SAG(08)3

Draft Report of the Meeting of the Scientific Advisory Group of the International Atlantic Salmon Research Board

Tryp Rey Pelayo Hotel Melia, Gijón, Spain
Sunday, 1 June, 2008

1. Opening of the Meeting

1.1 The Chairman, Dr Lars Petter Hansen (Norway), opened the meeting and welcomed participants to Gijon. He extended a particular welcome to the NGO representatives who have made valuable contributions to the SALSEA Programme. He thanked the Spanish hosts for the arrangements made for the meeting and referred to the significant progress made in implementing the SALSEA Programme since the Group's last meeting.

1.2 A list of participants is contained in Annex 1.

2. Adoption of the Agenda

2.1 The SAG adopted its agenda, SAG(08)2 (Annex 2).

3. Election of Officers

3.1 The SAG unanimously re-elected Dr Lars Petter Hansen as its Chairman for a further period of two years.

4. Review of the updated inventory of research

4.1 The Assistant Secretary provided an overview of the updated inventory of research relating to salmon mortality in the sea, ICR(08)2, which is considered by the Board to be an essential tool in identifying research gaps and priorities, in improving coordination of existing research and in support of promotion of SALSEA. For 2008, 55 ongoing projects had been included in the inventory and the annual expenditure on these projects was approximately £6.7million, an increase of 32% from 2007. Costings had been provided for all the ongoing projects. During the year, there had been considerable progress in obtaining funding for the marine surveys envisaged under Workpackage 3 of the SALSEA Programme. In particular, the SALSEA-Merge project, a £4.4 million three year study involving three marine surveys by Irish, Norwegian and Faroese research vessels in both 2008 and 2009 had been launched on 16 May 2008. In addition, the Canadian government had committed approximately £0.4 million to a twenty-three day research survey in the Northwest Atlantic in late August 2008. These two new projects were the main reason for the increased expenditure in 2008. There has also been progress in implementing additional

sampling of the West Greenland fishery. The inventory had been made available to the ICES Working Group on North Atlantic Salmon (WGNAS) to assist it in identifying data deficiencies, monitoring needs and research requirements.

4.2 The SAG welcomed the valuable information presented in the inventory but agreed that consideration should be given to how this information could be better utilised. The SAG therefore recommends to the Board that it should establish a Sub-Group of the SAG comprising at least one representative from each Party. The Terms of Reference for this Sub-Group should be to review the inventory to identify areas where there may be merit in encouraging improved coordination of research and to highlight gaps in the research programme where new work might significantly benefit the SALSEA Programme and which might be considered for funding by the Board. The SAG recommends that the Sub-Group should work by correspondence under the Chairmanship of Ted Potter (European Union) and report back to the SAG.

4.3 The SAG recommends that the Parties be given an opportunity to provide any additional information to the Secretariat for inclusion in the inventory by 30 June and that after that date the inventory should be made available on the Board's website.

5. The SALSEA Programme

(a) Progress with implementing SALSEA

(i) Analysis of historical tagging data

5.1 At 2007 meeting the SAG had reviewed the report of an ICES Workshop on the Development and Use of Historical Salmon Tagging Information from Oceanic Areas which had been held in St Johns, Newfoundland during 19-22 February 2007. The Board had supported this workshop by funding the participation of a GIS expert and this had been extremely useful in facilitating the group's work.

5.2 The SAG had recognized that analysis of historical tag recovery information could improve understanding of salmon distribution and migration at sea and, therefore, benefit the SALSEA programme. On the recommendation of the SAG, the Board had agreed to:

- encourage the Parties to compile historical tagging information using the format developed by the ICES Workshop;
- ask that NASCO request ICES to compile, on an annual basis, tag recovery information and report on the status of analysis of historical tag recovery data;
- fund the participation of a GIS expert and oceanographer at any follow-up workshop convened by ICES and that a sum of up to £5,000 be made available to support such participation;
- make the spreadsheet format for compiling historical tag recovery information available on the Board's website.

5.3 The Chairman reported that ICES has convened a follow-up Workshop on Salmon Historical Information – New Investigations from Old Tagging Data to be held in Halifax, Canada from 18 – 20 September 2008 immediately prior to the ICES Annual Science Conference. The objectives of this follow-up Workshop will include

- providing further information from historical oceanic tagging and recovery programmes in the format agreed at the first workshop
- updating the database of tagging and tag recovery information established at the first workshop;
- developing and testing hypotheses of salmon migration and behaviour using information compiled at the first workshop and any new information that becomes available;
- using the information to describe the distribution of salmon of different river origins and sea age in time and space and assessing changes in the distribution over time in relation to hydrographical factors.

5.4 The SAG recommends that the Board encourages countries to make available to the Workshop any relevant tagging data using the agreed template. It was suggested that in the case of tag recoveries at West Greenland, the countries in which the tags were applied should provide the data and that there was a need for some coordination among those countries prior to the Workshop.

(ii) Progress on stable isotope analysis of West Greenland samples

5.5 One-sea-winter salmon from both North America and the North-East Atlantic migrate to feeding grounds at West Greenland during their second year at sea. Understanding of the marine ecology of these fish can be advanced through studies of trophic state and condition through analysis of lipid and stable isotope ratios. In 2007, the Board agreed to support a preliminary study at West Greenland with an emphasis on comparisons between the continent of origin. The questions that were to be addressed in the project included:

- 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 1SW maturing 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 when these fish finally return to home rivers as 2SW salmon?

5.6 The same questions would be examined for lipid content to assess fish condition and how this influences survival. A report on this study was presented by Dr Gerald Chaput (Canada). This report is contained in Annex 3. The initial results from this first year of work indicate that there are slight but consistent differences in condition (weight at given length) and relative lipid content (C:N ratio) between 1SW non-maturing salmon from NEAC and NAC at the actively feeding and growing life stage at West Greenland. NEAC fish had higher relative lipid content in both the liver and the muscle than the NAC fish. Both groups were more lipid rich than the maturing 1SW fish from the Miramichi. Differences noted in the isotope ratio of N between fish at West Greenland and the maturing 1SW salmon in the Miramichi may reflect differences in trophic feeding state or differences in feeding status of fish. Follow-up studies would be valuable.

5.7 Mr Tim Sheehan (USA) referred to the international sampling programme for the West Greenland fishery. This programme provides a very valuable method of obtaining samples of both European and North American origin salmon without the need for research vessel time. Under the SALSEA Programme it had been suggested that this sampling programme be extended and he reported that consideration was being given to purchasing a small number of whole salmon from the fishermen to enable stomach content, disease and stable isotope analyses to be conducted. It is anticipated that the number of whole fish that would be obtained would be in the range of 300 – 900 compared to a total subsistence harvest of around 8,000 salmon in 2007. However, concerns had been raised by NASF that this proposed extended sampling could lead to increased harvests at West Greenland. The SAG recommends that this matter be considered further by the Board and the West Greenland Commission but fully supports the proposed extended sampling as a source of valuable scientific information for the SALSEA Programme.

(iii) Report on the SALSEA-Merge Project

5.8 Dr Jens Christian Holst, the Scientific Coordinator of the SALSEA-Merge project, presented a progress report on this £4.4 million three year project. The project had commenced on 1 April 2008 and involves three marine surveys by Irish, Faroese and Norwegian vessels in both 2008 and 2009. The origin of post-smolts sampled will be identified using genetic stock identification methods. In February 2008, the Board had organised a symposium and workshop in Paris, with funding from the TOTAL Foundation, to consider the way forward for defining a practical framework and strategy for the development of an appropriate suite of genetic markers and the integration of existing data sets and new regional markers into European, North American and trans-Atlantic databases. A further meeting is scheduled for July to resolve inter-laboratory calibration and the suite of markers to be used. In May, two marine surveys had been conducted by Irish research vessels and more than 430 post-smolts had been captured. Fin-clipped and microtagged salmon had been observed. The project had started very successfully and there will be further surveys in July and August. There had been interest in the results of the surveys from scientists working on pelagic species.

(iv) Report on plans for marine surveys in the north-west Atlantic

5.9 A summary of SALSEA- North America was presented by Dr Gerald Chaput. The research strategy comprises three inter-related activities building on the existing index river programme in eastern North America. These address life-history monitoring, electronic technologies and marine capture surveys. A marine survey will be conducted during 1 - 24 August using both pelagic trawling and surface gillnets deployed from the Canadian research vessel Wilfred Templeman and oceanographic data will be collected. The coordinators for this project are Gerald Chaput and Tim Sheehan. Nearshore – offshore transects will be fished to coincide with existing ongoing oceanographic surveys

(v) Reports on sonic telemetry studies

5.10 The SAG had previously recognized that acoustic telemetry work can contribute valuable information on the migration and distribution of salmon at sea and that

acoustic arrays are being located increasingly further offshore. A report on these ongoing studies is contained in the 2008 Report of the WGNAS. It was noted that there are plans through the Ocean Tracking Network to install acoustic arrays off Halifax, Nova Scotia (2008) and in the Cabot Strait, Newfoundland (2009). There is already an array across the Strait of Belle Isle. The Group was advised that an application for funding of the Coast Track project has been submitted to the European Commission.

