

CNL(08)28 (rev)

Council

***SALSEA-North America
Research Strategy for the Study of Atlantic Salmon Marine Ecology***

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A research strategy in support of the SALSEA initiative promoted by parties at NASCO was drafted and finalized in late 2007. The research strategy was prepared by a steering group consisting of Gerald Chaput and Dave Reddin (Department of Fisheries and Oceans, Canada), Tim Sheehan (National Marine Fisheries Service, NOAA, USA) and Fred Whoriskey (Atlantic Salmon Federation).

The research strategy consists of three inter-related activities which build on existing index rivers programs in eastern North America. Research activities are linked to the overall marine research program (SALSEA) advocated by NASCO. The suite of existing projects currently taking place in Canada and USA are integrated into the research strategy (Appendix A, B).

This paper summarizes the main elements of the research strategy and provides details specific to the marine survey to be delivered in August 2008, with the considerations for the survey in 2009 based on the results of the 2008 initiative.

Context

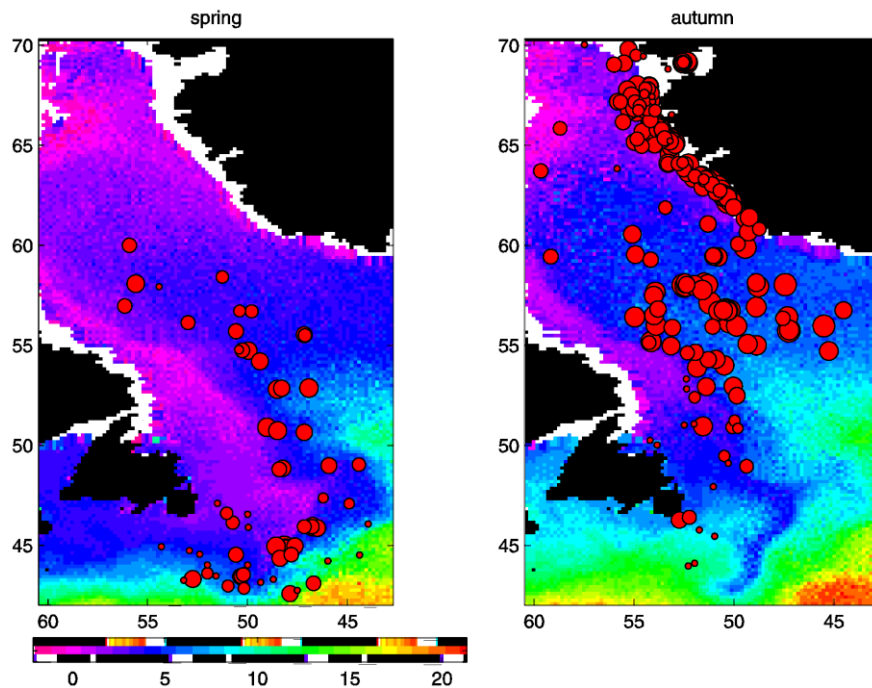
Atlantic salmon stocks have declined in both Europe and North America and much evidence points to there having been changes in their ecology and survival in the ocean phase. Concerns about increases in marine mortality of salmon prompted a number of workshops and meetings to consider factors contributing to mortality at sea. The present knowledge of the marine ecology of salmon is insufficient to explain the significant decline in Atlantic salmon abundance since the late 1970s.

What we know about salmon ecology at sea

It is evident from trawling for postsmolts at sea, from acoustic tracking of postsmolts in fjords, and in net catches in surface waters that postsmolts spend at least some time in the upper portion of the water column. Data storage tags applied and retrieved from postsmolts and kelts show diurnal differences in water depth and temperature use.

Growth in the marine environment is rapid, weight increases 75-fold between the smolt stage and 1SW salmon stage, and over 200 fold from smolts to 2SW salmon. Marine-phase Atlantic salmon are primarily opportunistic, pelagic to mid-water feeders.

