Atlantic salmon (POPMOD) | |
| | | |
| Objective of research project | To improve the scientific basis for setting biologically appropriate conservation limits for salmon rivers in line with NASCO obligations effectively regulate the salmon movements under the new Aquaculture and Fisheries Act providing advice on conservation and restoration initiatives in support of the TWG process and Gs Contingency Planning, and the EU Habitats and Water Framework Directives accurately and cost-effectively monitoring the status of salmon stocks The anticipated outcomes of the project are: a general model which can be used to predict population structuring within any Scottish salmon rivers an optimised, cost-effective methodology which can be used to test model predictions an evaluation of the potential for using genetic estimates of effective numbers of breeders for monitoring the conservation status of breeding populations | |
| Brief description of research project | Building on the information collected as part of previous MS and associated SNH, AST/AFT and DSFB contracts, and linked associated projects (FASMOP, SALSEA MERGE), microsatellite and mtDNA markers will be used to assess the spatial boundaries of Atlantic salmon selected Scottish river systems. The genetic information on the relatedness of salmon in the systems will be analysed and the number and spatial boundaries of salmon populations present within each river explored. The genetic information will be combined with biophysical information on river structure, including salmon habitat distribution, water chemistry, and presence of natural and man-made barriers, to develop a general predictive model. The generality of these associations will be explored and tested using GIS and Bayesian statistical methods. For identified populations, genetic data will be further analysed for each breeding population to determine the effective numbers of breeders contained in each population. The estimates derived will be compared with the spatial extent of the population and estimates of census size based on electrofishing, wetted area, and angling catches. | |
| Dates during which research will take place | 1 April 2008 to 31 March 2011 | |
| Area in which research will take place | -river systems across Scotland | |
| Estimated number and weight of salmon to be retained | - not applicable | |

| Project No. Sc/ Status: Ongoing - New entry | Project No. | Sc7 | Status: | Ongoing - New entry |
|---|-------------|-----|---------|----------------------------|
|---|-------------|-----|---------|----------------------------|

| Resources | |
|------------------------------|-------------------------|
| Estimated cost of the | Estimated Costs: |
| research project | |
| Details of the full | FEC £800,883 |
| economic costs of each | |
| study are requested, | Breakdown |
| including staff costs, | Staff Costs: £350,228 |
| equipment and overheads. | T&S: £6,000 |
| For collaborative | Equipment: £32,000 |
| projects, a breakdown of | Consummables: £78,000 |
| costs between public and | Overheads: £367,740 |
| private partners is | |
| requested. | 100% public (SG) funded |
| Number of participating | 3 |
| scientists | |
| Name and e-mail address | Dr. Eric Verspoor |
| of coordinating scientist in | verspoor@marlab.ac.uk |
| charge of project | |
| Details of research | -none used for work |
| vessels, e.g. name, | |
| registration, call sign and | |
| description of vessel | |
| Type and amount of gear | - not applicable |
| and other equipment to be | |
| used | |
| Details of any collaborating | - none |
| countries | |
| Summary of Progress: | |
| | |
| New entry | |
| | |

| Party or relevant jurisdiction | European Union – United Kingdom (Scotland) | | |
|--|--|--|--|
| Title of project | Focusing Atlantic salmon management on Atlantic salmon (FASMOP) | | |
| Objective of research project | The project seeks to: Establish the number and spatial boundaries of breeding populations of salmon within any Scottish river system using micro-satellite genetic markers; Establish the ancestral relationships and functional biological differences between wild salmon stock components across Scottish rivers; Use information and insights gained to improve local management practice and increase the of focus salmon management on local breeding populations as these are the fundamental biological units underpinning recruitment in river stocks | | |
| | This project will provide baseline information in support of project E1 | | |
| Brief description of research project | The project will provide: Detailed local population structure insights for rivers within Fisheries Trust and DSFB areas for application in local management decision making through the analysis of molecular microsatellite DNA genetic markers; Atlantic salmon population structure information for river catchments across Scotland; Contribute to the development of national and international scale knowledge and understanding of the factors underlying population structuring through the input of information into Marine Scotland Science projects and the SALSEA MERGE project | | |
| Dates during which research will take place | 1 April 2009 to 31 March 2011, with a possibility of the project extension depending of the nature of the findings and the demand for further work from individual Trusts. | | |
| Area in which research will take place | - river systems across Scotland for which local fisheries trusts have responsibility; this encompasses 24 Scottish Trusts covering in the order of 90% of Scottish river systems with salmon. | | |
| Estimated number and weight of salmon to be retained | - sampling of tissue for DNA analysis will be collected by individual Trusts for the programme of work and will to a large extent be taken non-destructively from salmon fry and parr collected by Trusts by electrofishing but samples will also be taken from returning adults captured by anglers, including both killed and catch-and-release fish. | | |

| Project No. | Sc8 | Status: | Ongoing - New entry |
|-------------|-----|---------|----------------------------|
|-------------|-----|---------|----------------------------|

| Resources | |
|--|---|
| Estimated cost of the research project Details of the full economic costs of each | FEC for two year programme of work is dependent on the precise funding stream but is estimated for the initial 2 year time frame to be $\sim \pounds 280,000$. |
| study are requested, including staff costs, equipment and overheads. For collaborative projects, a breakdown of costs between public and private partners is requested. | Staff costs: ~£146,000 Equipment costs: £20,000 Consumables costs: ~ £50,000 Overheads: ~ £50,000 (including both MS and RAFTS) Public (SG) contribution: ~50% Private (Trusts) contribution: ~50% |
| Number of participating scientists Name and e-mail address of coordinating scientist in charge of project | 2 post-doctoral research fellows and one part-time research assistant specifically employed for project work Dr. Eric Verspoor verspoor@marlab.ac.uk Dr. Calum Sinclair callum@rafts.org.uk |
| Details of research vessels, e.g. name, registration, call sign and description of vessel | - no research vessels used for work. |
| Type and amount of gear and other equipment to be used | - no marine gear to be used |
| Details of any collaborating countries Summary of Progress: | - no other collaborating countries |
| New entry | |

4. NORWAY

| Project No. N1 | Status: Completed |
|---|---|
| Party or relevant jurisdiction | Norway |
| Title of project | Identification of salmon by geochemical signatures; further development and testing of methods |
| Objective of research project | The main objectives of this project were to: test if geochemical signatures are stable from year to year test if geochemical signatures of salmon scale samples can be used to discriminate among fish from different rivers develop analytical procedures (otolith core sampling, chemical and statistical analyses) for application of this method in ecological studies on Atlantic salmon. |
| Brief description of research project | Analysis of the composition of trace elements in otoliths and other bone structures has proved to be a useful method for identifying the chemical milieu at the time the structures are formed. Trace elements may, therefore, provide a unique tool for identifying the natal origin of fish. In a sample of salmon parr from 14 rivers feeding into the Trondheimsfjord, 87.5% of the fish were correctly classified by a discriminant analysis based on six elements. In this project we will test some of the assumptions that the method is based on. |
| Dates during which research took place | 2002 |
| Area in which research took place | |
| Estimated number and weight of salmon retained | - |
| Resources | |
| Estimated cost of the research project | £ 30,000 |
| Number of participating scientists | 2 |
| Name of coordinating scientist in charge of project | Peder Fiske |
| Details of research vessels, e.g. name, registration, call sign and description of vessel | - |
| Type and amount of gear and other equipment used | - |
| Details of any collaborating countries | - |

The initial results suggested that salmon parr from different rivers could be differentiated based on the composition of trace elements in their otoliths. However, we could not classify new samples taken at a different time to the correct rivers using the discriminant functions based on the first sample. This suggests that there are year to year variations in the chemical composition of the otholiths, and that if the method should be used to identify salmon of unknown origin one would need year-specific samples from the possible rivers of origin. The usefulness of the method to identify salmon from mixed-stock fisheries to the river of origin therefore seems limited.

| Project No. | N2 | Status: | Completed |
|-------------|----|---------|-----------|
| | | | |

| Party or relevant jurisdiction | Norway | |
|---|---|--|
| Title of project | Development of models to predict marine survival and return of | |
| | salmon to Norway | |
| Objective of research | Develop models to predict marine survival and return of Atlantic | |
| project | salmon to Norway. | |
| Brief description of research | 1. Identify and examine the feasibility of applying time series of | |
| project | marine environmental data, zooplankton productivity, productivity of pelagic fish, and salmon life-history information for model development. | |
| | 2. Develop appropriate models | |
| | 3. Cooperate with scientists from other countries working with similar research. | |
| Dates during which research took place | 2002-2005 | |
| Area in which research took place | Desk Study utilizing information already available | |
| Estimated number and | None | |
| weight of salmon retained | | |
| Resources | | |
| Estimated cost of the | £50,000 - £60,000 per annum | |
| research project | | |
| Number of participating scientists | 7-10 | |
| Name of coordinating | Lars Petter Hansen | |
| scientist in charge of project | 1.p.hansen@nina.no | |
| Details of research | - | |
| vessels, e.g. name, | | |
| registration, call sign and | | |
| description of vessel | | |
| Type and amount of gear and other equipment used | - | |
| Details of any collaborating countries | Umass/NOAA CMER Program, University of Massachussetts, Amherst, MA USA Dep. Fisheries and Oceans, Newfoundland, Canada, Scientists from EU | |

A large amount of material on time series of hydrography, plankton production, biomass and condition of pelagic marine fish species and of salmon growth and survival indices (e.g. catches, estimated marine survival rates) has been analysed. A method to estimate the number of salmon entering the coast before exploitation (pre-fishery-abundance, or PFA) has been developed. Models were developed to forecast runs and PFA of 2- and 3SW salmon in years i+1 and i+2 based on the run of 1SW fish in year i. This approach is independent of smolt production. Models to forecast 1SW salmon were developed from environmental variables, plankton production and condition factor and biomass of herring. This approach is based on the assumption that the smolt production is the same every year. The precision of the forecasts were variable, lowest in south Norway and highest in north Norway. This has been the first approach to forecast salmon runs to Norway, and there is a significant potential to improve the predictions by further development of models. Important in this aspect is to maintain, improve and standardise the sampling of data so that the quality of appropriate time series would be less variable.