(vi) Coordination of European and North American elements of SALSEA

5.11 The SAG noted the complementary nature of SALSEA-Merge and SALSEA-North America and highlighted the importance of establishing a mechanism for information exchange on a regular basis. In particular, the SAG recommends that the research coordinators (Jens Christian Holst, Gerald Chaput and Tim Sheehan) should exchange experience and results, as soon as possible, after each marine survey and to report back to the SAG. Consideration might also be given to the possibility of an exchange of personnel between the SALSEA-Merge and SALSEA-North America projects. The importance of disseminating the results of these projects to a wide audience was also stressed in order to convey the progress being made to support future fund-raising initiatives.

(vii) 2010 Symposium

5.12 The Board had previously agreed to co-convene with ICES and the North Pacific Anadromous Fish Commission (NPAFC) an international symposium on mortality of salmon at sea in the North Atlantic and North Pacific Oceans. This 'salmon summit' had initially been scheduled for 2010 and NPAFC had indicated a preference for a meeting in the spring. However, as the SALSEA-Merge project will not be completed until April 2011 the SAG recommends to the Board that the symposium be scheduled for the spring of 2011. In the interim, however, the Board had agreed that there would be benefits from a continuing exchange between scientists working on these issues in the North Pacific and North Atlantic Oceans. To this end, representatives of NPAFC had been invited to participate in a Special Session on salmon at sea held during NASCO's Twenty-Fourth Annual Meeting in June 2007 and NASCO scientists would be invited to participate in the NPAFC BASIS Symposium to be held in Seattle in November 2008. The deadline for submitting abstracts is 30 June 2008. The Secretary had proposed to NPAFC that NASCO would be willing to provide an overview of the SALSEA Programme just as the NPAFC Secretariat had reported on its science programme at NASCO's 2007 meeting. The SAG recommends to the Board that it should appoint representatives to the symposium Steering Committee and suggests these should be the Secretary of NASCO (Dr Malcolm Windsor, Co-Convenor), the Assistant Secretary (Dr Peter Hutchinson), the Chairman of the SAG (Dr Lars Petter Hansen), the SALSEA-Merge Scientific Coordinator (Dr Jens Christian Holst) and a representative of the SALSEA-North America project (to be confirmed). The SAG noted that Mr David Reddin (Canada) was willing to serve in this capacity and welcomed this offer.

(viii) Other activities

5.13 There were no other reports on activities under the SALSEA Programme.

(b) Progress with promoting SALSEA

5.14 The Chairman of the Board presented a brief overview of activities in promoting the SALSEA-Programme, funding for which is being sought through public-private initiatives. Further consideration will be given to this aspect by the Board. It was, however, noted that there was now considerable momentum in implementing the SALSEA Programme and that these achievements should assist in future efforts to raise additional funding. In particular, it was suggested that the analogy of the Atlantic salmon as an 'aquatic canary' was a powerful support to fund-raising efforts. It was noted that further developments of the Board's website are planned including descriptions of the various SALSEA-Merge workpackages in layman's terms and brief reports of the marine surveys in the form of a 'Captain's log'. A separate technical SALSEA-Merge website is under consideration.

(c) ***Recommendations to the Board on funding research***

5.15 Dr Gerald Chaput presented two research proposals for funding from the Board. Details of these proposals are contained in Annex 4. These proposals were:

- a continuation of the study supported by the Board in 2007/2008 to examine any changes in trophic levels of Atlantic salmon through the marine phase of their life cycle. Funding is sought for analysis of samples of Can$39,000 in 2008, Can$55,900 in 2009 and Can$26,400 in 2010;
- a new study into the temperature history of Atlantic salmon at sea based on oxygen isotope ratios in otoliths. Funding is sought of Can$17,900 in 2008, Can$28,800 in 2009 and Can$15,240 in 2010.

5.16 Mr Ted Potter reported that the ICES Advisory Committee has recommended that efforts be continued to identify and collate further information on biological characteristics of salmon from river populations and fisheries throughout the North Atlantic. An ICES Study Group has been proposed and it was noted that there are scientists working in relevant research areas who may not easily be able to attend the proposed meeting. A proposal to support such participation is contained in Annex 5. The cost to the Board of supporting this Study Group would not exceed £5,000.

5.17 The SAG discussed mechanisms for supporting projects that might be considered for funding should resources be available. In addition to projects that might be funded directly by the Board, the Board could also play an important role in supporting the proposers of research projects in seeking funds from other sources. The SAG was made aware of possible interest in funding for projects related to the ongoing marine surveys which had not been presented at its meeting. The SAG recommends that the Board adopt a procedure under which the Secretary would write to the Members of the Board by 31 July each year requesting that proposals for research funding be submitted to the Secretariat. Any proposals received by 1 September would be evaluated by the nominated SAG representatives and prioritized for funding. It was suggested that a maximum funding level for a single project of £50,000 might be considered by the Board. The SAG recommends that the Board's priority theme for funding should remain studies of the distribution and migration of salmon at sea and that the SAG nominees should take the Board's previous decisions concerning

priority research topics into account when reviewing research proposals. The SAG also believes that the findings of the Sub-Group referred to in paragraph 4.2 above will be of assistance in prioritizing future research projects. In the interim, the SAG recommends that the Board consider funding the three projects described above if resources permit.

6. Other business

6.1 There was no other business.

7. Report of the Meeting

[7.1 The SAG agreed a report of its meeting.]

8. Date and place of next meeting

8.1 The SAG decided to agree the date and place of its next meeting by correspondence.

Annex 1

List of Participants

Canada

Bud Bird
Gerald Chaput
Dave Reddin

Denmark (in respect of the Faroe Islands and Greenland)

Jan Arge Jacobsen

European Union

Aleksandra Kordecka
Ted Potter
David Dunkley
Niall O'Maoileidigh
Ken Whelan

Norway

Lars Hansen (Chairman)

Russian Federation

Elena Samoylova
Tim Sheehan

NGO Representatives

Dick Shelton
Tony Andrews

SALSEA-Merge Scientific Coordinator

Jens Christian Holst

NASCO Secretariat

Peter Hutchinson

Annex 2

Agenda

1. Opening of the meeting
2. Adoption of the agenda
3. Election of Officers
4. Review of the updated inventory of research
5. The SALSEA Programme
   - (a) *Progress with implementing SALSEA*
     - (i) Analysis of historical tagging data
     - (ii) Progress on stable isotope analysis of West Greenland samples
     - (iii) Report on the SALSEA-Merge project
     - (iv) Report on plans for marine surveys in the north-west Atlantic
     - (v) Reports on sonic telemetry studies
     - (vi) Coordination of European and North American elements of SALSEA
     - (vii) 2010 Symposium
     - (viii) Other activities
   - (b) *Progress with promoting SALSEA*
   - (c) *Recommendations to the Board*
6. Other business
7. Report of the meeting
8. Date and place of next meeting

Annex 3

A FIRST LOOK AT DIFFERENCES IN TROPHIC LEVELS OF 1SW NON-MATURING ATLANTIC SALMON OF NAC AND NEAC ORIGIN

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CANADA

And

Tim Sheehan
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Woods Hole, MA
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USA

INTRODUCTION

Historical information on marine survival has revealed differences among maturing age groups, differences over time and within and between the continent of origin. Generally, survival rates are higher for northern populations relative to southern ones, are better for European fish relative to those from North America, and are higher in grilse stocks than in multi-sea-winter stocks. The role of prey available to salmon at sea in conditioning survival is not well understood but there is evidence for some stocks that marine survival is conditioned by growth at sea.

Atlantic salmon (*Salmo salar*) are opportunistic feeders during their freshwater and marine life-history phases. During the marine phase, salmon consume prey relative to their body size and as they grow, they consume prey in the upper end of the size spectrum with a preference for fish over crustaceans should both be available. The point in the life cycle when this change happens and the relative importance of these components is poorly understood. As well, maturing 1SW salmon do not undertake extensive feeding migrations to West Greenland in contrast to some of the non-maturing 1SW salmon and the prey community available to these maturing components should be different from the high seas migrants.