From catch rates during research vessel surveys in the Northwest Atlantic, 1965-2001, salmon were most abundant at sea surface temperatures (SSTs) between 3 and 13°C with peak catch rates at 7.5°C. No sampling has taken place at SSTs higher than 13.5°C.



Research vessel catch rates (circles, log of salmon caught per mile-hour of gear fished) for Atlantic salmon in the northwest Atlantic and corresponding mean sea surface temperature in spring and autumn for the period 1965 to 2001 (Reddin 2006).

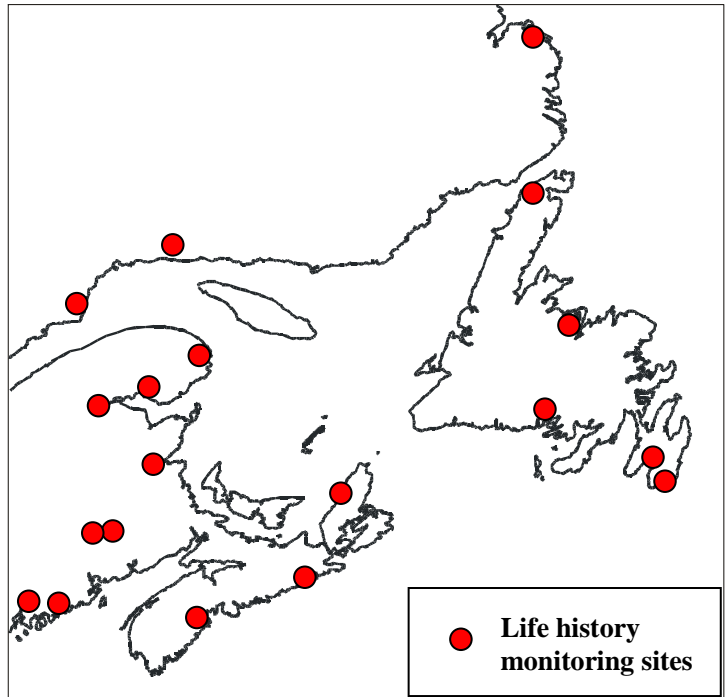
The historical information on marine mortality, marine distribution, migration and ecology was derived from monitoring programs in rivers, sampling of commercial Atlantic salmon fisheries, from marine recoveries of previously tagged and released smolts, from tagging of adult salmon at sea, and from a limited number of targeted research surveys for Atlantic salmon. Advances in pelagic trawling techniques and in parallel, developments in data storage tags, and acoustic tags provide opportunities for collecting new information on salmon distribution, behaviour and the physical environment.

Research Strategy

The research strategy consists of three inter-related activities which build on existing index rivers programs in eastern North America. Research activities are linked to the overall marine research program (SALSEA) advocated by NASCO. Different but complementary information on marine ecology of salmon can be obtained with these research approaches.

- Life History Monitoring:

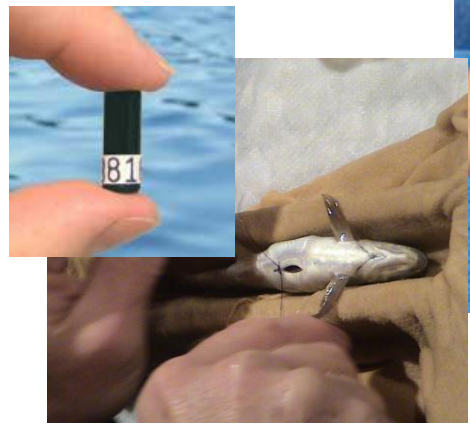
- These programs provide data on life history parameters, feeding, disease status, parasite communities, and overall marine mortality and provide data to test factors associated with survival of salmon over a broad geographic range.
- Index rivers monitoring program delivered by DFO, the province of Québec, and the US in 16 rivers of eastern North America.
- Sampling at West Greenland delivered by an international effort including Greenland home rule government, Canada, the US, and several European countries.