| Party or relevant jurisdiction | Norway | |
|---|--|--|
| Title of project | By-catch in pelagic fisheries as a population-regulating factor in wild salmon stocks | |
| Objective of research project | Concentrated migration paths of post-smolt Atlantic salmon of Norwegian and southern European origin have been described in the North-East Atlantic during the last 10 years. The post-smolts typically migrate northwards in the major slope currents outside the continental shelf in May-June with dispersal over large areas in the Norwegian Sea in July-August. One of the major migration paths described overlaps in time and geography with a pelagic trawl fishery for mackerel harvesting, in total, 50,000 tonnes a year during a short period of the summer. Based on preliminary observations made by the Institute of Marine Research (IMR) - research vessels there is good reason to believe that significant numbers of post-smolt salmon are caught in this fishery. | |
| | The main aim of this project was to carry out investigations to estimate the extent of such by-catch and, through cooperation with Russian scientists, to carry out investigations in order to estimate the by-catch and to develop management advice which could reduce by-catch of salmon while, at the same time, maintaining the catch rates in the mackerel fishery. | |
| Brief description of research project | The ongoing Norwegian investigations on marine migrations paths of post-smolt Atlantic salmon were intensified and focused in areas where interceptory fisheries have been described. Based on the data obtained, combined with data from the commercial fisheries, management advice which could lead to reduced salmon by-catch in the mackerel fisheries while maintaining the catch rates of the fishing fleet, was sought. | |
| Dates during which research took place | 2001 - 2005 | |
| Area in which research took place | Norwegian Sea | |
| Estimated number and weight of salmon retained | 500-1,000 fish pr year 500-3,000 kg pr year | |
| Resources | | |
| Estimated cost of the research project | Approx £80,000 per annum | |
| Number of participating scientists | 3-5 | |
| Name of coordinating scientist in charge of project | Jens Christian Holst jens.christian.holst@imr.no | |
| Details of research vessels, e.g. name, registration, call sign and description of vessel | R/V Johan Hjort (65 m) R/V G.O.Sars (70 m) | |

| Project No. N3 Status: Complet | ed |
|--------------------------------|----|
|--------------------------------|----|

| Type and amount of | Pelagic trawls | |
|--|-----------------------------|--|
| gear and other Ocean Fish Lift (Live catching device for trawls) | | |
| equipment used | Underwater video techniques | |
| Details of any collaborating | Probably PINRO, Murmansk | |
| countries | Scotland | |
| Summary of Findings | | |
| | | |
| No summary provided. | | |
| | | |

| Project No. | N4 | Status: | Completed |
|-------------|----|---------|-----------|
|-------------|----|---------|-----------|

| Party or relevant jurisdiction | Norway |
|---|---|
| Title of project | Sea lice as a population-regulating factor in Norwegian salmon: status, effects of measures taken and future management |
| Objective of research project | Sea lice are regarded as the major population-regulating factor in many Norwegian salmon and sea trout stocks, with documented mortality ranging up to over 95% in salmon. This project involved broad cooperation between the leading Norwegian institutions on sea lice/wild salmon interaction studies with the object of further clarifying the effects of sea lice on wild salmon populations, suggesting further actions and measures to reduce sea lice infections in wild salmon and developing alternative methods for critically affected stocks. |
| Brief description of research project Dates during which research | The project is a combined field and modelling exercise of interactions between farmed fish, wild fish and sea lice. The project included estimating the mortality in seaward-migrating post-smolts due to sea lice infections in major fjordic systems, counting of sea lice infections in wild and farmed salmon in the areas studied and developing a sea lice/salmon interaction management model and the development of additional measures for critically affected wild salmon stocks. 2002-2005. |
| took place | 2002-2003. |
| Area in which research took place | Sognefjord and Altafjord |
| Estimated number and weight of salmon retained | Up to 3,000 post-smolts per year (Maximum weight 60 kg) |
| Resources | |
| Estimated cost of the research project | Approx £140,000 per annum |
| Number of participating scientists | 7 |
| Name of coordinating scientist in charge of project | Jens Christian Holst (IMR) jens.christian.holst@imr.no |
| Details of research vessels, e.g. name, registration, call sign and description of vessel | R/V Johan Hjort (65 m) R/V Fangst (17 m) R/V Hyas (15 m) R/V Johan Ruud (45 m) R/V G.M.Dannevig (20 m) |
| Type and amount of gear and other equipment used | Pelagic trawl Ocean-Fish-Lift (live catching device for trawls) CTD |
| Details of any collaborating countries | |
| Summary of Progress | |
| No report provided. | |

| Project No. N5 | Status: Completed |
|--|---|
| Party or relevant jurisdiction | Norway, Institute of Marine Research, P.O. Box 1870 Nordnes, N-5817 Bergen |
| Title of project | Distribution of salmon in relation to environmental parameters and origin in the North Atlantic- capture, tagging and release of salmon with data storage tags (DSTs) |
| Objective of research project | Investigate the temporal and spatial distribution of DST- tagged salmon in the Norwegian Sea and adjacent areas with special emphasis on: Spatial distribution and temperature preferences Growth in relation to environmental parameters Vertical distribution of salmon during day and night (relating to possibility of intercepting fisheries) |
| Brief description of research project | The project was a joint effort between Norway, the Faroes and Iceland, and was based on earlier experiences in these countries. The project was partly funded by the Nordic Council of Ministers. The fish were captured with a special salmon trawl with live-capture device. Viable fish (approx. 2/3 of the catch) were tagged with DSTs inserted into the stomach and released. The research was in the Northern Norwegian Sea, in October in the Faroes' EEZ and in January-February in Iceland's EEZ. An important part of the investigation consisted of retrieving tags and recapture data from angling catches in home- waters. |
| Dates during which research took place | 2003 – 2006 (Data analysis only in 2005/2006. |
| Area in which research took place Estimated number and weight of salmon retained | The Northern North Sea - the Norwegian Sea; the Iceland Sea, the Greenland Sea 30-100 large post-smolts and older salmon (approx. 50-250 kg annually) |
| Resources | |
| Estimated cost of the research project Number of participating | £ 210,000 per annum in 2003 and 2004 £12,000 in 2005; £4,000 in 2006 5 scientists |
| scientists | |
| Name of coordinating scientist in charge of project | Marianne Holm, Senior Scientific Officer marianne.holm@imr.no |
| Details of research vessels, e.g. name, registration, call sign and description of vessel | R/V "Johan Hjort", Norway, LDGJ R/V "Magnus Heinason", Faroes Islands R/V "Arni Fridriksson", Iceland |
| Type and amount of gear and other equipment used | The ships were equipped with a specially designed trawl with live fish capture device attached to the cod end (Fish Lifter MKII, Holst & MacDonald 2000). |
| Details of any collaborating countries | Fisheries Research Institute, Torshavn, The Faroes The Marine Research Institute of Iceland, Reykjavik |

Within the framework of the Nordic project, 741 large post-smolts (October captures) and 1-2SW salmon had been captured in the North Atlantic by January 2005. Of these, 478 were captured and 293 were tagged with DSTs and released north of the Faroes, 28 captured and 11 tagged and released south-east of Iceland and 225 captured and 109 tagged and released in the Norwegian Sea. By January 2005, 5 of the tagged fish released in the Norwegian Sea had been recaptured. Two were recaptured in the Namsen fjord in mid-Norway after 18 and 74 days respectively and around 500 km of travel (shortest distance). Another salmon was recovered in the Trondheim fjord in June 2004 after 48 days at sea and \sim 480 km of travel. The fourth recapture was made in the Surna river after 122 days and ~ 500 km. The fifth fish was taken in the river Ätran on the Swedish west coast. This fish had travelled around 1,400 km in 127 days. 5 adipose fin-clipped salmon were found, but none of them carried a microtag. Most fish captured in April 2004 in the Norwegian Sea had entered the sea as 1-2 year-old smolts. The scale material from the Faroese catch will be analysed in 2005. Genetic samples and scales have been taken from most of the fish. In 2003 and 2004 all released salmon had an additional external yellow numbered tag (T-bar anchor) attached under the dorsal fin. In September 2004 the recapture of one such tag was reported from Scotland; unfortunately, however, the DST was either removed with the viscera or it had grown out through the body wall and shed, because it was never found. Data have been analysed in 2005 and two publications are in preparation.

| U | L L |
|--|---|
| Party or relevant jurisdiction | Norway |
| Title of project | Temporal variation in abundance of the northern-most populations of Atlantic salmon with emphasis on the River Tana |
| Objective of research project | The main objective of this project was to examine the importance of ocean climate, predation, marine fisheries, and smolt production as primary factors influencing the abundance of the northern-most and highly productive populations of Atlantic salmon (<i>Salmo salar</i>), with emphasis on the River Tana. |
| | Sub-goals: - |
| | • Examine the influence of ocean climate on temporal variation in Atlantic salmon abundance and life-history parameters of River Tana salmon and co-variation with salmon from other northern rivers |
| | • Evaluate the impact of predation by marine fish and birds on the abundance of River Tana salmon |
| | • Determine smolt and adult salmon abundance, initially from one tributary, as an index of marine survival for the River Tana system |
| | • Develop management plans for northern Atlantic salmon rivers by integrating biological and local knowledge of the resource. |
| Brief description of research project | Salmon rivers in northern-most Norway, Finland and the Kola peninsula (Russia), support important fisheries, both in coastal areas and in the rivers themselves, and contribute more than 40% of the world's freshwater catch of wild Atlantic salmon (<i>Salmo salar</i>). The River Tana, a large complex system that forms the border between northern-most Norway and Finland, at present supports the largest wild Atlantic salmon stock in the world and is also of particular importance to the Sami people. With the potential for increased exploitation of this and other northern stocks, interactions or impacts resulting from the proposed expansion of salmonid aquaculture into these northern areas, and uncertain consequences resulting from global climate change, it is important to study the dynamics of the world's largest salmon-producing rivers. Consequently, the objective of this proposal is to examine the importance of ocean climate, predation, marine fisheries, and smolt production as primary factors influencing the abundance of the northern-most and highly productive populations of Atlantic salmon, with emphasis on the River Tana. Biological knowledge gained from this project will be used in designing management strategies in cooperation with local managers. |
| Dates during which research took place | 2002-2006 |
| Area in which research took place | River Tana |

Project No. N6 Status: Completed

| Estimated number and | |
|---|--|
| weight of salmon retained | |
| Resources | |
| Estimated cost of the research project | £ 60,000 per annum |
| Number of participating scientists | 4-6 |
| Name of coordinating scientist in charge of project | Martin Svenning martin.svenning@nina.no |
| Details of research vessels, e.g. name, registration, call sign and description of vessel | |
| Type and amount of gear and other equipment used | |
| Details of any collaborating countries | Finland, Russia, Canada |
| Summary of Findings | |
| No summary provided. | |

| U U | • |
|--|---|
| Party or relevant jurisdiction | Norway |
| Title of project | The importance of early marine feeding on the growth and survival of Atlantic salmon post-smolts in Norwegian fjords |
| Objective of research project | The principal objective of the project (2002-2006) was to study the importance of early marine feeding on post-smolt growth and survival in coastal areas. The sub-goals were to: |
| | Analyse spatial variation in early marine post-smolt feeding and growth along a north-south geographic scale (comparative study) Investigate how post-smolt feeding and growth is associated with: timing of smolt descent, marine prey availability, parasite infection, fjord migration and abiotic factors (case study) |
| Brief description of research project | Much of the variation observed in marine survival of Atlantic salmon may be explained by differences in early post-smolt feeding and subsequent growth. Results from a pre-project indicate a prolonged fjord migration of post-smolts and extensive feeding on energy rich marine prey in northern Norway, while results from southern Norway suggest a shorter fjord residency and lower degree of feeding. However, feeding intensity varied annually within several of the systems, which may be related to variability in prey abundance on both temporal and spatial scales. We hypothesised that this may help explain why large variation in relative abundance is observed among years and why salmon populations are generally regarded as less sustainable in the south. This project studied: (A) the importance of early marine feeding and growth of post-smolts on a north-south geographical scale (comparative study). Furthermore, a detailed explanatory case study (B) provided complementary results to assist in evaluating important relationships among smolt run timing, marine prey availability, fjord migratory behaviour, incidence of marine parasites, and abiotic factors as they possibly relate to the subsequent growth and variation in abundance of adult salmon. This approach generated new knowledge important for future management of salmon populations, and contributed to a better understanding of the fluctuations in return rates of adult salmon. |
| Dates during which research took place | 2002 - 2007 |
| Area in which research took place | Central and Northern Norway |
| Estimated number and weight of salmon retained | |

| Project No. 1 | N7 | Status: | Completed |
|---------------|----|---------|-----------|
|---------------|----|---------|-----------|

| Resources | |
|------------------------------------|--|
| Estimated cost of the | Total expenditure: 2002 - £130,500; 2003 - £167,000; 2004 - |
| research project | £153,000; 2005 - £113,750; 2006 - £68,250; 2007 - £0 (publication of results only) |
| Number of participating scientists | 8 |
| Name of coordinating | Bengt Finstad |
| scientist in charge of | bengt.finstad@nina.no |
| project | |
| Details of research | F/F Hyas and F/F Johan Ruud |
| vessels, e.g. name, | |
| registration, call sign | |
| and description of | |
| vessel | |
| Type and amount of | Fish lift trawl |
| gear and other | |
| equipment used | |
| Details of any collaborating | Department of Fisheries and Oceans, Newfoundland, Canada |
| countries | |
| Summary of Findings | |

