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Proceedings of a Regional Advisory Process Meeting on Inner Bay of Fundy Atlantic Salmon in support of a COSEWIC Submission

Compte rendu du Processus consultatif régional Réunion sur le saumon atlantique de l'arrière-baie de Fundy à l'appui d'une évaluation du COSEPAC

11-12 June 2003
Veteran Affairs Board Room
Queen Square
Dartmouth, NS

Les 11 et 12 juin 2003
Salle de conférences du ministère des Anciens combattants
Queen Square
Dartmouth (N.-É.)

Robert N. O'Boyle
Meeting Chairperson

Robert N. O'Boyle
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July 2003 / Juillet 2003

Foreword

The purpose of these proceedings is to archive the activities and discussions of the meeting, including research recommendations, uncertainties, and to provide a place to formally archive official minority opinions. As such, interpretations and opinions presented in this report may be factually incorrect or mis-leading, but are included to record as faithfully as possible what transpired at the meeting. No statements are to be taken as reflecting the consensus of the meeting unless they are clearly identified as such. Moreover, additional information and further review may result in a change of decision where tentative agreement had been reached.

Avant-propos

Le présent compte rendu fait état des activités et des discussions qui ont eu lieu à la réunion, notamment en ce qui concerne les recommandations de recherche et les incertitudes; il sert aussi à consigner en bonne et due forme les opinions minoritaires officielles. Les interprétations et opinions qui y sont présentées peuvent être incorrectes sur le plan des faits ou trompeuses, mais elles sont intégrées au document pour que celui-ci reflète le plus fidèlement possible ce qui s’est dit à la réunion. Aucune déclaration ne doit être considérée comme une expression du consensus des participants, sauf s’il est clairement indiqué qu’elle l’est effectivement. En outre, des renseignements supplémentaires et un plus ample examen peuvent avoir pour effet de modifier une décision qui avait fait l'objet d'un accord préliminaire.

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ABSTRACT

In May 2001, the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) undertook an evaluation of the status of the Inner Bay of Fundy (iBoF) Atlantic Salmon population (to 1999) and an "endangered" designation resulted. The Committee is to re-evaluate this designation as early as April 2004 with the status report due from the COSEWIC contractor in September 2003. In preparation for this evaluation, DFO undertook an assessment of all (new) relevant information. This meeting was to ensure that the most complete information was available for the possible use in COSEWIC's 2004 re-evaluation of the status of the iBoF salmon population.

RÉSUMÉ

En mai 2001, le Comité sur la situation des espèces en péril au Canada (COSEPAC) a entrepris une évaluation de la population de saumon atlantique de l'arrière-baie de Fundy (jusqu'en 1999) et a désigné cette population comme étant « en voie de disparition ». Le Comité doit réévaluer cette appréciation dès avril 2004, le rapport sur l'état de la population devant être livré par l'entrepreneur retenu par le COSEPAC en septembre 2003. En préparation pour cette évaluation, le MPO a lui-même évalué tous les éléments d'information (nouveaux) pertinents. La réunion convoquée à cette fin visait à faire en sorte que l'information la plus complète possible soit à la disposition du COSEPAC, pour que celui-ci l'utilise éventuellement dans sa réévaluation de la population de l'arrière-baie de Fundy.

INTRODUCTION

The chair, R. O'Boyle, opened the meeting by greeting the participants (Appendix 1) and inviting them to introduce themselves. The meeting letter of invitation is presented in Appendix 2, which includes the meeting remit and initial agenda. It had been intended that the meeting would serve a dual purpose: 1) to peer review the information to be provided to COSEWIC and 2) to generate a peer reviewed stock assessment document for public dissemination. However, to allow a more focused review on the COSEWIC information, it was agreed that the generation of a peer reviewed assessment would be delayed until December 2003/January 2004. Thus, the time allocated to synthesis on Thursday afternoon was to be spent on the COSEWIC-related information.