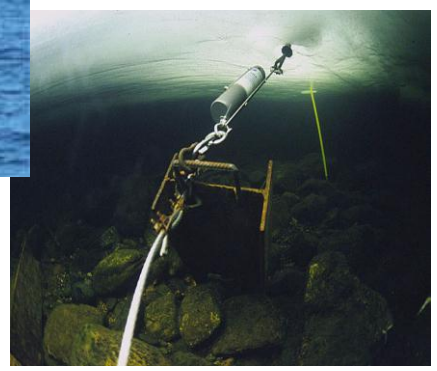
Location of life history monitoring projects to assess Atlantic salmon smolt and surviving adult characteristics.

- Electronic technologies:
 - Acoustic tracking work led and resourced by the Atlantic Salmon Federation is facilitated by access to suitable salmon smolts for tagging from the index rivers program
 - The research consists of implanting miniturized acoustic transmitters in salmon smolts which can later be detected by stationary acoustic receiving stations at various points in the migration, from inriver, estuaries, nearshore and offshore.

Transmitter

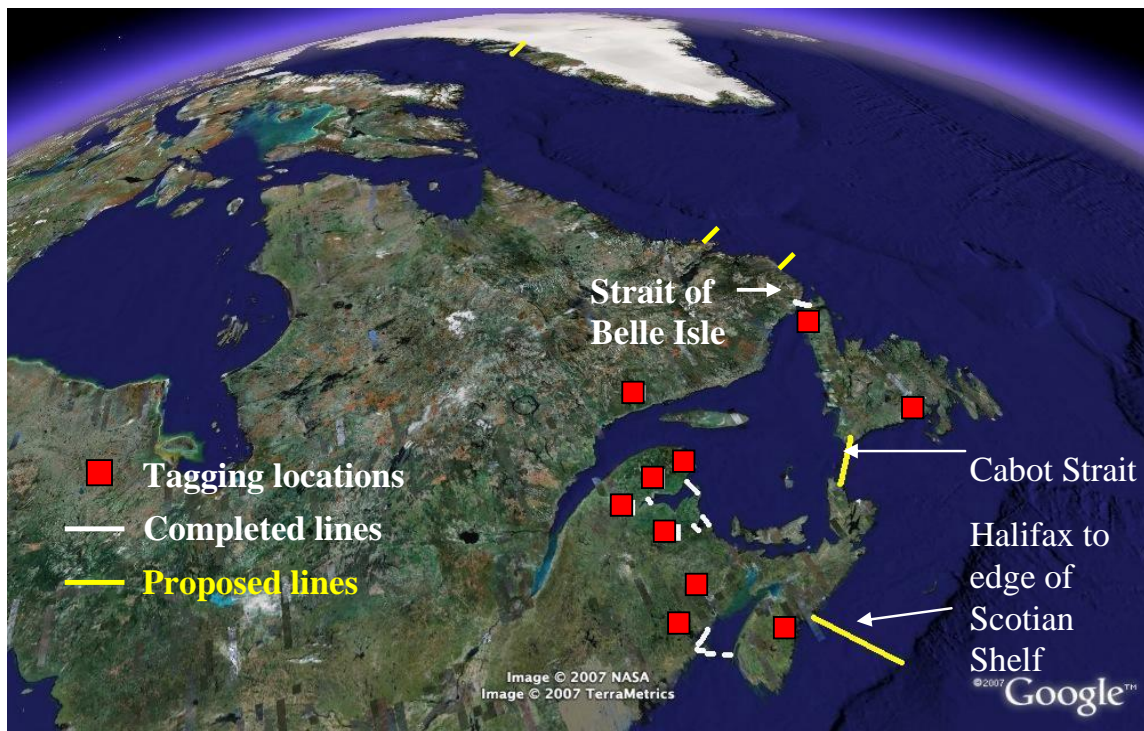


Receiver



Acoustic technology used to quantify migration rates, timing, synchronization and mortality rates at sea of wild Atlantic salmon smolts and salmon kelts from rivers in the northwest Atlantic. (photographs courtesy of Bill Curtsinger, ASF).