Post-smolts from southern Norway showed low feeding intensity in the fjords, whereas extensive feeding was observed in fjords in northern and middle parts of Norway. The results indicate that extensive feeding immediately after sea entrance may be more common for post-smolts in the northern and middle parts of Norway than in southern fjords. The observed differences in post-smolt feeding may be due to spatial and temporal differences in prey availability within and between different types of fjord systems, and this might influence post-smolt growth and survival. More information from these studies is given in: Rikardsen, A.H., Haugland, M., Bjørn, P.A., Finstad, B., Knudsen, R., Dempson, J.B., Holst, J.C., Hvidsten, N.A. & Holm, M. 2004. Geographical differences in early marine feeding of Atlantic salmon post-smolts in Norwegian fjords. J. Fish. Biol. 64: 1655-1679.

In another paper from the present project by Knudsen, R., Rikardsen, A.H., Dempson, J.B., Bjørn, P.A., Finstad, B., Holm, M & Amundsen, P.A. 2005. Tropically transmitted parasites in wild Atlantic salmon post-smolts from Norwegian fjords. J. Fish. Biol. 66: 758-772, it was shown that parasites of both freshwater and marine origin appear to be suitable as bio-indicators of feeding and migratory pattern of Atlantic salmon post-smolts and preadults during their seaward migration.

A third paper from this project is in press: Bjørn. P.A., Finstad, B., Kristoffersen, R., Rikardsen, A.H. & McKinley, R.S. (ICES J. Mar. Sci.). Differences in risks and consequences of salmon lice, Lepeophtheirus salmonis (Krøyer) infection on sympatric populations of Atlantic salmon, brown trout and Arctic charr within northern fjords. Results from this study indicate that Atlantic salmon seemingly may have a mismatch between time of lice infection and their post-smolt fjord migration in northern fjords. In contrast, brown trout and Arctic charr feed within the fjords throughout the summer and consequently have a higher risk of harmful infections in years with suitable environmental conditions for salmon lice development, especially in fish-farming areas. For 2007, 3-4 more papers will be published from this project.

| Party or relevant jurisdiction | Norway |
|---|--|
| Title of project | Distribution and ecology of post-smolts and salmon at sea |
| Objective of research project | By analysing age, growth, migratory paths in relation to environmental conditions and competitors, describe and expand the understanding of salmon marine life history in order to provide explanations to observed variations in salmon survival. Test hypotheses on: Independence of relationships between food availability and post-smolt feeding and growth Post-smolt migration and distribution in time and space Salmon stock separation/overlap in time and space |
| Brief description of research project | The oceanic phase of the Atlantic salmon and the influence of the marine environment encountered upon growth and survival of salmon stocks is increasingly recognised as an important stock regulatory factor among salmon scientists and managers. Knowledge of the migrations, the geographic distribution and general ecology of post-smolts and larger Atlantic salmon in oceanic waters is still sparse. The project followed up on and expanded a project started in 1995. Based on data needs identified during 1995 – 2002, new data were collected on cruises in 2003- 2005 and the project also provided historical and new post-smolt data to several other projects. Within the scope of a post-graduate fellowship, growth potential and patterns of post-smolts were examined by energetic content in fish and feed, and by computer-based image analysis of scale samples to assess influences of environmental traits on post-smolt growth and survival and to assess if it is possible to separate northern and southern European salmon stocks. |
| Dates during which research took place | 2002 - 2007 |
| Area in which research took place | West of Ireland – Faroes, northern North Sea, the Norwegian Sea |
| Estimated number and | • 5-10 salmon, total 30kg |
| weight of salmon retained | • 150-250 post-smolts, total 15kg |
| Resources Estimated cost of the research project | £120,000 per annum, including Ph.D. grant, and running costs, matching funds for ships and scientists at IMR and cooperative institutes |
| Number of participating scientists | 8 scientists |
| Name of coordinating scientist in charge of project | Marianne Holm, marianne.holm@imr.no |
| Details of research vessels, e.g. name, registration, call sign and description of vessel | • R/V "Johan Hjort", Norway, LDGJ |

| Project No. | N8 | Status: | Completed |
|-------------|----|---------|-----------|
|-------------|----|---------|-----------|

| Type and amount of gear and other equipment used | The ship was equipped with a specially designed trawl with live fish capture device attached to the cod end (Fish Lifter MKII, Holst & MacDonald 2000). |
|--|---|
| Details of any collaborating countries | Fisheries Research Institute, Torshavn, Faroe Islands |

By June 2004 a total of 1,767 post-smolts (850 and 917 in 2002 and 2003 respectively) and 124 adults have been captured since 2002 within this project. Of the adults, 27 have been tagged and released (cfr. project N5). The age structure of these fish is in conformity with earlier observations and, except for near the Norwegian coastline, smolt ages 1 and 2 are dominating the captures, i.e. these are fish of "southern origin". The post-smolts have been distributed over the same areas as previously recorded. The northern extension of the densest cohorts in recorded in June-July may vary somewhat within a couple of weeks, probably influenced by conditions at the time of migration and meteorological conditions at sea. Within the framework of the PhD scholarship the stomach contents have been analysed and fish larvae/0-group of varying species followed by amphipods seem to be dominating the diet. In 2002 when the herring larvae were abundant, the condition factor of the post-smolts was 1.19 on average, the highest recorded since the start of the marine investigations in 1995. In 2002 and 2003, 9 Irish, 1 Norwegian and 4 Irish microtags were recovered from the Norwegian Sea. High catches of mackerel have been recorded in the same hauls as post-smolts. In May - June 2004 around a hundred post-smolts were captured during a mackerel survey going from northwest Ireland to the Faroes. The salmon trawl was used for mackerel sampling. Results from the project are published in ICES reports, several scientific journals and 2 books.

Due to a reduction in available ship time, there was no cruise dedicated to post-smolt surveys in 2006. However, in 2006, 7 adults and 46 post-smolts were captured as by-catch in 4 different pelagic cruises. All fish except one adult taken in a SW- Norwegian fjord, were caught in the Norwegian Sea between 69.9 – 74.5 °N. The fish were caught in May (1 adult), June (5 adults), August (46 post-smolts) and November (1 adult). The post-smolts were all taken in one haul in one of the northern-most positions ever recorded during the salmon surveys. Within the framework of a PhD scholarship, the stomach contents have been analysed. Fish larvae/0-group of various species appear to dominate the diet followed by amphipods. In 2002 when the herring larvae were abundant, the condition factor of the post-smolts was, on average, 1.19, the highest recorded since the start of the marine investigations in 1995. Results from the project have been published in ICES reports, several scientific journals and two books. No ship time has been allocated for dedicated salmon investigations in 2007 and only occasional captures of salmon can be expected from surveys for pelagic fish other than salmon.

| Party or relevant jurisdiction | Norway |
|--|--|
| Title of project | Dispersal of salmon lice in Norwegian fjords |
| Objective of research project | Estimate and describe to what extent free-living salmon lice larvae disperse from wild and farmed sources within and between areas. |
| Brief description of research project | 1) Sentinel cages containing farmed salmon smolts free of salmon lice are used as passive traps to estimate the level of free living salmon lice larvae along the geographical length of the Hardanger fjord (16 in total). |
| | Hydrographical measurements and other measure methods are used to make physical oceanographic models of currents. A particle model is developed to predict the dispersal of larvae. |
| Dates during which research took place | 2007 Two surveys, one in May and one in June. |
| Area in which research took place | Hardangerfjord, Norway |
| Estimated number and weight of salmon retained | None, only farmed fish will be used |
| Resources | |
| Estimated cost of the research project | £131,000 |
| Number of participating scientists | 4 |
| Name and e-mail address | Karin Kroon Boxaspen |
| of coordinating scientist in charge of project | karinb@imr.no |
| Details of research vessels, e.g. name, registration, call sign and description of vessel | R/V G.M Dannevig, |
| Type and amount of gear and other equipment used | Sentinel cages, equipment for hydrographical measurements |
| Details of any collaborating countries | |
| Summary of Progress | |
| No summary provided. | |

| Project No. | N9 | Status: | Completed |
|-------------|----|---------|-----------|
|-------------|----|---------|-----------|

| Party or relevant jurisdiction | Norway, Scotland |
|---|---|
| Title of project | Experimental tagging programme for investigating the behaviour of escaped farmed salmon: pilot study |
| Objective of research project | The objective was to examine migration of escaped large farmed salmon and to test if they are transported with the currents and appear in Norwegian waters. |
| Brief description of research project | |
| Dates during which research will take place | 2006 - 2007 |
| Area in which research will take place | |
| Estimated number and weight of salmon to be retained | |
| Resources | |
| Estimated cost of the research project | |
| Number of participating scientists | 2 |
| Name and e-mail address of coordinating scientist in charge of project | Lars Petter Hansen (<u>l.p.hansen@nina.no</u> |
| Details of research vessels, e.g. name, registration, call sign and description of vessel | |
| Type and amount of gear and other equipment to be used | |
| Details of any collaborating countries | |
| Summary of Progress | |

Project No. N10 Status: Completed

Summary of Progress

Farmed Atlantic salmon reared at Ardmair near Ullapool in Scotland and at Rognaldsvåg outside Florø in Norway were individually tagged with external Lea tags and released from the fish farms in the spring of 2006 (Ardmair: 678 with mean length of 719 mm; Rognaldsvåg: 597 with mean length of 721 mm). Most of the salmon were expected to be sexually mature the autumn of 2006.

Five tags from the Scottish release (0.6% of the total number relased) have been reported recaptured, one was found on a beach in Scotland a bit north of the release site. Another tag was found on a beach in Shetland. A tagged salmon from the same batch was recaptured on the in the Göta River on the west coast of Sweden, and another was recaptured at the outlet of the Hardangerfjord in south west Norway. The fifth one was recaptured at the Lofoten area in north Norway.

Of the fish released from the Norwegian fish farm 42 have been recaptured (7 % of the number released). Most of the fish moved relatively quickly into nearby fjords and entered rivers there, only one individual moved a large distance, and was recaptured in the Drammenfjord in south east Norway.