Although conventional stomach content studies provide insight into the prey which are consumed by salmon at sea, they only provide a snapshot of the prey consumed in the recent hours and provide no information on the importance of different prey to the growth of the animal. Variability in the trophic ecology of Atlantic can be examined from analyses of stable isotope signatures of carbon and nitrogen ($\delta^{13}C$ and $\delta^{15}N$). Nitrogen stable isotope analysis

provides a quantitative means to determine trophic level since nitrogen signatures from organism tissue are consistently 3 to 5‰ more enriched than dietary sources. Analysis of different tissues also provide information on recent, short term and long term feeding of animals as the assimilation rates differ among tissues.

One-sea-winter salmon from both North America and the northeast Atlantic migrate to feeding grounds at West Greenland during their second year at sea. Analysis of stable isotope in tissues of these fish and comparatively of 1SW and 2SW maturing fish back in homewaters could advance our knowledge of the trophic state of salmon at sea. In particular, the following questions would be addressed:

1) are trophic states of 1SW non-maturing fish similar between NAC and NEAC origin salmon?
2) Are trophic states of 1SW non-maturing fish different from that of 1SW maturing of the same chohort? Can this tell us anything about when these different maturity groups separate in the North Atlantic?
3) Has there been a trophic state change between West Greenland and when these fish finally return to home rivers as 2SW salmon?

In 2007, this preliminary study was focused on comparing the stable isotope ratios in tissues of 1SW non-maturing salmon at West Greenland with an emphasis on the comparison between the continent of origin. A limited sampling program of 1SW maturing fish in the Miramichi River (Canada) provided insight into the stable isotope ratios in the maturing component of the same smolt cohort as the fish sampled at West Greenland in 2007.

MATERIALS AND METHODS

A total of 150 fish were purchased as fresh fish in their whole state and sampled by the sampling team stationed in Nuuk (West Greenland). Tissue samples from liver, dorsal muscle and caudal tissue were placed in individual cryo-tubes and frozen. The samples were obtained over the period of Aug. 9 to Sept. 5 2007. Additional information obtained from these fish included fork length, whole weight, sex, scale samples for determining age, and tissue samples for genetic stock identification of the continent of origin.

Between Aug. 15 and Aug. 20 2007, thirteen maiden one-sea-winter salmon were sampled from the catches at the index trapnet in the estuary of the Southwest Miramichi River. Similar biological data to the West Greenland samples were obtained from these fish. The fish were fresh sampled for disease diagnostics using bits of tissue from gill filaments, pyloric caecum, spleen, and kidney. Pieces of liver, caudal fin, dorsal muscle (immediately below the dorsal fin), ventral muscle (directly in line with dorsal fin) and muscle from the caudal peduncle were extracted and frozen for stable isotope analysis.

Stable isotope analysis

Stable isotope analysis was conducted by the Stable Isotope in Nature laboratory (SINLAB) at the Canadian Rivers Institute, University of New Brunswick (Fredericton, New Brunswick, Canada). Samples were analyzed for $\delta^{13}C$ and $\delta^{15}N$ using an isotope-ratio mass spectrometer interfaced with an elemental analyzer. The system was a continuous flow system using helium as a carrier gas. Carbon and nitrogen data were corrected with three international standards (CH6 (sucrose standard issued by the International Atomic Energy Agency with

$\delta^{13}C$ = -10.4‰), N2 (ammonium sulfate standard issued by the International Atomic Energy Agency with $\delta^{15}N$ = 20.3‰), acetanilide (commercially available pure compound with $\delta^{13}C$ = -33.2‰ and $\delta^{15}N$ = -1.1‰)) and three standards developed at SINLAB (nicotinamide (commercially available pure compound with $\delta^{13}C$ = -34.2‰ and $\delta^{15}N$ = -1.8‰), BLS (bovine liver standard developed by SINLAB with $\delta^{13}C$ = -18.7‰ and $\delta^{15}N$ = 7.3‰), SMB-M (smallmouth bass muscle developed by SINLAB with $\delta^{13}C$ = -23.3‰ and $\delta^{15}N$ = 12.4‰)). All of these standards are calibrated against Peedee Belemnite carbonate (PDB) and atmospheric nitrogen (AIR) for carbon and nitrogen, respectively. The analysis of the standards indicates that the results are within an acceptable range of error (Table 1).

As part of the routine quality assurance / quality control (QA/QC), replicates were run on four of every 73 samples. Replicated delta values within 0.5‰ are considered adequate. There was more uncertainty in the C and N values among replicates for caudal fin tissue than for either muscle or liver samples but differences averaged less than 0.5‰ for all tissues except for C in caudal fin (Fig. 1).

To account for different lipid content of tissues and its effect on the carbon isotope ratios, $\delta^{13}C$ values were normalized for lipid content following the procedure of McConnaughey and McRoy (1979) and as used by Dempson and Power (2004). The normalization allows for valid comparison among tissues and fish by removing the differential effects of lipid synthesis and storage, as lipids tend to be depleted for C isotopes relative to carbohydrates and proteins (McConnaughey and McRoy 1979). The normalized value for the carbon isotope ratio ($\delta^{13}C'$) is calculated from the equations of McConnaughey and McRoy (1979):

$$\delta^{13}C' = \delta^{13}C + D * [-0.207 + 3.90 / (1 + 287 / L)]$$

$$L = 93 / [1 + (0.246 * C{:}N - 0.775)^{-1}] \text{ and,}$$

where $\delta^{13}C$ is the measured carbon isotope ratio in the sample.
D is the isotopic difference between protein and lipid, assigned a value of 6‰
L is the relative lipid content, and
C:N is the measured carbon (%) to nitrogen (%) ratio in the sample.

McConnaughey and McRoy (1979) assumed that a C:N ratio of 4.0 was taken as a "normal" value for relative lipid such that $\delta^{13}C'$ is less depleted (smaller negative value) for fatty (C:N > 4.0) tissue, and vice versa.

The samples were run without lipid extraction. To address the high lipid content in some tissues from the Miramichi, samples were rerun after lipid extraction.

RESULTS

Genetic stock identification results of the 150 salmon sampled at West Greenland identified 139 fish of North American (NAC) origin and only 11 fish of northeast Atlantic (NEAC) origin (Table 2). The majority (96%) of the fish were non-maturing one-sea-winter (1SW) salmon with few maiden two-sea-winter salmon and repeat spawners.

The 1SW salmon from NAC and NEAC were of similar size and similar condition (weight to length) (Table 2; Fig. 2). The 1SW salmon sampled from the Miramichi were on average 5 cm shorter than the 1SW salmon at West Greenland and had a significantly lower condition than those at West Greenland (general linear model, log transformed length and weight, differences in intercept model); for a fish of 630 mm fork length, the predicted weight for the

Miramichi 1SW salmon was 2,400 g (95% C.I. 2,260 to 2,540 g) compared to 2,850 g (2,800 to 2,890) for NAC origin 1SW salmon and 2,820 g (2,670 to 2,980 g) for NEAC origin 1SW salmon at West Greenland (Fig. 3).

There were sufficient samples of NAC origin salmon at West Greenland to examine changes in size and condition between 9 August and 5 September 2007. Mean fork length increased from about 620 mm in early to mid-August to 635 mm by the end of August / early September. There was a proportionally greater increase in weight than length over the same period; the predicted weight of a 630 mm 1SW salmon in the latter period was 13% greater than the weight of a fish of similar length in the early period (Fig. 3).

The higher condition of salmon sampled at West Greenland relative to that of 1SW salmon in the Miramichi is reflected in the higher relative lipid content of the liver and muscle tissues from the fish at West Greenland. The C to N ratios were on average highest in fish from NEAC, followed closely by those from NAC which were both much higher than the ratios in tissues of salmon from the Miramichi (Fig. 4). Liver tissue was the most lipid rich, followed by muscle and least of all fin tissue (Fig. 4). This was the case for both the NEAC and NAC fish at West Greenland. The least lipid rich tissues were from the 1SW maturing salmon sampled from the Miramichi with relative lipid values of 4 or less for muscle and fin tissue and between 4 and 5 for liver (Fig. 4).

Although there were differences among sampling periods in the C:N ratios of liver and fin tissue of NAC origin salmon at West Greenland, no directional temporal differences were noted.

Stable isotopes

Among five tissues examined from the Miramichi River, the ventral muscle had the highest relative lipid content (C:N ratio), followed by liver, dorsal muscle, caudal peduncle muscle, and finally caudal fin (Table 3). There was no difference in normalized $\delta^{13}C$ values among tissues but $\delta^{15}N$ values were the most enriched in the caudal fin tissue and least so in the ventral muscle (Table 3).

Unnormalized $\delta^{13}C$ values suggest differences between maturing 1SW salmon in Miramichi and 1SW non-maturing salmon at West Greenland but the differences disappear after normalization for relative lipid content (Table 4). Lipid normalized $\delta^{13}C$' values are essentially identical for NAC and NEAC origin 1SW salmon at West Greenland as well as for the Miramichi 1SW salmon (Table 4) reflecting a common carbon source (marine based) for these fish. These values are similar to those reported from 1SW salmon muscle tissue of fish sampled from Conne River (Dempson and Power 2004) and for salmon from the Exploits River (Doucett et al. 1999).