The objective of the meeting was therefore to ensure that new information/analyses on the iBoF salmon population held by DFO would be available to COSEWIC. In support of this objective, working papers on the following issues were considered:

- Hatchery Stocking History
- Gene Flow and Live Gene Banking
- Indicators for Stewiacke River populations
- Indicators for Big Salmon River populations
- Summary status for additional 40 iBoF rivers

The products of the meeting are 1) these proceedings, which provide commentary on the discussions by working paper and 2) research documents, based on the working papers and independently submitted to CSAS by their authors. It was the responsibility of the working paper authors to incorporate the changes recommended at the meeting and submit these to CSAS.

The Chair outlined how the meeting would be conducted. For the Proceedings, there were three rapporteurs, each covering different sections of the meeting. The senior author of each working paper presented the results of the analyses, during which questions of clarification were addressed. Three reviewers had been specifically invited to comment on the documents: P. Bentzen (Dal. Univ.), C. Legault (NMFS) and G. Chaput (DFO Gulf). They were given the opportunity to comment on the documents first. Following this, the floor was opened to general discussion.

After points of clarification, the meeting commenced.

Prior to the presentation on Hatchery Stocking History (Gibson), P. Amiro provided background on the current COSEWIC listing of iBoF Salmon. (Amiro, P. 2000. Population status of inner Bay of Fundy Atlantic salmon (*Salmo salar*), to 1999. RAP Working Paper 2003/15).

REVIEW OF HATCHERY STOCKING HISTORY OF INNER BAY OF FUNDY RIVERS

Working Paper: Gibson, A.J.F., J. Bryan, and P. Amiro. 2003. Release of Hatchery Reared Atlantic Salmon into Inner Bay of Fundy Rivers from 1900 to 2002. RAP Working Paper 2003/17.

Presentator: J. Gibson
Rapporteur: K. Querbach

Abstract

The Atlantic salmon populations of the inner Bay of Fundy are currently listed as endangered by the Committee on the Status of Endangered Wildlife in Canada. Many of these rivers have a history of enhancement activities via the release of hatchery-reared fish into their waters. We attempted to compile records of these stocking activities around the inner Bay from 1900 to 2002. Exclusive of the years 1968-1971 and 1974, just over 40 million salmon have been released into 33 rivers in this region. The majority of these fish were released as fry prior to 1960. Release strategies evolved from fry releases in the early 1900's, to primarily parr releases in the mid 1900's, to primarily smolt releases in the later part of the century. Since 1970, most stocking has been of the progeny of inner Bay of Fundy salmon. We were unable to determine the stock of origin for most of the earlier stocking events, but were able to reduce the number of potential donor rivers by examining the records of egg collections within the Maritime Provinces. Eggs were collected from inner Bay rivers in two years between 1900 and 1965. Most collections were made from the Saint John and Miramichi Rivers in new Brunswick during this time period.

Discussion

This document is intended as a data report that presents a compilation of releases of salmon into iBoF rivers from 1900 to 2002. The data was compiled to assist with assessment of stock status. To do this, historical estimates are required for comparison with current abundance estimates. However, it was noted that there is a lack of a time series of reliable historical estimates of iBoF Atlantic Salmon abundance dating back more than 30 or 40 years other than the stocking data. It is very difficult to assess the status of the stock without the stocking information because stocking may affect population size.

The historical purpose of hatcheries was discussed. Historically, the purpose of the hatcheries was fisheries enhancement. At present, salmon released into iBoF rivers are part of the live gene bank program, with the purpose of reducing the extinction risk for these populations. The emphasis on production within the hatcheries changed from fry to parr to smolt from the early to late 1900's. The live gene bank program now produces fry, parr, smolts and adults. The success of fry stocking has been questioned and may depend on the abundance of wild fry. It was suggested that as long as fry are placed in vacant habitat, they could do quite well.

Whether stocking stopped the decline of Atlantic salmon was questioned and it was felt that it did not. Whether or not stocking supported the fishery was also questioned. The extreme view would be a ‘put and take’ fishery; however, there is evidence that the rivers still produced large numbers of salmon in the absence of stocking. It was also questioned whether the landings versus the pattern of stocking had been addressed. One of the reasons for compiling this data was to be able to address these kinds of questions.