Salmon released from the Norwegian fish farm showed a much higher survival that the fish released

at the Scottish farm and their migration pattern was very local. The migration pattern of the salmon released in Scotland can be explained by transport with the currents, and therefore some large salmon escaping from fish farms in this area in the spring may turn up in Norway and west coast of Sweden.

| Party or relevant jurisdiction | Norway |
|---|---|
| Title of project | Individual assignment of salmon caught in the ocean to region of origin |
| Objective of research project | Investigate genetic variation in Norwegian Atlantic salmon populations on different spatial scales; national, regional and within- river. Provide calibrated data on microsatellite markers for a database. Conduct genetic analysis of samples of ocean-caught salmon and attempt assignment of these samples to country/region of origin. |
| Brief description of research project | Samples were collected from approximately 30 Norwegian salmon rivers, spanning all geographical regions. One region was investigated in more detail, with sampling of all major rivers in the region and one river system was also sampled in more detail, covering all tributaries. All samples were analysed for the set of 15 SALMAN microsatellites. The variation in these markers on three spatial scales were investigated, to see if composite genetic signatures of rivers and regions can be built by aggregating data from individual components. The data were calibrated and made available for a common database of salmon populations. A collection of ocean samples of salmon was analysed, and assignment of these samples to country, region or river of origin was attempted. |
| Dates during which research took place | January 2006 – March 2009 |
| Area in which research took place | Norway, nationwide |
| Estimated number and weight of salmon retained | 3,000 parr, 30 kg |
| Resources | |
| Estimated cost of the research project | Total cost: £320,000 Staff costs (incl. overheads): £258,000 (Overheads: £88,000 Consumables, field work, meetings, and equipment: £55,000 Purchase R&D services: £7,000 |
| Number of participating scientists | 2 |
| Name and e-mail address of coordinating scientist in charge of project | Øystein Skaala <u>Oystein.Skaala@imr.no</u> Vidar Wennevik Vidar.Wennevik@imr.no |
| Details of research vessels, e.g. name, registration, call sign and description of vessel | |
| Type and amount of gear and other equipment used | Electrofishing equipment. Molecular biology laboratory at the Institute of Marine Research, Bergen, Norway |
| Details of any collaborating countries | Finland (Craig Primmer and Anti Vasemägi, University of Turku, Finland. Investigation of variation in EST-markers in Norwegian salmon populations) |

Project No. N11 Status: Completed

The project was originally intended to be completed by December 2008, but was extended to March 30 2009. During the projects final year, genotyping for 15 microsatellite markers has been completed for 35 Norwegian rivers, as well as for 1800 samples from ocean caught salmon. Further, a selection of samples from 8 different rivers, with differing environmental conditions, have been screened for a large number of EST-microsatellites and indel-markers in cooperation with the University of Turku, Finland. Presently data are being readied for analysis, and inclusion into the pan-European database developed for the EU-project SALSEA-Merge.

| Party or relevant jurisdiction | Norway, Institute of Marine Research, P.O. Box 1870 Nordnes, N- 5817 Bergen, Norway |
|--|---|
| Title of project | Migratory behaviour of smolts and post-smolts of cultured Atlantic salmon |
| Objective of research project | To study the change in migratory behaviour from smolts during the post-smolt stages in cultured Atlantic salmon. |
| Brief description of research project | Cultured 1+ smolts and groups of cage-reared postsmolts were tagged with acoustic transmitters and released at various dates from May to October 2008 from Matre Research Station. Cultured 0+ (autumn) smolts and post-smolts were tagged and released from September to December 2008. Their migratory behaviour was recorded by receivers covering the 22 km long Masfjorden. |
| Dates during which research took place | May 2008 – January 2009 |
| Area in which research took place | Masfjorden, western Norway |
| Estimated number and weight of salmon retained | |
| Resources | |
| Estimated cost of the research project | Total 2008: £100,000: £22,500; salary: £22,500; equipment: £50,000; other costs: £5,000 Total 2009: £40,000; overheads: £20,000; salary: £20,000 |
| Number of participating scientists | 2 |
| Name and e-mail address of coordinating scientist in charge of project | Ove Skilbrei ove.skilbrei@imr.no |
| Details of research vessels, e.g. name, registration, call sign and description of vessel | |
| Type and amount of gear and other equipment used | |
| Details of any collaborating countries | |
| Summary of progress | I |

Completed

Status:

Project No.

N12

Results have been submitted for publication. Migratory behaviour was highly developed in 1+ smolts and in post-smolts released 6 weeks later, but was gradually lost during autumn, when many fish resided and were recaptured in the fjord. Data on 0+ smolts not analyzed yet.

| 110jeet110. 1115 | Status. Ongoing | | |
|--|--|--|--|
| Party or relevant jurisdiction | Norway, Institute of Marine Research, P.O. Box 1870 Nordnes, N- 5817 Bergen, Norway | | |
| Title of project | Significance of salmon lice for growth and survival of salmon in the sea | | |
| Objective of research project | To estimate the effects of salmon lice on post-smolt growth and survival, dependent on release site, and time and year of release. | | |
| Brief description of research project | Cultured smolts have been treated against salmon lice, tagged with microtags and released in the River Dale, western Norway, each year from 2002 to 2009. The effect of the time of "escape" is studied by releasing T-bar anchor tagged smolts and post-smolts from May to August from Matre Research Station in 2005, 2007 and 2008. A comparison of the effect of salmon lice in fjord versus coastal areas is done by releasing smolts in both environments; from Matre and at the nearby coast in 2006 and 2007, and from Dale River and at the coast from 2007 to 2009. Further releases will occur in 2010. | | |
| Dates during which research will take place | Fish releases during 2006-2010. | | |
| Area in which research will take place | Western Norway; River Dale, Matre Aquaculture Station and nearby coast. | | |
| Estimated number and weight of salmon to be retained | Catch of adult tagged fish: 30-300 fish each year. | | |
| Resources | | | |
| Estimated cost of the research project | Total: £75,000 per annum; overheads: £25,000; salary: £33,000; equipment: £13,000; other costs: £4,000 | | |
| Number of participating scientists | 3 | | |
| Name and e-mail address of coordinating scientist in charge of project | Ove Skilbrei, ove.skilbrei@imr.no | | |
| Details of research vessels, e.g. name, registration, call sign and description of vessel | No vessels | | |
| Type and amount of gear and other equipment to be used | Tags; 25,000 microtags, | | |
| Details of any collaborating countries | | | |
| Summary of Progress | | | |

Ongoing

• •

Project No.

N13

Status:

Returns of grilse to the River Dale were sufficient for statistical analysis in 2002 and 2003 and an effect of salmon lice was observed. The marine survival of smolts seems to have been very low in the following years, with no differences between treated and control groups, except for a higher survival and significant benefit for treated smolts released at the coast 2007. Small or no differences in survival with time of release have been observed after the successive releases from May to August 2005 in Matre, but very low survival in following years. New releases of smolts treated against sea lice are planned in 2010.

| Project No. | N14 | Status: | Ongoing |
|-------------|-----|---------|---------|
| | | | |

| Party or relevant jurisdiction | Norway |
|--|--|
| Title of project | Marine survival, growth and exploitation of salmon from the Rivers Figgjo, Imsa, Drammenselv and Halselv. |
| Objective of research project Brief description of research project | Estimation of marine survival Estimation of marine growth Estimation of marine exploitation Data input in predictive models Monitoring Maintain time series of smolt taggings (wild and hatchery-reared) and tag returns in index rivers. Use the information to study fluctuations |
| | in marine survival and growth as well as describe changes in marine exploitation. |
| Dates during which research will take place | Long-term ongoing monitoring project |
| Area in which research will take place | Tagging in rivers Figgjo, Imsa, Drammenselv and Halselv with tag recovery programme in fisheries along Norwegian coast and elsewhere |
| Estimated number and weight of salmon to be retained | |
| Resources | |
| Estimated cost of the research project | Approximately £134,000 per annum |
| Number of participating scientists | 5 |
| Name and e-mail address of coordinating scientist in charge of project | Lars P. Hansen <u>l.p.hansen@nina.no</u> Nina Jonsson <u>nina.jonsson@nina.no</u> Arne Johan Jensen <u>Arne.jensen@nina.no</u> |
| Details of research vessels, e.g. name, registration, call sign and description of vessel | |
| Type and amount of gear and other equipment to be used | Fish traps, electric fishing |
| Details of any collaborating countries | |

The long-term monitoring of salmon from the four rivers has revealed that marine survival has improved compared with the poor survival in the late 1990s. Survival rates of wild and hatcheryreared salmon are correlated. Survival rates of 1SW fish are correlated with survival rates of 2- and 3SW fish from the same smolt cohort. There is a significant relationship between growth and survival, and slow-growing individuals tend to become sexually mature at a higher sea age than fast-growing individuals. The marine exploitation rates have continued to decrease. In the River Halselv a significant correlation has been found between return rates of first-time migrants of sea trout and sea charr, and return rates of salmon of the same smolt year class.

| Project No. 1815 | Status: Ongoing |
|--|--|
| Party or relevant jurisdiction | Norway |
| Title of project | Population-limiting mechanisms for Atlantic salmon during early estuarine and coastal migration (SalPoP) |
| Objective of research project | The main objectives of the project are to: Map migratory behaviour and quantify where, when and why mortalities of Atlantic salmon post-smolt occur. Correlate data on migration and mortalities with health status and major population-limiting factors. Significantly contribute to the future sustainability of Atlantic salmon populations by developing improved mitigating actions and management strategies. |
| Brief description of research project | The proposed project consists of five integrated workpackages (WPs). The first four WPs are aimed at examining specific population limiting factors, while WP5 is aimed at summarising the results in order to evaluate actions and management strategies for maintenance and re-establishment of wild Atlantic salmon populations. Groups of smolt will be exposed to various contaminants using a common protocol to establish dose response relationships affecting smolt health. Fish health will be assessed on basis of physiological, immunological and morphometric measurements. Movements, behaviour and survival will be studied with both acoustic telemetry methodology for smaller sub-samples. The use of telemetry will provide more detailed and comprehensive knowledge regarding survival and behaviour of the post-smolt than has been possible in earlier large scale external tagging studies. |
| Dates during which research will take place | January 2008 – January 2012 |
| Area in which research will take place | Eresfjord in Møre and Romsdal, middle Norway |
| Estimated number and weight of salmon to be retained | Wild and farmed salmonids |
| Resources | |
| Estimated cost of the research project | Funding from the Norwegian Research Council, Statkraft Energy AS and The Norwegian Directorate for Nature Management: 2008: £191,200 (NOK 1,950 000) 2009: £209,800 (NOK 2,140 000) 2010: £200,000 (NOK 2,040 000) 2011: £124,500 (NOK 1,270 000) |
| Number of participating scientists | 15 |

Project No. N15 Status: Ongoing

| Name and e-mail address | Bengt Finstad | |
|--|--|--|
| of coordinating scientist in | bengt.finstad@nina.no | |
| charge of project | | |
| Details of research | | |
| vessels, e.g. name, | | |
| registration, call sign and | | |
| description of vessel | | |
| 1 | | |
| Type and amount of gear and other equipment to be used | | |
| Details of any collaborating | • Prof. Thrandur Björnsson and Dr. Ingibjörg E. Einarsdottir - | |
| countries | Göteborg University (GU) | |
| | Dr. Andy Moore – Centre for Environment, Fisheries and Aquaculture Science (CEFAS) | |
| | • Prof. Robert Scott McKinley - University of British Columbia | |
| | (UBC) | |
| | | |
| Summary of Progress | · | |

Both the telemetry (acoustic) and laboratory experiments (contaminants) have been performed in the 2009 field season and a progress report to the Norwegian Research Council has been submitted and approved by the Council.