The measured $\delta^{15}N$ values all three tissues were lowest for the NEAC fish, followed by the NAC fish at West Greenland and the most enriched for the 1SW salmon in the Miramichi (Table 4). The caudal fin was relatively lipid poor (C:N < 4.0) in all samples but the most important difference was in the $\delta^{15}N$ values in the caudal fin tissue of the Miramichi which was enriched compared to fish at West Greenland.

Bivariate plots of the $\delta^{13}C$' and $\delta^{15}N$ stable isotope ratios show a complete mix of the 1SW salmon from NEAC within the cloud of values for NAC in all three tissues examined (Fig. 5).

Liver and muscle had similar isotope ratios for C but both were depleted (fewer ^{13}C isotopes) relative to caudal fin tissue (Fig. 5; Table 3). Nitrogen isotope ratios were similar in all three tissues , ranging between 9 and 13 δ ‰ (Fig. 5, 6; Table 4). Miramichi fish are in the upper end and enriched for N compared with fish at West Greenland (Fig. 6).

DISCUSSION

The initial results from this first year of work indicates that there are slight but consistent differences in condition (weight at given length) and relative lipid content (C:N ratio) between 1SW non-maturing salmon from NEAC and NAC at the actively feeding and growing life stage at West Greenland. NEAC fish had higher relative lipid content in both the liver and the muscle than the NAC fish and both groups were substantially more lipid rich than the maturing 1SW fish from the Miramichi.

Differences noted in the isotope ratio of N between fish at West Greenland and the maturing 1SW salmon in the Miramichi may reflect differences in trophic feeding state or differences in feeding status of fish. Fasting animals have been shown to have stable isotope ratios which are distinct from those fed ad libitum with starved animals having tissues which are enriched for ^{15}N (Doucett et al. 1999). However, Doucett et al. (1999) did not find ^{15}N was enriched in the white muscle of anadromous and fasting Atlantic salmon during the spawning migration and overwintering. To resolve this, sampling maturing 1SW salmon at the earliest time in the spring and periodically through the return to the river would assist in resolving this question.

Fin tissue is a mixture of bone, muscle and cartilage and does not contain as much lipid as muscle or liver (Kelly et al. 2006). It is also considered to have slower turnover rates relative to muscle and liver and would be representative of the longer term integration of prey. In this study, the greatest difference between the maturing 1SW salmon in Miramichi and the non-maturing 1SW salmon at West Greenland was in the enrichment of ^{15}N in the caudal fin tissue of the former. As such, the enrichment of the fin tissue for 1SW maturing salmon relative to the non-maturing component may represent actual differences in trophic level consumption. The results indicate an avenue of research which is worth pursuing and in particular, that should be matched with tissue sampling from 2SW maturing salmon from the same smolt cohort.

Stable isotope comparisons of salmon between continent of origin, between age at maturity should be examined further. Fin tissue (or scales) provide a non-lethal choice for sampling from returning adults at the 1SW and 2SW stages. Liver and muscle tissue samples would provide short term and medium term indicators of trophic status which would be useful for examining differences between 1SW non-maturing salmon at West Greenland based on the continent of origin.

Table 1. Results of standards tests at SINLAB.

Standards	Element	Expected (delta values ‰)	Derived values (δ ‰)		
			Mean	Std. Dev.	N
CH6	$\delta^{13}C$	-10.4	-10.50	0.16	10
N2	$\delta^{15}N$	20.3	20.47	0.24	10
acetanilide	$\delta^{13}C$	-33.2	-33.16	0.18	97
	$\delta^{15}N$	-1.1	-1.18	0.24	97
nicotinamide	$\delta^{13}C$	-34.2	-34.24	0.11	49
	$\delta^{15}N$	-1.8	-1.77	0.13	49
BLS	$\delta^{13}C$	-18.7	-18.73	0.10	48
	$\delta^{15}N$	7.3	7.22	0.14	48
SMB-M	$\delta^{13}C$	-23.3	-23.23	0.09	49
	$\delta^{15}N$	12.4	12.44	0.19	49

Table 2. Biological characteristics of salmon sampled at West Greenland and in the Miramichi River in 2007.

Sea age	Statistic	NAC	NEAC	Miramichi
All	N	139	11	
	Mean weight	2847	2747	
	(range)	(1720 to 7220)	(2160 to 3240)	
	Mean length	627	626	
	(range)	(556 to 836)	(584 to 664)	
	Percent female	91%	64%	
	Mean date	18 Aug	17 Aug	
	(range)	(9 Aug to 5 Sept)	(9 Aug to 5 Sept)	
1SW	N	134	10	13
	Mean weight	2783	2762	1730
	(range)	(1720 to 4080)	(2160 to 3240)	(968 to 2530)
	Mean length	623	625	567
	(range)	(556 to 690)	(584 to 664)	(499 to 628)
	Percent female	90%	70%	8%
	Mean date	18 Aug	18 Aug	17 Aug
	(range)	(9 Aug to 5 Sept)	(9 Aug to 5 Sept)	(15 Aug to 20 Aug)
2SW maiden	N	1		
	Weight range	7220		
	Length range	832		
	Percent female	100%		
	Date range	29 Aug		
Repeat spawner	N	4	1	
	Weight range	2840 to 6190	2600	
	Length range	620 to 836	631	
	Percent female	100%	0%	
	Date range	13 Aug to 29 Aug	10 Aug	

Table 3. C:N ratio, $\delta^{13}C$, normalized $\delta^{13}C$ ($\delta^{13}C'$), and $\delta^{15}N$ values of five tissues from 1SW salmon sampled from the Miramichi River, 2007.

	Liver	Muscle ventral	Muscle dorsal	Muscle caudal	Caudal fin
C:N					
N	13	13	13	13	13
Mean	4.53	6.20	3.83	3.59	3.08
Std. deviation	0.80	2.08	0.40	0.38	0.18
$\delta^{13}C$					
Mean	-20.47	-21.19	-19.84	-19.50	-18.03
Std. deviation	0.43	0.93	0.42	0.51	0.50
$\delta^{13}C'$					
Mean	-20.03	-19.87	-20.10	-20.09	-19.42
Std. deviation	0.27	0.37	0.21	0.22	0.28
$\delta^{15}N$					
Mean	12.10	11.71	12.13	12.41	13.14
Std. deviation	0.72	0.75	0.58	0.54	0.75

Table 4. C:N ratio, $\delta^{13}C$, normalized $\delta^{13}C$ ($\delta^{13}C$'), and $\delta^{15}N$ values in three tissues of 1SW salmon at West Greenland by continent of origin and from the Miramichi River, 2007.

		NEAC	NAC	Miramichi
C:N				
Caudal fin	N	10	134	13
	Mean	3.69	3.66	3.08
	Std. deviation	0.44	0.67	0.18
Muscle	N	10	133	13
	Mean	5.79	4.99	3.83
	Std. deviation	1.22	1.30	0.40
Liver	N	10	134	13
	Mean	6.36	5.68	4.53
	Std. deviation	0.87	0.98	0.80
$\delta^{13}C$				
Caudal fin	Mean	-18.95	-18.94	-18.03
	Std. deviation	0.69	0.99	0.50
Muscle	Mean	-22.17	-21.37	-19.84
	Std. deviation	0.82	0.79	0.42
Liver	Mean	-21.97	-21.62	-20.47
	Std. deviation	0.26	0.53	0.43
$\delta^{13}C$'				
Caudal fin	Mean	-19.41	-19.49	-19.42
	Std. deviation	0.26	0.46	0.28
Muscle	Mean	-20.90	-20.63	-20.10
	Std. deviation	0.22	0.25	0.21
Liver	Mean	-20.33	-20.37	-20.03
	Std. deviation	0.21	0.24	0.27
$\delta^{15}N$				
Caudal fin	Mean	10.98	11.32	13.14
	Std. deviation	0.73	0.63	0.75
Muscle	Mean	11.23	11.56	12.13
	Std. deviation	0.61	0.53	0.58
Liver	Mean	10.54	10.78	12.10
	Std. deviation	0.75	0.60	0.72

Figure 1. Differences (absolute) in delta values (‰) between replicate analyses for $\delta^{13}C$ (upper panel) and $\delta^{15}N$ (lower panel) for caudal fin, liver and dorsal muscle samples. Results within 0.5 ‰ are considered acceptable.