The question was raised as to whether historical stocking was actually the cause of the decline. While there may be some cause and effect, it was suggested that there was not enough information to make any conclusion on this. Discussion also ensued on whether iBoF Atlantic salmon have been in peril for a long time? The rivers have a long history of human activities; however, it is complicated among rivers and it will be difficult to ever have a complete grasp on what was occurring.

The documents shows that approximately 40 million fish were released since 1900 into iBoF rivers; however, these numbers need to be kept in perspective. The numbers in the Saint John River are much higher and could be used as a reference. The idea that perhaps taking a snap shot from the Saint John River would be beneficial to show that these numbers are not high relative to some other rivers.

Recommendations for the Research Document

There was a recommendation to scale/standardise the data to the salmon habitat available, as some river habitats are smaller than others. A table should be added to the research document, which provides the size of the river habitats. The authors responded that this was a data report and that the unstandardized data could be more useful. The information on the size of the habitats was compiled for some rivers for a critical habitat workshop and the information for those rivers is available in a research document about critical habitat (presently in review).

A recommendation was made to put the value of the approximately 40 million salmon that were released since 1900 into perspective. This could be accomplished by performing a comparison to the Saint John River and then using the proportion of iBoF salmon to compare with everything else present.

The philosophy underlying release of salmon into iBoF rivers has changed from fishery enhancement to preservation of the populations. A paragraph discussing these changes could be added to the document.

A suggestion was made to make modest enhancements in the data from Big Salmon River. These include the adult releases in the early 1990's and the fall LGB parr releases in 2002.

REVIEW OF GENE FLOW WITHIN THE INNER BAY OF FUNDY RIVERS

Working Paper: O'Reilly, P. 2003. Patterns of genetic variation among Atlantic salmon (*Salmo salar*) of the inner Bay of Fundy. RAP Working Paper 2003/16.

Presentator: P. O'Reilly
Rapporteur: A. McPherson

Abstract

Inner Bay of Fundy salmon exhibit unique life history traits, such as local migration, maturation after one winter at sea, and high incidence of repeat spawning. This assemblage of populations, listed by COSEWIC as endangered, has also declined precipitously in the last few years. Information on patterns of genetic structuring among populations of the inner Bay, and between inner and outer Bay of Fundy salmon, is of direct relevance to both the future re-evaluation of conservation units within Atlantic Canada, and in the prioritisation of populations for Live Gene Banking measures, currently underway. Here, we review previous studies of molecular genetic variation in and around the Bay of Fundy, and present new results based on extensive microsatellite genotype analyses of Live Gene Bank salmon from primarily Big Salmon and Stewiacke populations. Most of the earlier studies report significant heterogeneity within the inner Bay, but clear evidence of reduced gene flow exists only for mtDNA between salmon of the Minas Basin and those from elsewhere, although preliminary findings also suggest some degree of reproductive isolation between salmon from Chignecto Bay and those of the outer of Fundy. However, these analyses say little about possible homogenisation of nuclear DNA via effective migration by males. Microsatellite analyses of Live Gene Bank salmon indicated significant between population differences, but also large variation between years within populations. Additional analyses were conducted to help identify the cause of these temporal fluctuations, and to minimise year to year variation in allele frequencies and subsequent estimates of theta (an unbiased estimator of Wright's F_{ST}) between samples taken from the same locations from different years. Results obtained here indicate restricted gene flow between Stewiacke and Big River salmon populations, between Stewiacke and

the Saint John River salmon, and possibly between the Big Salmon and Saint John salmon.

Discussion

Question: Paul Bentzen asked the author if minimal overlap in generations in both the Big Salmon River (BSR) and Stewiacke River could contribute to the annual variation detected across years. The author responded that according to NRC's Interim report from the committee on Atlantic Salmon in Maine, increased generational overlap results in greater levels of between year-year variation in allele frequencies. This document (Genetic status of Atlantic Salmon in Maine) and supporting evidence of increased temporal variation in species/populations with overlapping generations versus discrete generations has been sent to Dr. Bentzen, and Dr. Bentzen has confirmed receipt of the information.