| brway ne Hardangerfjord salmon lice project yen though strategies for lice treatment in fish farms have been greatly |
|--|
| |
| a need to extend the time series to cover more combinations of vironmental and management factors which influence salmon lice levels the different salmonid populations. This will enable us to obtain a tter understanding of the fjord system by: 1. Improving sea lice monitoring and management on individual farms and the region in general by fjord integrated pest management and synchronized delousing processes. 2. Evaluating the success of sea lice management strategies in the Hardangerfjord through investigation of the infection level on farmed and wild fish. 3. Quantifying the abundance and distribution of salmon lice in the Hardangerfjord area based on the physical oceanographical and meteorological conditions for a given salmon lice production. 4. Analyzing data sets being collected at the Hardangerjord for possible risk factors associated with varying lice infection pressure with the aim of developing a mathematical population model for the Hardangerfjord system. |
| his three-year research effort will focus on the interactions of salmon lice tween farmed and wild salmonids in the Hardangerfjord and will be a ntinuum of the project which was initiated in 2004 (see: tp://www.nina.no and the attachment to the present application; FRProgressReportHardanger2005). The applied project consists of four osely linked workpackages: 1) Salmon lice abundance on wild and caped salmonids; 2) Optimised salmon lice monitoring and control rategies in farms; 3) Understanding the physical oceanographical factors a salmon lice abundance and distribution in the Hardangerfjord and 4) evelopment of a mathematical population model for the Hardangerfjord stem. The Hardangerfjord has the largest density of fish farms in Norway. Devever, even though strategies for lice treatment in fish farms have been eatly improved during the present project, we still experience episodes high lice infestation on wild salmonids in this fjord. Therefore, there is great need to extend the time series to cover and understand more of the fferent combinations of environmental and managemental factors which fluence salmon lice levels on the different salmonid populations. |
| |

Project No. N16 Status: Ongoing

| | the risk of salmon lice infestation on wild and farmed fish stocks. |
|--|--|
| | Epidemiological models in combination with lice dispersal models is vital to understand the complex relationship between hosts, parasites, environment and measures taken in fish farms. Modelling will also give advice to the industry for optimal placement of fish farms within a fjord system. The degree of international collaboration also shows that results obtained in this project can be used for other fjord systems globally in management schemes aimed at minimising the risk of salmon lice infestation on wild and farmed fish stocks. |
| Dates during which research will take place | January 2007- June 2010 |
| Area in which research will take place | Hardangerfjord at the Norwegian West Coast |
| Estimated number and weight of salmon to be retained | Wild- and farmed salmonids |
| Resources | |
| Estimated cost of the research project | Funding from The Norwegian Fisheries and Aquaculture Research Fund and the Norwegian Research Council: 2007: £143,600 (NOK 1,465 000) 2008: £151,000 (NOK 1,540 000) 2009: £149,000 (NOK 1,520 000) |
| Number of participating scientists | 14 |
| Name and e-mail address of coordinating scientist in charge of project | Bengt Finstad bengt.finstad@nina.no |
| Details of research vessels, e.g. name, registration, call sign and description of vessel | |
| Type and amount of gear and other equipment to be used | |
| | Prof. Robert Scott McKinley, University of British Columbia (UBC) |

All 4 work packages (see above) have been performed in the 2009 field season and a progress report to the Norwegian Research Council has been submitted and approved by the Council. A final report for the project period will be delivered by June 1, 2010.

| Party or relevant jurisdiction | Norway, Norwegian Institute for Nature Research, Trondheim, | | |
|--|---|--|--|
| Title of project | Norway Origin of Atlantic salmon off Svalbard | | |
| Title of project | | | |
| Objective of research project | To identify the origin of Atlantic salmon occuring in gill net fisheries at Isfjorden, Spitsbergen, by life history (age, growth) and genetic analyses. | | |
| Brief description of research project | Some individuals of Atlantic salmon are annually caught as by-catch in a gill net fishery outside Lonyearbyen, Svalbard. Scales of about 40 individuals were collected each year in 2008 and 2009. Life history (age, growth) and genetic analyses of these individuals will be conducted in an attempt to identify their conntry/region of origin. | | |
| Dates during which research will take place | September 2008 – February 2011 | | |
| Area in which research will take place | Isfjorden, Spitsbergen | | |
| Estimated number and weight of salmon to be retained | 80 | | |
| Resources | | | |
| Estimated cost of the research project | £22,500 i.e. £7,500 per annum | | |
| Number of participating scientists | 4 | | |
| Name and e-mail address of coordinating scientist in charge of project | Arne Johan Jensen (arne.jensen@nina.no) | | |
| Details of research vessels, e.g. name, registration, call sign and description of vessel | | | |
| Type and amount of gear and other equipment to be used | Gill nets | | |
| Details of any collaborating countries | | | |
| Summary of progress | <u> </u> | | |

Project No. N17 Status: Ongoing - New entry

About 40 Atlantic salmon were caught each year in 2008 and 2009. Age and growth analyses from their scales are in progress.

| Party or relevant jurisdiction | Norway, Tromsø |
|--|--|
| Title of project | SALMOTRACK - Electronic tracking of northern anadromous salmonids |
| Objective of research project | To track different life-stages of northern Atlantic salmon and other anadromous species in river, fjord and open ocean. |
| Brief description of research project | The SALMOTRACK-project is a primary framework that coordinates many activities on electronic tracking of northern anadromous salmonids, with special emphasis on Atlantic salmon. This also includes coordination of available logistics and equipment in order to maximize the synergistic effects and reduce the cost of each sub-project. The project utilizes several types of electronic tracking techniques to map the migrations and behaviour of almost all life stages of salmon, including juveniles, smolts, post-smolts in fjords, open ocean migrations of adults, returning adults in fjords and rivers, kelts (post- spawners) in the river and fjord and escaped farm salmon. In addition, silver eels, anadromous Arctic charr and sea trout have been tracked in fjords, rivers and lakes. Two post-doc positions, three PhD positions and several master and bachelor students are directly involved in the project. The SALMOTRACK-project was initiated in 2006 through support from the Norwegian Research Council, but has since then grown considerably in extent due to additional support from other funds and institutions. |
| Dates during which research will take place | 2006-2012. |
| Area in which research will take place | Northern Norway (Alta, Neiden, Tana, Skibotn, 2007-2012), Middle Norway (Orkla, 2010), Western Norway (Hardangerfjord, 2006). |
| Estimated number and weight of salmon to be retained | Electronic tagging of all stages from parr and smolts to adults |
| Resources | |
| Estimated cost of the research project | Approximately £1,500,000 for the whole study period (2006-2012) ie £250,000 per annum |
| Number of participating scientists | About 25 Norway: University of Tromsø (9), Norwegian Institute of Nature Research (5) and the Norwegian Institute of Marine Research (2) Several international participants, see below |
| Name and e-mail address of coordinating scientist in charge of project | Audun H. Rikardsen, audun.rikardsen@uitno |
| Details of research vessels, e.g. name, registration, call sign and description of vessel | 22 ft Buster Magnum with 150 HP engine (on trailer) FF Johan Ruud (100 ft trawler) |
| Type and amount of gear Different telemetry equipment and tags | |

| Project No. | N18 | Status: | Ongoing - New entry |
|-------------|-----|---------|----------------------------|
|-------------|-----|---------|----------------------------|

| and other equipment to | (PIT, acoustic, radio, archival, PSAT's) | |
|------------------------------|--|--|
| be used | | |
| Details of any collaborating | Kim Aarestrup (Denmark), David Righton (UK), Paddy Gargan | |
| countries | (Ireland), R. Scott McKinley (Canada), Brian Dempson (Canada), | |
| | Jaakko Erkinaro (Finland), Ben Letcher (US), Hiro Mitamura (Japan) | |

The project has so far been very successful, and has already obtained new and important information related to migratory behaviour of northern salmonids. In total, more that 1,900 fish (mostly salmon, but also charr, trout, pike and eel) have been tagged with electronic tags (acoustic, archival, radio, satellite pop-up archival tags) from 2006 to 2010. In addition, 4,000 salmon parr have been tagged with PIT-tags.

5. **RUSSIAN FEDERATION**

| Project No. R1 | Status: Completed | | |
|---|---|--|--|
| Party or relevant jurisdiction | Russian Federation | | |
| Title of project | Assessment of by-catch of post-smolts of Atlantic salmon in pelagic fisheries in the Norwegian Sea | | |
| Objective of research | Assess occurrence of post-smolts in catches by Russian vessels | | |
| project | engaged in the pelagic fisheries for mackerel, blue whiting and herring. | | |
| Brief description of research project | Catches were screened for post-smolts. Materials were collected in accordance with the methods applied for biological sampling. In addition, all information relating to vessel name, haul serial number, trawl type, surface temperature, duration of haul (start-end), depth of haul (min-max), trawling speed, trawl details, positions, catch, sample size, etc. was recorded. | | |
| Dates during which research | 2002 - 2007 | | |
| took place | | | |
| Area in which research took place | The Norwegian Sea | | |
| Estimated number and weight of salmon retained | N/A | | |
| Resources | | | |
| Estimated cost of the research project | Approximately £80,000 per annum | | |
| Number of participating scientists | Variable | | |
| Name of coordinating | Boris Prischepa (PINRO) | | |
| scientist in charge of project | elena@pinro.ru | | |
| | Alexander Zubchenko (PINRO) | | |
| | <u>zav@pinro.ru</u> , <u>salmon@pinro.ru</u> | | |
| Details of research vessels, | N/A | | |
| e.g. name, registration, call | | | |
| sign and description of | | | |
| vessel | | | |
| Type and amount of gear and other equipment used | Standard pelagic trawl | | |
| Details of any collaborating countries | N/A | | |

Summary of Findings

Results from surveys to map the distribution of post-smolts of Atlantic salmon in the Norwegian Sea conducted by IMR (Institute of Marine Research, Bergen, Norway) on a regular basis since 1995 (Holm et al., 2000) enabled WGNAS to conclude that areas of the distribution of post-smolts and mackerel in the Norwegian Sea in June-August overlap (ICES 2000/ACFM:13). Both species migrate in a surface layer: mackerel in the depth interval 0-50 m (ICES 2002/G:03), while post-smolts are found more frequently between 0 and 1 m (ICES 2002/ACFM:14). Targeted surveys conducted by IMR between 13 and 17 June 2001 in the Norwegian Sea in the vicinity of the area, where an intensive commercial fishery of mackerel took place later, showed simultaneous occurrence of mackerel and post-smolts in catches taken by the salmon survey trawl specifically designed for sampling post-smolts in the surface layer (ICES 2002/ACFM:14). Their findings gave rise to speculations that mackerel fishery in the Norwegian Sea in June-August can be viewed as the most precarious in terms of by-catch of post-smolts of Atlantic salmon.

In the light of this, the Russian Federation carried out a programme in 2002-2006 to study the Atlantic salmon post-smolt potential by-catch in the Russian mackerel fishery in the Norwegian Sea.