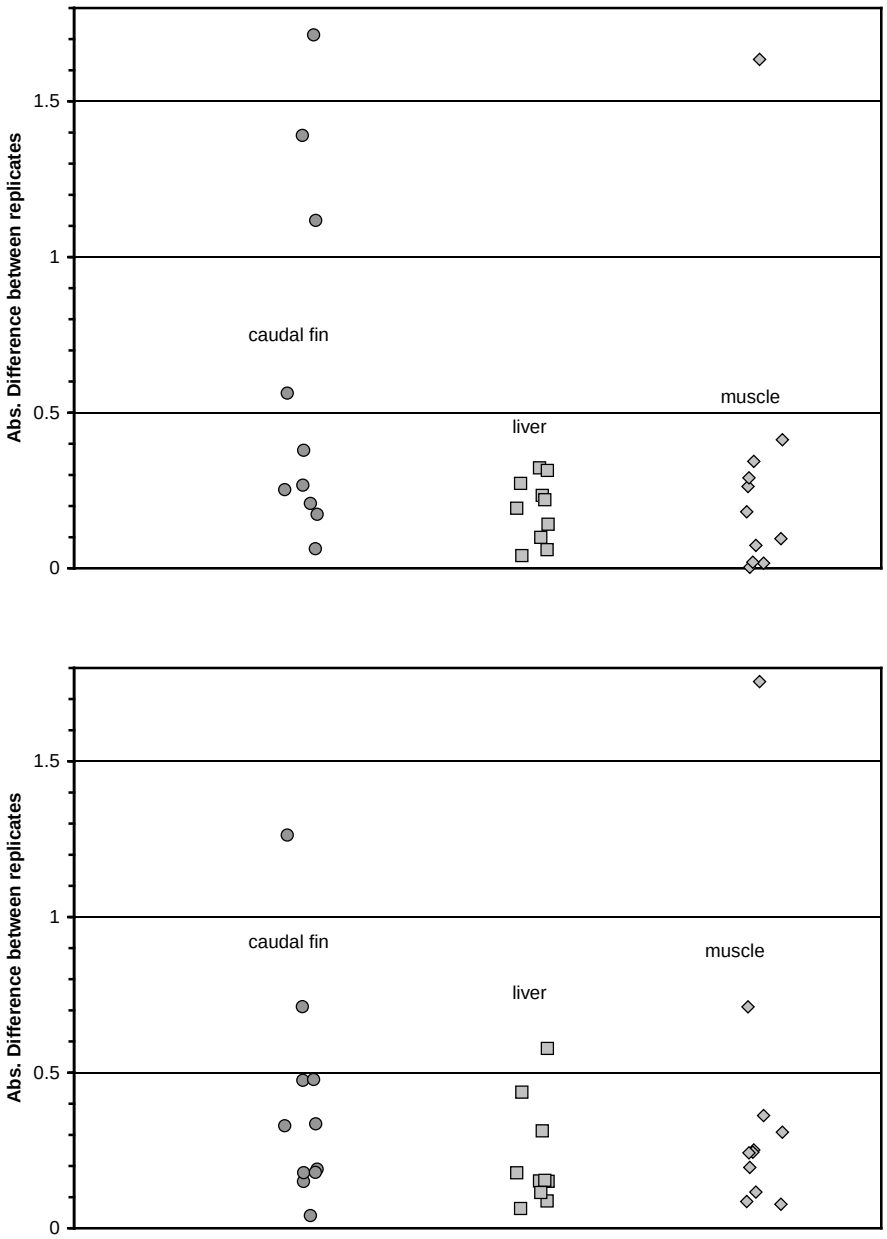


Figure 2. Fork length (mm) to whole weight (g) relationship for 1SW salmon from North America (NAC), Europe (NEAC), and Miramichi in 2007. Only salmon of one-sea-winter sea age are shown.

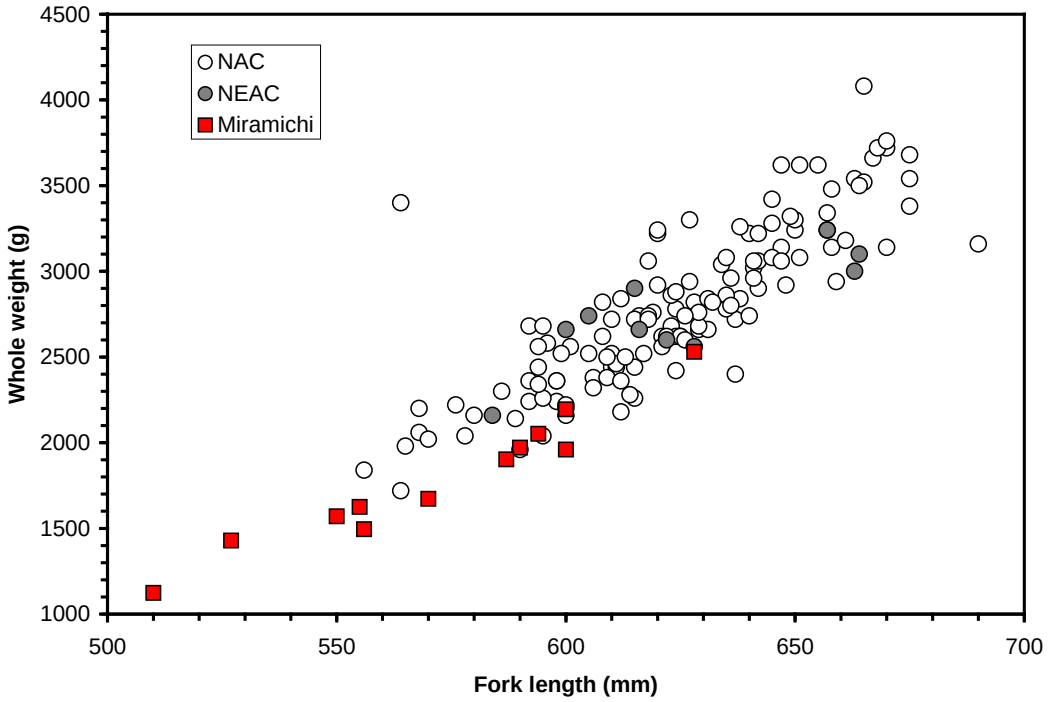


Figure 3. Predicted whole weight (g, with two standard error bars) of 1SW salmon measuring 630 mm fork length over all samples (square symbol) for NAC (white shading), NEAC (grey shading), and Miramichi (red shading) as well as predicted weight by sampling date for NAC 1SW salmon (circles, white shading).

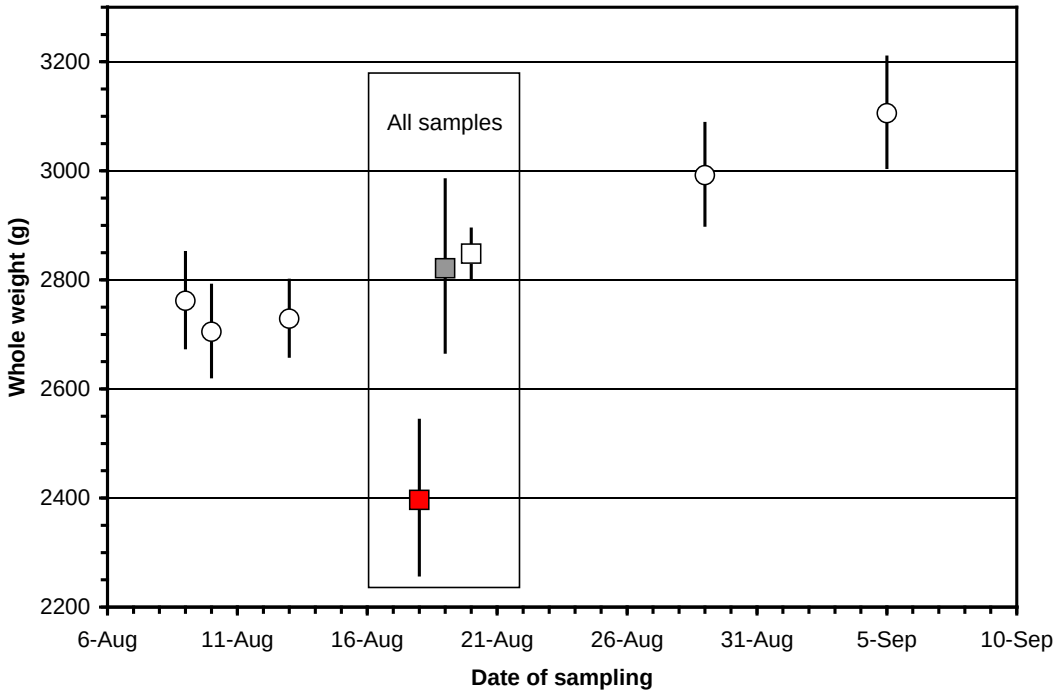


Figure 4. Carbon (%) to nitrogen (%) ratio (C:N) in tissues of 1SW salmon of NEAC and NAC origin captured at West Greenland and 1SW salmon sampled from the Miramichi River, 2007. The higher the ratio, the higher the relative lipid content.