Question: The sample obtained in 1999 from the Big Salmon River appears to be the most divergent of the three samples taken from this location. Also, this year's collection was predominantly male. Could this have effected the results? It is possible that this may have influenced the results at the locus Ssa202, which turns out to be sex linked.

Question: There seemed to be fewer alleles in the smaller rivers: e.g. Economy River, approximately half that observed in, for example, the Big Salmon River. Answer: This observation may reflect historical bottlenecks in this population, or recent demographic declines.

Question: The author was asked if the iBoF mtDNA haplotype has been found elsewhere. Answer: Eric Verspoor has looked at many rivers in close proximity to iBoF rivers and has not detected the iBoF mtDNA haplotype. Tim King has conducted broader North American surveys, involving thousands of individuals, and has also not detected this allele. No microsatellite alleles were observed at high frequency in the inner Bay that were absent in outer Bay of Fundy populations.

Question: Can you further address the issue of the biological significance of the unique Minas Basin haplotype by looking at historic samples? Answer: yes, we are now in the process of looking at mtDNA variation in historical samples from the inner Bay that go back 20-30 years, and are looking for samples that extend 60-80 years. Although the stocking history extends back over 100-120 years, if we see no change in the last 60-80 years, during which stocking was more intense, it will be reasonable to assume that changes did not occur during the first 60 years of less intense stocking.

Comment: It is difficult to put *Ne* (effective population size) in the context of *N* (census population size) because *Ne* is very hard to calculate reliably, especially in the absence of large temporally replicated samples.

Comment: Because the salmon surveyed in this study were parr and smolt, the sample may not be reflective of the adult population. The use of juveniles was accounted for in the FST calculations by equalising family size in the population database used to estimate FST. It was noted that samples were not collected for the purpose of this paper but were used opportunistically. As a result of kinship adjustments, the among year differences decreased considerably while the among location estimates did not. The resulting lower population sizes would affect associated P values but not the FST estimates themselves.

When questioned, the author speculated that Atlantic salmon from Maine would likely be significantly different from iBoF Atlantic salmon.

Standardising the number of alleles for sample size was done using resampling techniques; it was noted that a rarefaction method was available in the latest version of Fstat, that could also be used for standardisation..

The captive breeding programs attempt to maintain 90-95% of the founder diversity that occurs within a population, over 100 or more years. If we can assume that the Economy River began with approximately the same number of alleles as the BSR, we may have lost 50% of the alleles of the Economy River. The author provided some introductory remarks on the use of microsatellites as genetic markers. Specifically, microsatellites are random sections of the genome and therefore may be linked to a gene susceptible to selection. However, microsatellites are generally assumed to be neutral.

The author was questioned on the absence of iBoF versus non-iBoF comparisons in the working paper. The author clarified that there were only a few non-iBoF locations sampled. This genetic study was designed (in part) to prioritise populations that may be included in the gene bank, and to identify which populations may be able to be interbred to conserve the remaining biodiversity. The author noted that to adequately compare the iBoF with the non-iBoF salmon, a large number of samples from both iBoF and proximate non-iBoF rivers would be required.

When questioned about the purpose of protecting the iBoF salmon mtDNA haplotype, the author responded that the aim of this recovery project was not to conserve the unique mtDNA haplotype, but rather to protect what this haplotype may represent (unique lineages of salmon, or unique populations separated by others by reduced gene flow, and thus the potential for adaptive differences to have accrued)

The major finding of the paper is the observed limited gene flow between salmon from BSR and Stewiacke River. The reported differentiation may influence future population viability analyses and/or recovery planning.

As the details of the live gene bank program were not reviewed in the current RAP, it was suggested that the proceedings of the Species at Risk Salmon Peer Review meeting (Nov 2002) be made available.

Recommendations for the Research Document

(1) It was suggested that an AMOVA (analysis of molecular variance) be performed on iBoF and non-iBoF data.