Scientific observers and fisheries inspectors worked onboard Russian fishing vessels that fished mackerel in the Faeroese fishing zone and international waters of the Norwegian Sea. Usually 2-5 Russian inspectors and 5-7 scientific observers stayed permanently onboard the vessels during the season. They checked licenses, logbooks, gear, catches and collected biological samples. Their tasks included also screening of the mackerel catch for potential by-catch of post-smolts and adult Atlantic salmon. The vessel's crew assisted in the work. The catches were screened immediately after retrieval of the trawl, during discharge of the fish into bins and at a ship factory during grading. All Russian trawlers had a factory and every single catch was graded onboard. The entire Russian commercial catch of mackerel was used for human consumption and most vessels froze and stored their products onboard. Consequently all catches were sorted and packed by species in standard boxes. Some of the vessels also produced canned fish. In all cases the catch was loaded from the trawl onto an accumulation conveyor at the vessel's factory immediately and sorted by the crew, which implied that the fish were handled more or less individually before packing or milling.

Calculation of the ratio of total number of post-smolts per tonne of mackerel in the international zone gave an estimated of 0.0015 post-smolts per metric tonne captured in the commercial fishery in 2002, and 0.0003 in 2003. The ratio of total number of adults per 1 tonne of mackerel in the international zone was 0.0019 in 2002 and 0.0039 in 2003. No adult salmon or post-smolts were recorded in 2004. Like in 2002 and 2003 the results from 2005 and 2006 suggested very low numbers of post-smolts and adult salmon caught in the mackerel fishery in July-August in the Norwegian Sea.

Such a low by-catch could, apparently, be explained by two reasons: first, most post-smolts pass the international waters before a large-scale fishery of mackerel starts there, second, commercial pelagic trawl practically does not capture post-smolts, migrating very close to the surface, which can be attributed to both specific features of its design and fishing technique for mackerel, these include the overall size, towing speed, ratios of width to height and the mesh sizes used in the construction, particularly in the fore part of the net.

The main design parameter of concern is the mesh sizes used in the front part of the trawl. The mesh sizes range from 0.8 m for the salmon survey trawl up to 50 m for the largest commercial net. With a commercial pelagic trawl mackerel are fished in the 0-5 m layer and down to 50-70 m from the sea surface. Post-smolts inhabit the upper 10 m of the surface, which is only filtered by the section of the net with the largest meshes. It is thought that the smolts simply pass through the large meshes, while mackerel tend to dive in response to a vessel and are visually herded by the netting bars. The presence of significant quantities of post-smolts in the salmon survey trawl, which only covers the top 10 m of the surface and is designed specifically for the capture of post-smolts, supports this.

As regards the post-smolt run timing, it could be suggested, that the majority of post-smolts among those migrating with the western branch of the Norwegian current pass the international waters before a large-scale fishery of mackerel begins, it usually starts in July. In addition, as the map of distribution of post-smolts in the Norwegian Sea shows (ICES 2002/ACFM:14), the main route of post-smolt northward migration is to the east of the area where the fishery is prosecuted.

All said above suggests a conclusion that the pelagic fisheries in the Norwegian Sea and, of mackerel in particular, cannot be considered as a significant source of post-smolt mortality. This is also

supported by assessments undertaken by ICES.

| supported by assessments unde | • | | |
|--|--|--|--|
| Project No. R2 | Status: Ongoing | | |
| Party or relevant jurisdiction | Russian Federation | | |
| Title of project | Monitoring of the stock status, abundance assessment and provision of advice on the allowable level of harvest of Atlantic salmon. | | |
| Objective of research project | Derive estimates of survival of juveniles and adult return rates, estimates of natural and fishing mortality, study the dynamics of population characteristics, assess population sizes and spawning escapement, estimate allowable catch. | | |
| Brief description of research project | Research fishing is conducted. Data is collected on the Atlantic salmon population characteristics (age structure, size distribution, sex composition, fecundity, proportion of various salmon groups in the spawning run). Adults and smolts are marked with tags to assess population size and survival rates. The dynamics of the smolt migration and the spawning run, and the behaviour of adults are studied. The quality of Atlantic salmon spawning habitat and the impact of human activities on the habitat are assessed. | | |
| Dates during which research will take place | Annual monitoring programmes (May-October). | | |
| Area in which research will take place | Atlantic salmon rivers of the Kola Peninsula, Archangel Region and Karelia Republic. | | |
| Estimated number and weight of salmon to be retained | About 1,500 salmon and 5,500 parr and smolts | | |
| Resources | | | |
| Estimated cost of the research project | Approximately £80,000 for 2010 | | |
| Number of participating scientists | ~ 25 scientists from PINRO | | |
| Name of coordinating scientist in charge of project | Sergey Prusov (PINRO) <u>prusov@pinro.ru</u> Gennady Ustuzhinsky (PINRO) <u>gena@sevpinro.ru</u> | | |
| Details of research vessels, e.g. name, registration, call sign and description of vessel | N/A | | |
| Type and amount of gear and other equipment to be used | Barrier fences, nets, electrofishing units, smolt traps, external tags | | |
| Details of any collaborating countries | N/A | | |

Adult returns in 2009 to home waters were assessed. The level of attainment of spawning requirements was determined, the condition and success of spawning was assessed, and estimates of parr density were derived. The harvestable surplus was determined. Recommendations on TACs and quotas for 2010-2011 salmon fisheries was developed for the Federal Agency for Fisheries of the Russian Federation and for the Regional Committees on Management of Salmon Fisheries.

| Party or relevant jurisdiction | Russian Federation and Norway |
|--|--|
| Title of project | Establishing a genetic baseline of northern salmon populations across the Russian – Norwegian border for management purposes. |
| Objective of research project | Establish a genetic baseline of sufficient resolution for the purposes of partitioning bag net catches between Russian and Norwegian regions. |
| Brief description of research project | In northern Norway, salmon are caught in bag net fisheries along the coast. Tagging studies conducted in the 1960s and 1970s demonstrated that these fisheries were mixed-stock fisheries (Prusov & Zubchenko 2009, Hansen <i>et al.</i> in prep.), intercepting salmon returning to a large number of rivers, both in Russia and Norway. Though fishing effort in marine fisheries for salmon has decreased since these studies were conducted, there is still a substantial marine fishery in Norway's two northernmost counties with a catch totalling 44,414 salmon (55% of the total marine fishery) in 2008 (ICES 2009). The proportion of Russian salmon in these catches is unknown, and whether the proportions observed in earlier tagging studies are stable over this time period is also uncertain. The development of a genetic baseline of Norwegian and Russian salmon populations provides an opportunity for applying genetic methods to investigate the present distribution of different salmon populations contributing to the coastal fisheries. The development of the baseline will be conducted in cooperation between PINRO, IMR and NINA. DNA will be extracted from the samples using commercial kits such as Qiagen DNEasy, which gives high quality DNA for long-term storage. The samples will be conducted on ABI 3130XL (NINA) and ABI 3730XL (IMR) Genetic Analyzers. DNA will be analyzed for variation in 18-25 microsatellite markers The analyses of bag net sampled fish will be conducted at IMR. The statistical analysis and assignment will be conducted in cooperation between NINA and IMR, with participation from PINRO. The common dataset of Norwegian and Russian rivers will be made available for the purposes of the SALSEA-Merge project. The data will also be used for constructing a national genetic baseline for Norwegian and Russian Atlantic salmon populations. |
| Dates during which research will take place | 2009-2010 |
| Area in which research will take place | Northern Norway, North-West of the Russian Federation |
| Estimated number and weight of salmon to be retained | N/A |

| Project No. | R3 | Status: | Ongoing - New Entry |
|-------------|----|---------|----------------------------|
| | | | |

| Resources | | | |
|--|--|----------|---------|
| Estimated cost of the | | | |
| research project | | Norway | Russia |
| | Collection of av samples | £3,400 | £33,600 |
| | Meetings & Travel | £5,600 | £1,100 |
| | Analyses (incl. labour) | £50,500 | - |
| | Evaluating results | £13,500 | - |
| | Analysis of bagnet samples | £25,250 | - |
| | Assignment/Mixed stock analysis and report | £9,000 | - |
| | Total | £107,250 | £34,700 |
| | Total: £141,950 | | |
| Number of participating scientists | Norway – 4, Russian Federation – 3. | | |
| Name and e-mail address of coordinating scientist in charge of project | Dr. Vidar Wennevik (IMR) <u>vidar.wennevik@imr.no</u> Dr. Sergey Prusov (PINRO) <u>prusov@pinro.ru</u> | | |
| Details of research vessels, e.g. name, registration, call sign and description of vessel | N/A | | |
| Type and amount of gear and other equipment to be | Electrofishing units – 5 (PINRO, IMR) | | |
| used | Smolt traps – 2 (PINRO) Genetic Analyzer ABI 3730XL – 1 (IMR) Genetic Analyzer ABI 3130XL – 1 (NINA) | | |
| Details of any collaborating countries | Norway | | |
| Summary of Progress: | l | | |
| New entry | | | |

6. UNITED STATES OF AMERICA

| Party or relevant jurisdiction | United States of America | |
|---|--|--|
| Title of project | Forecasts of Atlantic salmon transoceanic migration: climate | |
| | change scenarios and anadromy in the North Atlantic | |
| Objective of research | 1) develop and evaluate marine migration models for Atlantic | |
| project | salmon from North American and European stocks | |
| | 2) evaluate the potential effects of climate change on migration | |
| | patterns for Atlantic salmon | |
| Brief description of research project | Atlantic salmon undertake transoceanic migrations as part of their complex anadromous life history. In addition to the impact of climate on growth, maturation, and distribution in the ocean, salmon must home to their natal rivers to spawn, the success of which is likely impacted by ocean conditions. After rearing in fresh water, salmon juveniles employ a range of migration cues to time their seaward migrations. Since they are entering a new set of habitat regimes, the climate-related timing of this migration and the conditions they find in the coastal ocean are critical. We have developed a migration model that can be validated for most stocks of Atlantic salmon from North America and Europe. The probability of migration distribution is determined as a function of swimming potential, current vectors, and migration orientation. The absence of foraging behavior in the model has not significantly compromised its performance, owning to the likelihood that prey co-vary with other environmental variables. The model was run with forecasted surface temperature and currents for the North Atlantic segment of the Climate System Model developed at the National Center for Atmospheric Research. These simulations attempt to define the range of possible impacts climate change may have on | |
| | salmon populations. | |
| Dates during which research | 2002-2004 | |
| took place | | |
| Area in which research took | Area modelled included North Atlantic Ocean | |
| place | | |
| Estimated number and weight of salmon to be retained | No Atlantic salmon were sampled or retained during the course of this project. | |
| Resources | | |
| Estimated cost of the research project | | |
| Number of participating scientists | 1 | |
| Name of coordinating scientist in charge of project | Dr. Kevin Friedland friedlandk@forwild.umass.edu | |
| Details of research vessels, e.g. name, registration, call sign and description of vessel | None | |