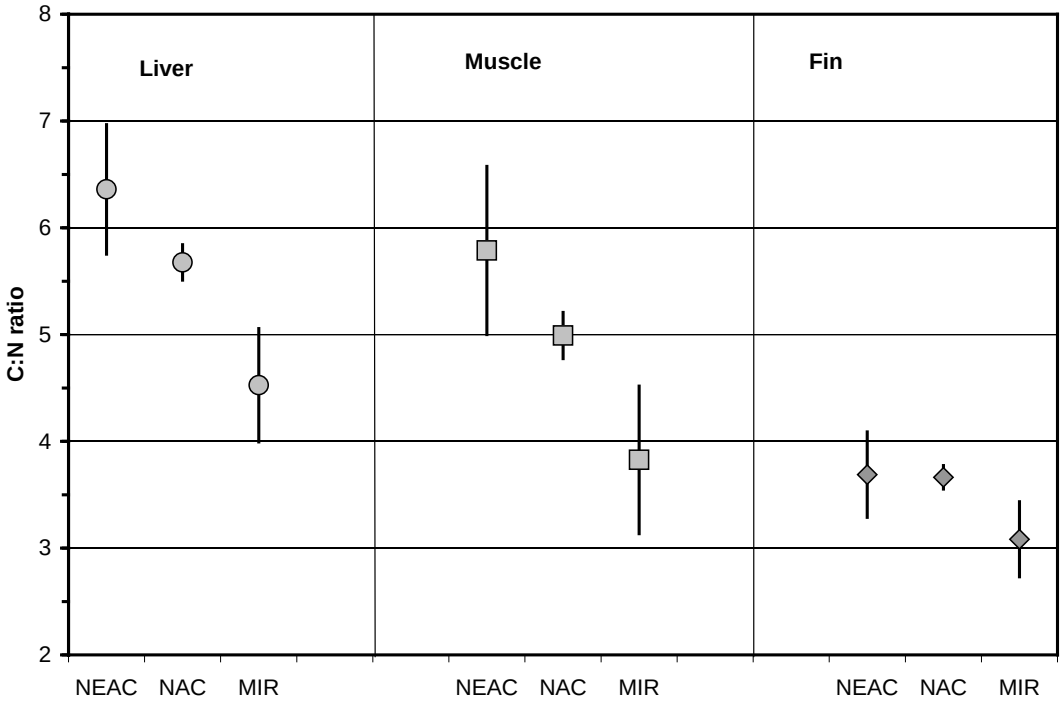


Figure 5. Association between $\delta^{13}C$' to $\delta^{15}N$ in liver (upper), dorsal muscle (middle), and caudal fin (lower) tissues from 1SW maiden salmon of North American and European origin at West Greenland and from the Miramichi River, 2007.

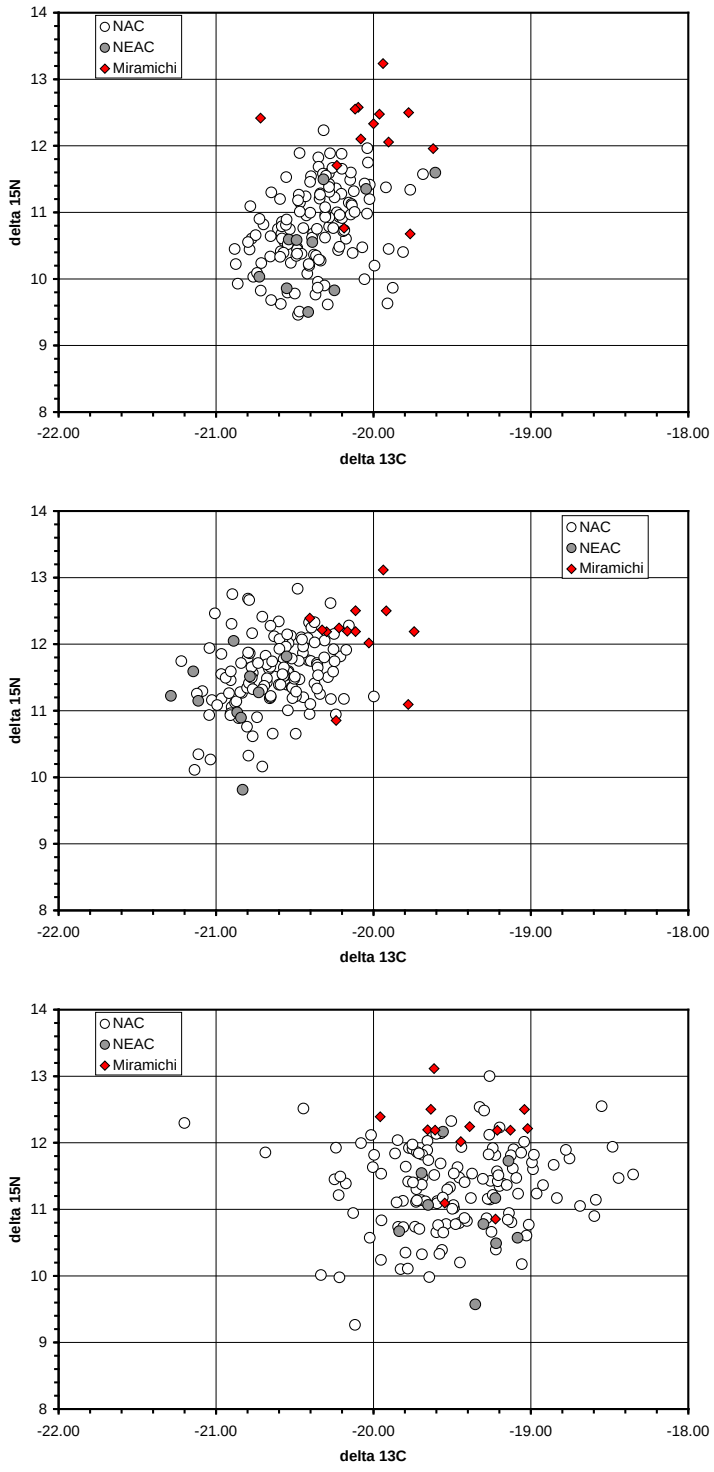
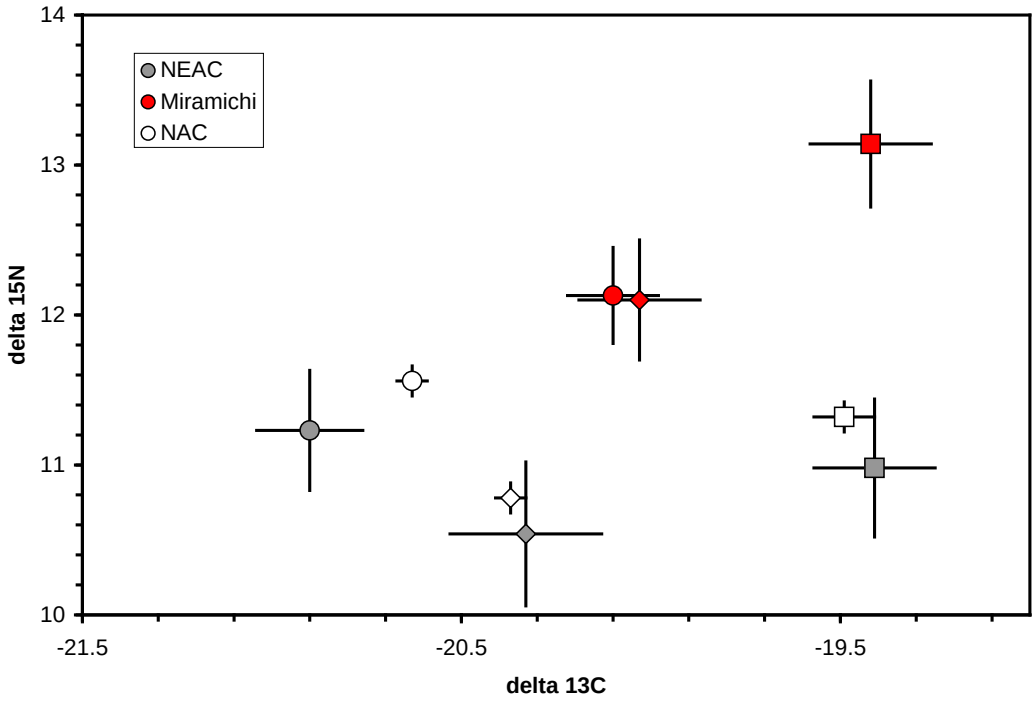


Figure 6. Mean (+/- 2 standard errors) of the stable isotope ratios of C and N in liver (diamond), dorsal muscle (circle), and caudal fin (square) tissue of 1SW non-maturing salmon at West Greenland (NEAC, NAC) and maturing 1SW salmon from the Miramichi River, 2007.