- Since 2006, the Atlantic Salmon Federation (ASF) has deployed receiver lines in the Strait of Belle Isle, between Newfoundland and Labrador. ASF researchers have tracked salmon 800 to 1000 km from home rivers in New Brunswick and Quebec to this northern migration exit from the Gulf of St. Lawrence, about half the distance to West Greenland feeding grounds. This work has provided new information on the migration rates, timing and synchronization of movements of post-smolts and salmon kelts, and relative survivals during the first several months at sea.
- These activities will be enhanced in the coming years with the deployment of infrastructure by the Oceans Tracking Network, a \$35 million (Can) investment by the Canadian Foundation for Innovation.

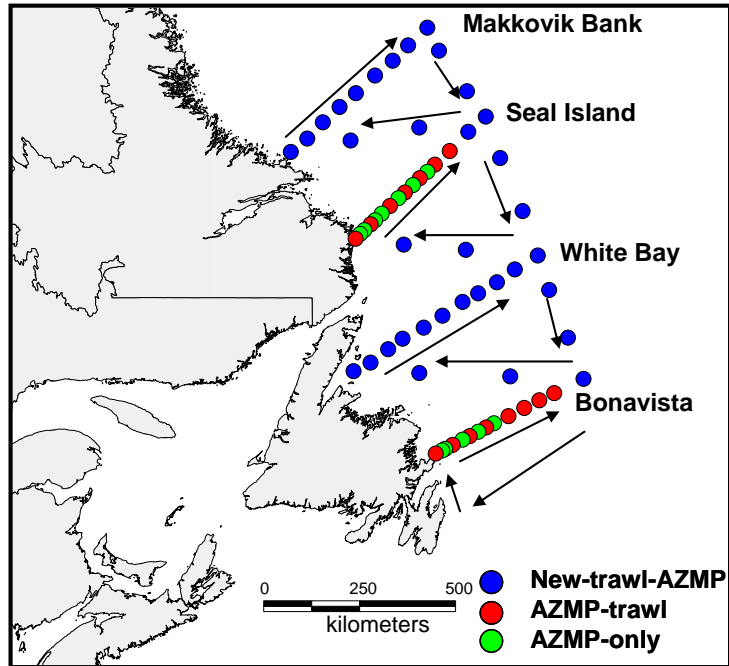


Existing and proposed nearshore and offshore acoustic receiver lines for quantifying marine mortality, migration routes and speed, and synchrony among stocks in the Northwest Atlantic.

- Marine capture surveys

- Marine capture surveys will sample the upper column pelagic ecosystem during the period corresponding to the early postsmolt phase (August) of Atlantic salmon.
- The survey design would address hypotheses of post-smolt distribution (mixing of stocks, mixing of maturing and non-maturing components) and oceanographic features.
 - For example, based on reported temperature preferences of salmon at sea, few post-smolts are expected in waters above 10°C. Sea surface temperature plots indicated that in recent years, 2006 for example, temperatures below 10°C in August occurred only off Labrador with much warmer temperatures on the northeast coast, Grand Banks and southern areas presumably making these areas unsuitable for salmon. Implications of this associated with climate change scenarios are obvious.

- Catches of post-smolts will provide information on distribution and relative abundance of salmon in an intermediate location and time than that provided by the life history monitoring program and international sampling at West Greenland.
- Data on relative abundance of other species, including macroplankton aggregations, will provide information on the distribution of salmon within this larger pelagic ecosystem.
- August is the priority sampling month.
- Survey transects designed to characterize the nearshore versus offshore distribution of postsmolts. Some of the transects would duplicate those monitored as part of the Atlantic Zone Monitoring Program (AZMP).