Project No. U1 Status: Completed

| Computers, Databases |
|--|
| |
| |
| Some collaboration with Canadian investigators |
| |
| |
| |
| |
| |

| Party or relevant jurisdiction | United States of America |
|--|--|
| Title of project | Stable isotope composition of Atlantic salmon scales |
| Objective of research project | The objective of this study was to develop a retrospective time series of stable isotope ratios for the DPS in Maine and the mixed-stock samples from the continental stock complex to evaluate the feeding patterns of the stocks over time. |
| Brief description of research project | Atlantic salmon populations in the North Atlantic have experienced unprecedented declines in abundance during the past two decades. Of greater concern for the management of US salmon populations are the trends in the two-sea-winter salmon, especially those comprising the populations in the ESA distinct population segment. Although studies of climate and salmon survival suggest recruitment is patterned by events early in the post-smolt year, the apparent tele-connection between stock complexes suggests that factors related to life history events later in the post-smolt year or during the one-sea-winter year may be important as well. If growth has decreased in salmon during the post-smolt or one-sea-winter years, survival would likely be negatively impacted. Concomitant with the decline in stock abundance of salmon in the North Atlantic, a number of lines of evidence suggest that growth has also declined in the same time period. It is not known if this decline in size-at-age is a reflection of decreased growth during the post-smolt year or a decline in feeding opportunity when the fish are on the feeding grounds as one-sea-winter salmon. It is also not known if fish from the DPS are suffering the same decreased growth and tracking with the general pool of salmon in the Northwest Atlantic. There is no direct feeding data to approach these problems; however, many investigators have had success in evaluating feeding position with the analysis of stable isotopes in fish hard parts, such as scales. Furthermore, retrospective time series of growth were developed to provide an explanatory variable in regard to the feeding patterns. |
| Dates during which research | 2001-2002 |
| took place Area in which research took place | Scale samples collected during West Greenland sampling programme and from returning adults in the United States. |
| Estimated number and weight of salmon retained | No Atlantic salmon were retained during this project. |

| Project No. | U2 | Status: | Completed |
|-------------|-----------|---------|-----------|
|-------------|-----------|---------|-----------|

| Resources | |
|------------------------------|---|
| Estimated cost of the | |
| research project | |
| Number of participating | 1 |
| scientists | |
| Name of coordinating | Dr. Kevin Friedland, |
| scientist in charge of | NOAA Fisheries, Amherst, MA |
| project | friedlandk@forwild.umass.edu |
| Details of research | None |
| vessels, e.g. name, | |
| registration, call sign | |
| and description of | |
| vessel | |
| Type and amount of | Standard laboratory and isotope analysis equipment |
| gear and other | |
| equipment used | |
| Details of any collaborating | Collaboration with some international investigators to secure scale |
| countries | samples. |
| Summary of Progress | |
| No report provided. | |

| Troject No. 05 | Status. Completeu | |
|---|---|--|
| Party or relevant jurisdiction | United States of America | |
| Title of project | Ultrasonic telemetry of smolts and post-smolts in the | |
| | Narraguagus River and Narraguagus Bay | |
| Objective of research project | 1) evaluate migration timing and pathways in the lower | |
| | Narraguagus River and Narraguagus Bay | |
| | 2) estimate survival of migrating smolts and post-smolts | |
| Brief description of research | Telemetry data was collected on wild outmigrating Atlantic salmon | |
| project | smolts from 1997-1999 and 2002-2005 in the Narraguagus River | |
| | Maine, USA. During these years, 60-100 wild Atlantic salmor | |
| | smolts annually were surgically implanted with ultrasonic tags. In | |
| | 2005, Automated Pinger Detection Units (APDU) were deployed | |
| | through the Narraguagus River (5), Estuary (10), Bay and nearshore | |
| | environment (6), excluding the coastal arrays established in 2002 to | |
| | evaluate the number of smolts passing ecological transition zones. | |
| Dates during which research | 2002-2009 | |
| took place | Fieldwork in 2002-2005. Data analysis and publication in 2005 | |
| | 2008. | |
| Area in which research took | Narraguagus River (1997-1999, 2002-2005) | |
| place | Narraguagus Bay (1997-1999, 2002-2005) | |
| <u></u> | Gulf of Maine (2002-2004) | |
| Estimated number and weight | It is anticipated that no Atlantic salmon will be retained during this | |
| of salmon retained | project. | |
| Resources | | |
| Estimated cost of the | Approximately £49,000 per annum (public funding) | |
| research project | | |
| Number of participating | ~3 | |
| scientists | Laure Hereiter | |
| Name and e-mail address | James Hawkes | |
| of coordinating scientist | James.Hawkes@noaa.gov | |
| in charge of project Details of research | Equipment deployed from small research boats and leased | |
| vessels, e.g. name, | Equipment deployed from small research boats and leased commercial vessels. Vessel use is subject to change annually. | |
| registration, call sign and | commercial vessels. Vessel use is subject to change annually. | |
| description of vessel | | |
| Type and amount of gear | Ultrasonic Telemetry Tags (~60-100 annually) | |
| and other equipment used | Automated Pinger Detection Units (20-60 annually) | |
| Details of any collaborating | Automated Pinger Detection arrays deployed by Canadian | |
| countries | investigators were capable of detecting and recording tagged fish | |
| | Automated Pinger Detection arrays deployed for this study were | |
| | capable of detecting and recording Canadian tagged fish. | |
| Summary of Findings: | | |
| v | | |

Completed

Project No.

U3

Status:

Kocik, J. F., J. P. Hawkes, T. F. Sheehan, P.A. Music and K. F. Beland. 2009. Assessing estuarine and coastal migration and survival of wild Atlantic salmon smolts from the Narraguagus River, Maine using ultrasonic telemetry. In: Haro, A. J., K. L. Smith, R. A. Rulifson, C. M. Moffitt, R. J. Klauda, M. J. Dadswell, R. A. Cunjak, J. E. Cooper, K. L. Beal, and T. S. Avery, editors. Challenges for Diadromous Fishes in a Dynamic Global Environment. American Fisheries Society Symposium 69. Bethesda, Maryland. pp 293-310.

| Project No. U4 | Status: Ongoing |
|--|---|
| Party or relevant jurisdiction | United States of America |
| Title of project | Penobscot hatchery versus wild smolt telemetry |
| Objective of research project | Evaluate migration timing and pathways in the Penobscot Estuary and Bay Estimate survival of migrating smolts and post-smolts |
| Brief description of research project | Telemetry data was first collected on hatchery-reared out-migrating Atlantic salmon smolts in the Penobscot River, Maine, in 2005, and this research effort is continuing. Atlantic salmon smolts are surgically implanted with ultrasonic tags. Automated fish identification receivers are deployed throughout the estuary and near- shore marine arrays in Penobscot Bay. The array identifies the migration pathways of smolts as they exit the system between release groups. |
| | In 2005, 180 hatchery-reared smolts were tagged and released. In 2006, 25 hatchery and 25 naturally reared smolts were tagged and released. In 2007, no smolts were tagged. In 2008, 80 hatchery-reared smolts, 31 fall parr stocked smolts and 46 naturally reared smolts were tagged and released. In 2009, 122 hatchery reared and 37 fall parr stocked smolts were tagged and released. |
| Dates during which research will take place | 2005-2012 |
| Area in which research will | Penobscot Estuary |
| take place | Penobscot Bay |
| Estimated number and weight of salmon to be retained | It is anticipated that no Atlantic salmon will be retained during this project. |
| Resources | |
| Estimated cost of the research project | Approximately £66,750 annually (Public Funding) |
| Number of participating scientists | ~5 |
| Name and e-mail address of coordinating scientist in charge of project | James Hawkes James.Hawkes@noaa.gov |
| Details of research vessels, e.g. name, registration, call sign and description of vessel | Equipment deployed from small research boats and leased commercial vessels. Vessel use is subject to change annually. |
| Type and amount of gear and other equipment to be used | Ultrasonic Telemetry Tags (~150-250 annually) Automated Pinger Detection Units (100-150 annually) |
| Details of any collaborating countries | Automated Pinger Detection arrays deployed by Canadian investigators were capable of detecting and recording tagged fish. Automated Pinger Detection arrays deployed for this study were capable of detecting and recording Canadian tagged fish. |

Field activities and preliminary analysis are currently ongoing. 159 smolts were tagged in 2009. The 2009 array was put in place and maintained in cooperation with the University of Maine and the U.S. Geological Survey (other species are being tracked with the array – e.g., shortnose sturgeon). Approximately 150 salmon smolts will be tagged in 2010. Detailed analysis and development of peer-reviewed manuscript(s) will be released upon conclusion of field studies.

| Party or relevant jurisdiction | United States of America |
|--|--|
| Title of project | Comprehensive evaluation of marine survival of hatchery- stocked smolts: Migration behaviour and success of Dennys River smolts |
| Objective of research project | evaluate migration speed and behaviour from lower river release sites through estuarine habitat estimate survival of migrating smolts and identify areas where mortality may be occurring |
| Brief description of research project | An experimental evaluation of river-specific Atlantic salmon smolt stocking in the Dennys River was developed. The program was scheduled to run for a minimum of five years (2001-2006), but ultrasonic telemetry efforts on the Dennys were discontinued in 2005. Ultrasonic telemetry investigations were used to evaluate the migration success, nearshore marine mortality and nearshore migration routes of these stocked smolts. Approximately 50,000 smolts are released annually and, of these, approximately 70-150 fish are released with surgically implanted ultrasonic pingers. |
| Dates during which research will take place | Data collection April – June, 2001-2005. Data analysis and publication 2005-2010. |
| Area in which research will take place | Dennys River Cobscook Bay Gulf of Maine |
| Estimated number and weight of salmon to be retained | It is anticipated that no Atlantic salmon will be retained during this project. |
| Resources | |
| Estimated cost of the research project | Approximately £3,500 per annum (public funding) |
| Number of participating scientists | ~3 |
| Name and e-mail address of coordinating scientist in charge of project | James Hawkes James.Hawkes@noaa.gov |
| Details of research vessels, e.g. name, registration, call sign and description of vessel | Equipment deployed from small research boats and leased commercial vessels. Vessel use is subject to change annually. |
| Type and amount of gear and other equipment to be used | Ultrasonic Telemetry Tags (70-200 annually) Automated Pinger Detection Units (20-40 annually) Electro-fishing gear for juvenile assessments |
| Details of any collaborating countries | Automated Pinger Detection arrays deployed by Canadian investigators were capable to detecting and recording tagged fish. Automated Pinger Detection arrays deployed for this study were capable to detecting and recording Canadian tagged fish. |

| Project No. | U5 | Status: | Ongoing |
|-------------|----|---------|---------|
| | | | |

Ultrasonic telemetry efforts on the Dennys River were discontinued in 2005. Preliminary results suggest that emigrating smolts pass through the freshwater zone quickly, experiencing low mortality. However, once fish entered the near-shore environment, mortality markedly increased and large variations were observed in the timing of emigration. Low numbers of smolts were detected entering the Gulf of Maine. Detailed analysis and development of peer-reviewed manuscripts are ongoing (2010).

| Project No. U6 | Status: Ongoing |
|--|--|
| Party or relevant jurisdiction | United States of America |
| Title of project | Comprehensive evaluation of marine survival of hatchery- stocked smolts: Dennys River smolt stocking assessment |
| Objective of research project | evaluate smolt-to-adult survival rates of Atlantic salmon smolts based on temporal and spatial patterns of release determine optimal stocking levels to achieve stock rebuilding objectives |
| Brief description of research project | The Maine Atlantic Salmon Technical Advisory Committee (TAC) developed, and fishery managers supported, the experimental evaluation of river-specific Atlantic salmon smolts in the Dennys River for a minimum of five years (2001-2006). Stocking rates were developed based on retrospective analysis of Penobscot River stocking and adult return data during the period from 1973 to 1995. Model results indicated that a range of 32,000 (low) to 56,000 (high) would result in a 75% probability of achieving 2SW Atlantic salmon returns of at least 67 (low) or 117 (high) adults. Approximately 50,000 smolts will be released annually. All stocked fish will receive an elastomer mark and adipose fin clip to allow quantitative evaluation of survival in relation to release location and time. Returning adults will be enumerated and identified at a weir-based adult trap. |
| Dates during which research will take place | May – October, 2001-2010 |
| Area in which research will take place | Dennys River Cobscook Bay Gulf of Maine |
| Estimated number and weight of salmon to be retained Resources | It is anticipated that no Atlantic salmon will be retained during this project. |
| Estimated cost of the research project | Approximately £14,000 per annum (public funding) |
| Number of participating scientists | ~3 |
| Name and e-mail address of coordinating scientist in charge of project | Greg Mackey greg.mackey@maine.gov |
| Details of research vessels, e.g. name, registration, call sign and description of vessel | None |
| Type and amount of gear and other equipment to be used | Elastomer Marks and Marking Equipment Rotary Screw Smolt Trap Weir-Based Smolt Trap Weir-Based Adult Trap |
| Details of any collaborating countries | Elastomer marks may be recovered during the NASCO international cooperative sampling programme at West Greenland. |