Annex 4

Proposal submitted to the International Atlantic Salmon Research Board relative to furthering the knowledge on marine ecology of Atlantic salmon.

June 2008

By

Gérald Chaput, Tim Sheehan, and Brian Dempson
SALSEA North America

CHANGES IN TROPHIC LEVELS OF ATLANTIC SALMON THROUGH THE MARINE PHASE OF THEIR LIFE CYCLE

The following proposal for funding for 2008 is to analyze tissue samples from Atlantic salmon collected at index rivers in eastern Canada, as post-smolts in the northwest Atlantic, and as non-maturing 1SW salmon at West Greenland.

Costs associated with sample collection are covered by existing and new initiatives independent of this proposal.

Context

While the issue of Atlantic salmon survival is complicated by their complex life cycle requirements, there are various hypotheses regarding survival and production that may pertain to variations in Atlantic salmon abundance. One hypothesis stresses the implications of trophic structure and anthropogenic disturbances of trophic structure that have led to shortened food chains at sea. Hence, the need for investigations of variability in the trophic ecology of salmon. Trophic level can be evaluated by an examination of stomach contents over time, or through stable isotope analysis (SIA). While stomach contents provide a snapshot of recent dietary resource use, stable isotope analyses yield time integrated measures of energy assimilation since analyses are performed on body tissues built from diet assimilated over time. Consequently, SIA has been increasingly used in ecological studies as a reliable means of inferring trophic status and the impacts of anthropogenic disturbance on trophic relationships.

Atlantic salmon are considered opportunistic feeders during their freshwater and marine life-history phases. While in freshwater, juvenile salmon feed on aquatic invertebrates particularly various stages of insect groups. Differences in feeding strategies may occur between systems where parr rear extensively in lacustrine (lake) habitats versus other locations where fluvial (stream) rearing is common. During the marine phase, salmon often target prey in the upper end of the size spectrum with a preference for fish over crustaceans should both be available, but the point in the life cycle when this change happens and the relative importance of these components is poorly understood. Thus, owing to the opportunistic nature of salmon feeding habitats, the species lends itself well to studies

associated with aquatic environmental conditions and food web interactions. This is particularly relevant given the variability in freshwater habitats and differences in smolt size throughout Atlantic Canada, and the potential variation in ocean climate conditions that salmon encounter when first migrating to sea over a geographic range that extends from southern Nova Scotia and New Brunswick to Labrador and into the Ungava region of Quebec.

Variability in the trophic ecology of Atlantic will be examined from analyses of stable isotope signatures of carbon and nitrogen ($\delta^{13}C$ and $\delta^{15}N$). Nitrogen stable isotope analysis provides a quantitative means to determine trophic level since nitrogen signatures from organism tissue are consistently 3 to 5‰ more enriched than dietary sources. In contrast, carbon stable isotopes are conserved up the food chain owing to the slight 0.0 to 1.0‰ enrichment occurring between prey and consumer. Because ^{13}C is conserved during trophic transfer, but varies at the base of the food web, consumer tissue stable isotope signatures will also reflect dietary source information. Various tissues have been used in the analysis of isotopic signatures, including muscle, liver, scales, and fins. Scales tend to provide a longer term perspective of trophic information while analyses of muscle and liver tissue reflect more recent energy assimilation.

We propose to sample salmon at various points in its life cycle and characterize variations and changes in trophic state from the smolt to adult life-stage. This will be accomplished by sampling smolts and adult survivors back to the river from a broad geographic range in eastern North America. Smolt information will provide information on river-specific variability in freshwater feeding strategies. Intermediate marine life-history stages will be investigated from samples obtained at West Greenland as non-maturing one-sea-winter salmon, coupled with the proposed marine research survey intended to target the early post-smolt phase.

Study design

Variability in the trophic ecology of Atlantic will be examined from analyses of stable isotope signatures of carbon and nitrogen ($\delta^{13}C$ and $\delta^{15}N$) with comparisons among populations at the freshwater-smolt stage, as well as between life-history stages from post-smolts caught at sea, non-maturing 1SW salmon feeding at West Greenland, and with adults that return to respective rivers in the following year.

We propose to analyze isotope signatures from muscle, liver, scales and adipose fin tissue. In situations where lethal sampling of salmon is not an option (e.g., catch-and-release angling fisheries, populations at low abundance), scales and adipose fins provide non-lethal alternatives. As noted earlier, this approach will yield information on ontogenetic differences in isotope signatures across life-history stages (smolt, post-smolt, adult) across a broad geographic area.

Samples from West Greenland and from the proposed research cruise will be obtained on an opportunistic basis with a target of approximately 150 specimens from each but with potentially more samples from the marine research cruise should they be available; this, however, would increase the estimated costs of analysis. The potential river sampling locations and the respective tissues identified for stable isotope analyses are identified in Table 1.

To complement salmon trophic information, isotope analyses will also be carried out on a subset of other species that may be captured in the pelagic trawl, or obtained from stomach contents of salmon at sea. These data will provide insight into key dietary items of the food web structure within which salmon operate. Thus, five replicate samples of each of the key prey types within the size range consumed would be desirable.

Table 1. *Location, life stage and tissues to be sampled from Atlantic salmon to examine trophic ecology.*

							Returning adults			
			From Smolts				1SW salmon		2SW salmon	
SFA/Zone	River	Tributary	Muscle	Liver	Fin	Scales	Fin	Scales	Fin	Scales
23	Nashwaak		X	X	X	X	X	X	X	X
21	LaHave		X	X	X	X	X	X	X	X
18	Margaree		X	X	X	X	X	X	X	X
16	Miramichi	Southwest	X	X	X	X	X	X	X	X
		Northwest	X	X	X	X	X	X	X	X
15	Restigouche	Kedgwick	X	X	X	X	X	X	X	X
		Upsalquitch	X	X	X	X	X	X		
Q2	St-Jean		X	X	X	X	X	X	X	X
Q7	De la Trinite		X	X	X	X	X	X	X	X
11	Conne		X	X	X	X	X	X		
9	Rocky		X	X	X	X	X	X		
4	Campbellton		X	X	X	X	X	X		
4	Exploits		X	X	X	X	X	X		
14A	Western Arm		X	X	X	X	X	X		
2	Sand Hill		X	X	X	X	X	X	X	X
			Post-smolt and West Greenland							
Post-smolt			X	X	X	X				
West Greenland			X	X	X	X				

Samples will be collected over three years with the objective of tracking changes in trophic ecology of salmon through the marine phase (Table 2). In addition, annual variation in trophic state among 1SW maturing, 1SW non-maturing and 2SW salmon will be examined by sampling these stages even if some of the data on smolts or early post-smolt stages are not available. The samples from West Greenland will also provide inter-continental comparisons of trophic ecology for that life stage.

Table 2. *Schedule of samples to be collected by life stage.*

	2008					2009					2010				
	May	June	July	August	September	May	June	July	August	September	May	June	July	August	September
Smolt	X	X				X	X								
Post-smolt				X					X						
Marine prey (post-smolt)				X					X						
1SW salmon							X	X				X	X		
1SW non-maturing (WG)				X	X				X	X				X	X
Marine prey (WG)				X	X				X	X				X	X
2SW salmon							X	X				X	X		

Estimated cost of analysis over the next three years (2008 to 2010)

As the number of life stages sampled varies with the year, the cost of analysis also varies. Stable isotope analysis for C and N costs $10 per tissue sample. For 2008, the proposed cost of analysis is $39,000 (Cdn).