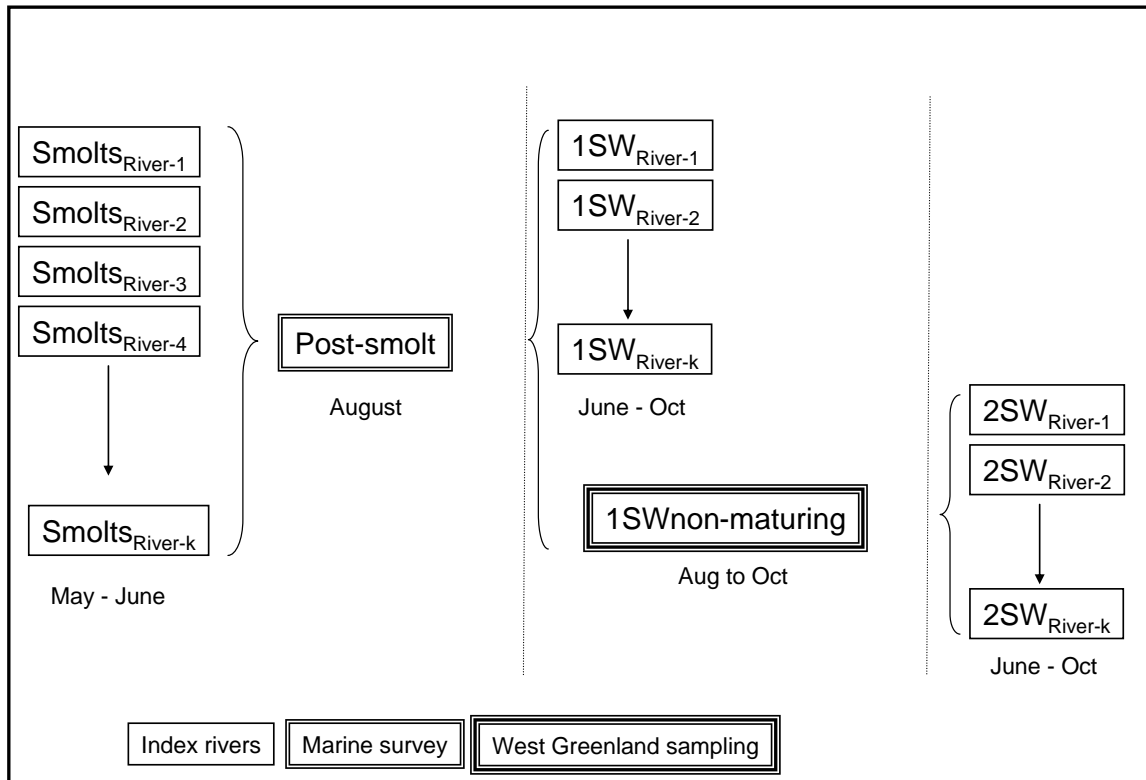
Proposed transects to be sampled during the August 1 to 24, 2008 survey in the northwest Atlantic using pelagic surface trawls deployed on the Canadian research vessel *CCGS Wilfred Templeman*.



The marine survey is scheduled to take place July 31 to August 23, 2008 using the DFO Canadian research vessel *CCGS Wilfred Templeman*

- The marine survey will be delivered as an international program involving the three Atlantic provinces DFO regions, the province of Quebec, and personnel from USA NOAA.

The inter-relations of the life history monitoring program and the marine surveys are seen in the following diagram.



Questions to be addressed using data from the marine research survey(s), life history monitoring and acoustic telemetry studies include:

1. Where are the early marine phase nursery areas of Atlantic salmon?
2. Are stocks from the greater than 600 rivers in eastern Canada mixed at sea?
3. What is the rate and location of losses of salmon post-smolts?
4. What are the other components of the pelagic community occupied by Atlantic salmon?
5. What prey are they consuming relative to what is available?
6. Are they being consumed by other fish predators within the pelagic zone?
7. What has been their marine growth profile and how does it differ from the profile of subsequent survivors the following year?
8. What is their disease profile compared to profiles of outgoing smolts?
9. What is the parasite community and does it differ in smolts going to sea from adults returning?
10. Are maturing (grilse) and non-maturing (multi-sea-winter) salmon mixed at sea or have they segregated and use different parts of the ocean?
11. Are there aquaculture escapees in the same areas as the wild fish?

APPENDIX A. CANADA'S CONTRIBUTIONS TO SALSEA.