Monitoring of hatchery-origin smolts on the Dennys River was performed from 2001 to 2005. Stocking groups of Visual Implant Elastomer marked smolts are released at different times and from different stocking sites. An adult weir trap is used to monitor the contribution of each stocking group. Preliminary results indicate extremely low numbers of returning adults have been documented, indicating very low marine survival levels. Analysis is ongoing.

| | Status. Ongoing |
|--|--|
| Party or relevant jurisdiction | United States of America |
| Title of project | Evaluation of estuary and nearshore marine distributions of Atlantic salmon post-smolts in Penobscot Bay and the Gulf of Maine |
| Objective of research project | evaluate nearshore distribution and migration pathways of smolts and post-smolts estimate the relative contribution of stocked hatchery smolts to overall post-smolt populations evaluate the relative contribution of spatially and temporally distinct smolt releases on post-smolt populations evaluate the physiological condition of post-smolts in marine environments |
| Brief description of research project | Synchronous declines in the survival of Atlantic salmon smolts throughout North America indicate a sharp decline in marine survival. Many investigators hypothesize that this decline occurs early in the marine phase, as Atlantic salmon smolts transition from freshwater to marine environments. A surface pelagic trawl survey was initiated in 2001 in the Penobscot Bay estuary and nearshore waters of the Gulf of Maine to sample hatchery- and naturally reared Atlantic salmon smolts in the marine environment. A Norwegian- designed pelagic net with a modified aquarium cod end is towed through the surface waters enabling live capture and release. Biological data including size, scale samples, genetic samples, physiology samples, and diet composition are collected from a subsample of fish. |
| Dates during which research will take place | Data collection from May, 2001-2005. Data analysis from 2005 to present (2010). |
| Area in which research will take place | Penobscot Bay Gulf of Maine |
| Estimated number and weight of salmon to be retained | Although project objectives and methodology strive to minimize mortality of Atlantic salmon, immediate trawl and or sampling induced mortality is estimated to be approximately 5%. |
| Resources | |
| Estimated cost of the research project | Approximately £20,000 per annum (public funding) |
| Number of participating scientists | 2 |
| Name of coordinating scientist in charge of project | Tim Sheehan <u>Tim.Sheehan@noaa.gov</u> |
| Details of research vessels, e.g. name, registration, call sign and description of vessel | F/V Nobska and F/V Morue 30-m commercial trawler |
| Type and amount of gear and other equipment to be used | Post-smolt trawl Standard oceanographic instruments |

Project No. U7 Status:

Ongoing

| Details of any collaborating countries | No direct collaboration |
|---|---|
| Summary of Progress | |
| Two manuscripts summarizing considered for publication. | g the findings of this project are currently under review and being |

| Party or relevant jurisdiction | United States of America |
|--|--|
| Title of project | Cormorant harassment in the Narraguagus River/Narraguagus Bay |
| Objective of research project | To reduce predation on migrating Atlantic salmon smolts by excluding double-crested cormorants from the lower Narraguagus River and Narraguagus Bay, and to assess the efficacy of non-lethal predator exclusion as a means of reducing predation on migrating Atlantic salmon smolts. |
| Brief description of research project | U.S. Department of Agriculture (USDA) Wildlife Services professionals will use non-lethal methods to exclude cormorants from the lower Narraguagus River and Narraguagus Bay. These professionals will use fire-cracker shells, "screamers", and other non- lethal methods to displace foraging cormorants anywhere they are encountered within the study area. Effort will be focused within areas in which substantial amount of smolt mortality occurs. |
| | Observational data on the frequency and occurrence of cormorants in Narraguagus Bay during the smolt migration will also be collected. These data will be useful for comparing smolt movements with the occurrence of cormorants before, during, and after cormorant exclusion. USDA personnel will fill out a data sheet each day they are in the field. Additionally, cormorant abundance will be documented using two automated digital cameras. |
| | Telemetry arrays, already in place in the Narraguagus system, will allow us to assess the efficacy of the cormorant harassment by providing mortality data at each telemetry array. |
| Dates during which research will take place | May-June 2005. This research will expand upon similar work that was done in May-June 2004. Data analysis and publication of findings in 2005-2010. |
| Area in which research will take place | Lower Narraguagus River, Estuary and Narraguagus Bay, Maine |
| Estimated number and weight of salmon to be retained | It is anticipated that no Atlantic salmon will be retained during this project. |
| Resources Estimated cost of the research project | £3,500 per annum (public funding) |
| Number of participating scientists | Approximately five, representing Federal and State resource management agencies |
| Name and e-mail address of coordinating scientist in charge of project | James Hawkes James.Hawkes@noaa.gov |
| Details of research vessels, e.g. name, registration, call sign and description of vessel | N/A |
| Type and amount of gear and other equipment to be used | Small boat, digital cameras, shotguns with fire-cracker and screamer shells, laser. |

| Project No. U8 | Status: | Ongoing |
|----------------|---------|---------|
|----------------|---------|---------|

| | None |
|-----------------------|------|
| countries | |
| Commence of Duc anosa | |

Cormorant harassment activities concluded in 2005 and analysis is being performed to determine what effect was observed as a result. Ultrasonic telemetry data collected during the harassment period is used to determine success of the project. Preliminary results suggest that emigrating smolts pass through the fresh water with a high rate of success. However, once fish enter the estuary, mortality increases, specifically during daylight hours. Detailed analysis and development of peer-reviewed manuscript is ongoing and expect to be completed in 2010.

| Party or relevant jurisdiction | United States of America |
|--|--|
| Title of project | SALSEA Greenland |
| Objective of research project | To advance understanding of the ecology of the Atlantic salmon West Greenland stock complex and to gain an insight into the factors resulting in recent significant increases in marine mortality across the North Atlantic. |
| Brief description of research project | SALSEA Greenland involves purchasing fresh whole Atlantic salmon from individual fishers and performing an Enhanced Sampling Program on these fish in addition to the Baseline Sampling Program referenced in project D1 "West Greenland Salmon Fishery Sampling Programme". The enhanced sampling protocols are similar to the sampling protocols followed for SALSEA North America and SALSEA-Merge and will allow the results from these three marine sampling programs to be combined and analyzed across temporal and spatial scales. |
| Dates during which research will take place | Sampling is expected to occur during the fishing season, August - October 2009 and 2010, and sample processing and analysis is expected to continue through 2012. |
| Area in which research will take place | Sisimiut, Nuuk and Qaqortoq, Greenland |
| Estimated number and weight of salmon to be retained | Maximum of 900 1SW non-maturing (primarily) adults annually |
| Resources | |
| Estimated cost of the research project | Many of the sample collection costs are accounted for in project D1. Only costs additional to those are provided here: |
| | Approximately \$147,000 (USD) or £98,000 (GBP) – all public funding over three years, i.e. £33,000 per annum |
| Number of participating scientists | 2 additional personnel above and beyond those identified in projec D1 actively worked on this project in 2009 |
| Name and e-mail address of coordinating scientist in charge of project | Tim Sheehan <u>Tim.Sheehan@noaa.gov</u> |
| Details of research vessels, e.g. name, registration, call sign and description of vessel | None |
| Type and amount of gear and other equipment to be used | Standard sampling and laboratory equipment |
| Details of any collaborating | Collaborative project with investigators from US (T. Sheehan) Canada (G. Chaput and D. Reddin) and scientists from SALSEA |

Project No. U9

of SALSEA Greenland. In addition to the Baseline sampling (outlined in project D1), the full suite of Enhanced Sampling samples were also collected from these fish. The Enhanced Samples will be used to evaluate a wide variety of topics such as age and growth, diet, origin, lipid analysis, stable isotope analysis, parasites, diseases, sea age at maturity as well as genetic relations and SLICER resistance in sea lice. Samples collected in 2009 are either in the auditing or initial processing/analysis phase. The 2009 sampling effort was largely successful and the data collected will provide novel insights into the health and status of the West Greenland Stock complex. These data will be valuable in furthering our understanding of marine phase salmon once they are combined with the data collected under the SALSEA North America and SALSEA-Merge programs.

7. FRANCE (IN RESPECT OF ST PIERRE AND MIQUELON)

| Project No. | F1 | Status: | Ongoing |
|--------------|------|---------|---------|
| 110jeet 110. | T. T | Blatus. | Ongoing |

| Party or relevant jurisdiction | France (In respect of St Pierre and Miquelon) |
|--|--|
| Title of project | St Pierre and Miquelon Salmon Fishery Sampling Programme |
| Objective of research projects | To improve the understanding of the biological characteristics and origin of salmon harvested in the fishery at St Pierre and Miquelon. |
| Brief description of research project | The Scientific Programme at St Pierre and Miquelon was introduced in 2003 under the direction of the Institut Francais de Recherche pour l'Exploitation de la Mer (IFREMER). The project was developed through cooperation with NASCO and was designed so as to include three components: A biometric study A genetic study A disease and parasite study. |
| Dates during which research will take place | Annually during the fishing season (1 May – 31 July) |
| Area in which research will take place | Around the islands of St Pierre and Miquelon |
| Estimated number and weight of salmon to be retained | Sampling of harvest : none in 2009 |
| Resources | |
| Estimated cost of the research project | - |
| Number of participating scientists | 1 |
| Name and e-mail address of coordinating scientist in charge of project | Herlé Goraguer herle.goraguer@ifremer.fr |
| Details of research vessels, e.g. name, registration, call sign and description of vessel | N/A |
| Type and amount of gear and other equipment to be used | Samples obtained from the fishery |
| Details of any collaborating countries | Canada (Newfoundland) |

Studies regarding salmon harvest at sea `: the biometric study has been conducted annually since 2003 and includes the weighing and measuring of salmon harvested in the fishery. In addition, water temperature is recorded at the fishing sites. The number of salmon sampled has varied between 310 and 391 in the 2003-2006 period, but comprised only 12 individuals in 2007, and 68 in 2008. In 2004, genetic analyses were conducted in cooperation with the Canadian scientists and authorities, and the results were presented in the 2005 WGNAS Report. To date, it has not been possible to conduct the pathology study.

In 2009, the sampling programme was not conducted. The studies will restart in 2010.

Note: A study was conducted during the 2009 summer in some sections of the Belle Rivière de Langlade, to map potential salmon habitat and to investigate the presence of a salmon population. Young salmons were captured between June and September, showing the existence of a limited population. A number of river sections were identified as potential favourable habitats. The study will be continued during the 2010 summer.