Life stage	Number of locations	Tissues	Number of samples per tissue	Total
Smolt	15 index rivers	Muscle, liver, scales, adipose	30	$18,000
Post-smolt	Labrador Sea	Muscle, liver, scales, adipose	150	$6,000
Marine prey	Labrador Sea, Two locations	20 prey item types	5	$2,000
1SW non-maturing (WG)	West Greenland	Muscle, liver, scales, adipose	150	$6,000
Marine prey	West Greenland	20 prey item types	5	$2,000
Labour for laboratory preparations				$5,000
Funding for analysis for 2008				**$39,000**

Smolt	15 index rivers	Muscle, liver, scales, adipose	30	$18,000
Post-smolt	Labrador Sea	Muscle, liver, scales, adipose	150	$6,000
Marine prey	Labrador Sea, Two locations	20 prey item types	5	$2,000
1SW salmon	15 index rivers	Scales, adipose	30	$9,000
1SW non-maturing (WG)	West Greenland	Muscle, liver, scales, adipose	150	$6,000
Marine prey	West Greenland	20 prey item types	5	$2,000
2SW salmon	9 index rivers	Scales, adipose	30	$5,400
Labour for laboratory preparations				$7,500
Funding for analysis for 2009				**$55,900**

1SW salmon	15 index rivers	Scales, adipose	30	$9,000
1SW non-maturing (WG)	West Greenland	Muscle, liver, scales, adipose	150	$6,000
Marine prey	West Greenland	20 prey item types	5	$2,000
2SW salmon	9 index rivers	Scales, adipose	30	$5,400
Labour for laboratory preparations				$4,000
Funding for analysis for 2010				**$26,400**

Timelines for the tissue collections and analysis

<u>For 2008</u>

The tissue collections from smolts from the index rivers began in May 2008 and will be completed by the end of June 2008. The post-smolt survey for the Labrador Sea is anticipated for August 2008 with tissue collection occurring on the vessel. The West Greenland samples would be collected in August and September and be available for analysis by the end of October 2008.

All the laboratory analyses would be conducted between September 2008 to February 2009 with preliminary analyses and interpretation available for the ICES Working Group meeting in April 2009 and the NASCO meeting of June 2009.

Timelines for other years would follow a similar schedule.

Coordination, data analysis and interpretation

Tissue collection from the index rivers and for post-smolts is being coordinated by Gerald Chaput (DFO Gulf Region).
Tissue collection and prey items from West Greenland are coordinated by Dr. Tim Sheehan (NMFS, NOAA, US).
Isotope analyses will be coordinated by Dr. Michael Power and conducted at the Environmental Isotope Laboratory, University of Waterloo (Canada).
Data analysis and interpretation will be lead by Brian Dempson (DFO NL, Canada) and Dr. Michael Power (U. of Waterloo, Canada).

Proposal submitted to the International Atlantic Salmon Research Board relative to furthering the knowledge on marine ecology of Atlantic salmon.

June 2008

By

Gérald Chaput, Tim Sheehan, and Brian Dempson
SALSEA North America

Inferring temperature history of Atlantic salmon at sea based on oxygen isotope ratios in otoliths

In addition to tissue samples to evaluate the trophic ecology of salmon, we propose to analyze oxygen isotopes that are deposited in otoliths. Because oxygen isotopes are deposited in equilibrium with the environmental waters in which the fish live, they can provide a temperature history experienced by the fish. Measurement of thermal habitat use relies on temperature dependent fractionation of δ^{18} oxygen isotopes during the formation of otoliths and established otolith δ^{18} oxygen–temperature relationships for conversion between the two. Ideally, insight into the thermal habitat use of salmon across various life-history stages from analyses of oxygen isotopes will be coupled with ecological information on smolt size and age and corresponding food web data as inferred from carbon and nitrogen signatures. Collectively, these analyses may shed additional insight into respective productivity differences among stocks throughout much of the natural distribution of salmon in the North West Atlantic Ocean ranging from Nova Scotia, New Brunswick, Quebec, Newfoundland and possibly southern Labrador.

This proposal complements the stable isotope research and uses the same material sources as for the stable isotope project. As such, the costing of this proposal is for analysis purposes only. A water sample is to be collected at every location where fish are collected.

SFA/Zone	River	Tributary	Smolts	1SW	2SW	Water sample
23	Nashwaak		X			X
21	LaHave		X			X
18	Margaree		X			X
16	Miramichi	Southwest	X	X	X	X
		Northwest	X	X	X	X
15	Restigouche	Kedgwick	X	X		X
		Upsalquitch	X	X		X
Q2	St-Jean		X	X		X
Q7	De la Trinite		X	X		X
11	Conne		X	X		X
9	Rocky		X	X		X
4	Campbellton		X	X		X
4	Exploits		X	X		X
14A	Western Arm		X	X		X
2	Sand Hill		X	X		X
			Post-smolt and West Greenland			
Post-smolt			X			X
West Greenland			X			X

Table 2. *Schedule of samples to be collected by life stage.*

	2008					2009					2010				
	May	June	July	August	September	May	June	July	August	September	May	June	July	August	September
Smolt	X	X				X	X								
Post-smolt				X					X						
1SW salmon							X	X				X	X		
1SW non-maturing (WG)				X	X				X	X				X	X
2SW salmon							X	X				X	X		
Water sample	X	X		X	X	X	X	X	X	X				X	X

Estimated cost of analysis over the next three years (2008 to 2010)

As the number of life stages sampled varies with the year, the cost of analysis also varies. Otolith analysis of oxygen isotopes costs $20 (Cdn) per sample. For 2008, the proposed cost of analysis is $17,900 (Cdn).

Life stage	**Number of locations**	**Tissues**	**Number of samples per tissue**	**Total**
Smolt	15 index rivers	Otoliths	30	$9,000
Post-smolt	Labrador Sea	Otoliths	150	$3,000
1SW non-maturing (WG)	West Greenland	Otoliths	150	$3,000
Water samples	20 locations (15 rivers + 3 Labrador Sea + 2 WG)	Water	1	$400
Labour for laboratory preparations				$2,500
Funding for analysis for 2008				**$17,900**

Smolt	15 index rivers	Otoliths	30	$9,000
Post-smolt	Labrador Sea	Otoliths	150	$3,000
1SW salmon	12 index rivers	Otoliths	30	$7,200
1SW non-maturing (WG)	West Greenland	Otoliths	150	$3,000
2SW maturing	Miramichi River (2 sites)	Otoliths	30	$1,200
Water samples	20 locations (15 rivers + 3 Labrador Sea + 2 WG)	Water	1	$400
Labour for laboratory preparations				$5,000
Funding for analysis for 2009				**$28,800**

1SW salmon	15 index rivers	Otoliths	30	$9,000
1SW non-maturing (WG)	West Greenland	Otoliths	150	$3,000
2SW salmon	Miramichi River (2 sites)	Otoliths	30	$1,200
Water samples	2 locations (WG)	Water		$40
Labour for laboratory preparations				$2,000
Funding for analysis for 2010				**$15,240**

Timelines for the tissue collections and analysis

For 2008

The otolith collections from smolts from the index rivers began in May 2008 and will be completed by the end of June 2008. The post-smolt survey for the Labrador Sea is anticipated for August 2008 with tissue collection occurring on the vessel. The West Greenland samples would be collected in August and September and be available for analysis by the end of October 2008. The otoliths will be extracted from the same fish sampled for tissues for C and N stable isotopes.

All the laboratory analyses would be conducted between September 2008 to February 2009 with preliminary analyses and interpretation available for the ICES Working Group meeting in April 2009 and the NASCO meeting of June 2009.

Timelines for other years would follow a similar schedule.

Coordination, data analysis and interpretation

Tissue and otolith collections from the index rivers and for post-smolts is being coordinated by Gerald Chaput (DFO Gulf Region).
Otolith collections from West Greenland are coordinated by Dr. Tim Sheehan (NMFS, NOAA, US).
Isotope analyses will be coordinated by Dr. Michael Power and conducted at the Environmental Isotope Laboratory, University of Waterloo (Canada).
Data analysis and interpretation will be lead by Brian Dempson (DFO NL, Canada) and Dr. Michael Power (U. of Waterloo, Canada).

Annex 5

FUNDING PROPOSAL TO IASRB

Participation of additional experts at ICES Study Group on Biological Characteristics of Salmon

Funding sought: Up to £5,000

Rationale:

In the request for scientific advice in 2007, NASCO asked ICES to examine and report on associations between changes in biological characteristics of all life stages of Atlantic salmon, environmental changes and variations in marine survival with a view to identifying predictors of abundance. Such information may provide valuable insights into the factors affecting the changes in marine mortality of salmon and therefore support the SALSEA programme. Work was initiated by the North Atlantic Salmon Working Group in 2008, and ICES has recommended that efforts be continue to identify and collate further information on biological characteristics of salmon from river populations and fisheries throughout the North Atlantic. It has therefore proposed that an ICES Study Group be established to facilitate a unified effort to further develop and investigate the datasets for changes in biological characteristics and stock performance. A proposal will be submitted to the ICES Diadromous Fish Committee in September for a Study Group to meet in the next year.

The IASRB SAG has noted the need for greater co-ordination of research activities related to the SALSEA programme, in relation to both the marine and freshwater factors affecting the survival of salmon at sea. The SAG has further noted that there are scientists working in relevant research areas who may not easily be able to attend the proposed ICES Study Group, for example from universities, because of lack of funding.

Funding is therefore sought from the IASRB to pay for up to two additional scientists to participate in this Study Group at the invitation of the Study Group Chair. The total cost will not exceed £5,000.