COMPLETED PROJECTS

Parties	Project title – Summary	Year removed from inventory
DFO	Marine migration and survival of post-smolt Atlantic salmon from Bay of Fundy Rivers Provide knowledge about	2003
DFO	Distribution, health and condition of Atlantic salmon from Bay of Fundy rivers while at sea	2004
Laval University Province of Quebec	Marine migration and survival of post-smolt Atlantic salmon from the Saint-Jean River (Gaspé)	2005
Province of Quebec	Marine migration and survival of kelt Atlantic salmon from the Saint-Jean River (Gaspé)	2006
Atlantic Salmon Fed	Tracking experimentally “escaped” farmed salmon	2006
DFO	Atlantic salmon distribution and abundance at sea	2006
DFO	Integrated field and laboratory assessment of the effects of endocrine – disrupting substances on smolts	2008
DFO	Use of stable isotopes to assess long-term changes in marine trophic ecology of Atlantic salmon	2008
Dalhousie University	Effective population size, gene flow and population structure of Atlantic salmon in Newfoundland & Labrador	2008

ONGOING PROJECTS

Parties	Summary of objectives	Title	Date Research
DFO / NOAA	Sample upper pelagic ecosystem during early post-smolt phase (August). Obtain data	C1	2008 – 23 days
Atlantic Salmon Fed	Document spring movements and survival of kelts from Miramichi River as they return to sea	C2	2008-2010
DFO	Long-term monitoring of smolt production and adult return from rivers in Nfld, Maritimes, Gulf & Qc	C3	Apr.-Nov. annual
Atlantic Salmon Fed	Provide time-series of estimate of mortality rates for smolts at various points of at-sea migration	C4	2003-2008
UK- Laval U	Develop & apply approach capable of relating the behavior of smolts during their migration	C5	2005-2008
DFO	Track & document migratory behavior of kelts as leave river for open ocean & bright salmon when return	C6	2006-2008
DFO	Tag and track migratory behavior of smolts & kelts leaving Conne River	C7	2006-2008
Laval University	Provide knowledge about river of origin at West Greenland - estimate impacts of fishing on population	C8	2006-2008
Laval University	Elucidate genetic population structure of salmon from small river to large coast spatial scale	C9	2004-2008
Greenland/USA/DFO	Improve understanding ecology of salmon at WG through studies of status of trophic state & condition	C10	2007-2008

IN 2007-2008, CANADA ALSO CONTRIBUTED \$100,000 CAD TO THE INTERNATIONAL ATLANTIC SALMON RESEARCH BOARD.

APPENDIX B. USA CONTRIBUTIONS TO SALSEA.

Parties	Project Title (status)
NOAA Fisheries Service	Forecasts of Atlantic salmon transoceanic migration: climate change scenarios and anadromy in the North Atlantic (removed from inventory, 2005)
NOAA Fisheries Service	Stable isotope composition of Atlantic salmon scales (removed from inventory, 2005)
NOAA Fisheries Service	Penobscot hatchery versus wild smolt telemetry
NOAA Fisheries Service	Ultrasonic telemetry of smolts and post-smolts in the Narraguagus River and Narraguagus Bay
NOAA Fisheries Service/ State of Maine Department of Marine Resources	Comprehensive evaluation of marine survival of hatchery-stocked smolts: Migration behaviour and success of Dennys River smolts
NOAA Fisheries Service	Comprehensive evaluation of marine survival of hatchery-stocked smolts: Dennys River smolt stocking assessment
NOAA Fisheries Service	Evaluation of estuary and nearshore marine distributions of Atlantic Salmon post-smolts in Penobscot Bay and the Gulf of Maine
NOAA Fisheries Service	Cormorant harassment in the Narraguagus River/Narraguagus Bay
NOAA Fisheries Service/Greenland Institute of Natural Resources/Fisheries and Oceans Canada/The Marine Institute/Fisheries Research Services/Center for Environment, Fisheries and Aquaculture Science	West Greenland Salmon Fishery Sampling Programme