(2) The author was encouraged to include allele frequencies for all sample populations in bubble diagrams.

(3) It was suggested that Table 3 be revised to include adjustments for kinship for the Saint John SAMPLE (and other rivers if able).

(4) It was suggested that population abundance estimates be presented for sampling locations.

(5) The author was asked to test for differences in the number of alleles and standardised number of alleles among populations.

REVIEW OF LIVE GENE BANKING OF INNER BAY OF FUNDY SALMON POPULATIONS 1998-PRESENT

Working Paper: O'Neil, S., T. Goff, S. Ratelle, S. McBride, C. Harvie, and D. Stewart. 2003. Live gene banking of Atlantic salmon (Salmo salar L.) as a component of the maintenance and recovery of the populations of salmon in Inner Bay of Fundy. RAP Working Paper 2003/14.

Presentators: S. O'Neil, T. Goff
Rapporteur: K. Querbach

Abstract

Declines in abundance of Inner Bay of Fundy Atlantic salmon led to designation of those populations as endangered by the Committee on the Status of Endangered Wildlife in Canada in 2001. Plans to preserve the salmon stocks of the Inner Bay of Fundy were initiated by the Department of Fisheries and Oceans in 1998, and through subsequent broad stakeholder input, since then, in the form of maintaining live gene banks. Population maintenance is based on a combined ex situ and in situ program. Wild parr were captured in the autumn, annually, from 1998 to 2002, with plans for future captures of both wild and "wild-exposed" live-gene-bank reared fish. Fish are reared at the federally operated Coldbrook and Mersey (in Nova Scotia) and Mactaquac (in New Brunswick) biodiversity facilities and the Province of New Brunswick's Minto Hatchery. River population size and genetic data

influenced stocks targeted for collections which, to date, have included the Big Salmon River in New Brunswick, and the Stewiacke, Great Village, Harrington, Folly, Debert, Economy, and Gaspereau rivers in Nova Scotia. Fish of the Gaspereau River have a different marine migration than the other river stocks so that population was managed separately within the maintenance program. Live-gene-bank brood fish are reared to maturity in freshwater and mated according to a prescribed mating strategy which limits inbreeding depression and is designed to maximize preservation of the genes of separate families. Release location and stage for progeny is governed by priority. Priority is influenced by the degree of representation of a family and previous contribution to the gene bank. The release strategy is designed to limit the exposure of fish to the artificial environment while monitoring the efficiency and genetic diversity of the population. Fish were released as unfed fry, 6-week feeding fry, age 0 parr (26-52 weeks), and limited numbers as 1-year-old smolt. Release locations have been limited to the principle gene bank rivers, the Stewiacke, Gaspereau, and Big Salmon (N.B.), with satellite releases occurring in the Debert, Folly, Chiganois, and Salmon, in N.S. and the Demoiselle and Petitcodiac rivers in N.B. In Nova Scotia there were approximately 130,000 and 400,000 fish released in 2001 and 2002, respectively, with proposed releases for 2003 of about 500,000 fish. Past and planned fish releases for New Brunswick were 300,000 ; 260,000; and 400,000, in 2001, 2002, and 2003, respectively. Future contributions to the broodfish for the live gene bank will come from the "wild exposed" releases, and progeny of either wild spawners or gene-bank-produced adult spawners that survive the marine phase of their life cycle. The ex-situ live-gene-bank, in addition to rearing wild parr to maturity, consists of F1's kept in captivity for future use to replace any genetic diversity lost in the in-situ (riverine) gene bank.

Discussion

The issue of outdated facilities was raised. The existing facilities were constructed for the culture and release of brook trout or salmon smolt. Current live gene bank practices require the rearing of Atlantic salmon parr captured in the wild to adults; the rearing and release of age 0 fry that are released at various stages, 2-4 weeks of age, 6-week-feeding fry, 26-52 week old fry; and the release of smolt.

There was some discussion on the mating plan and it was clarified that the papers presented at this RAP regarding the genetic uniqueness of the iBoF fish did not cover the mating plan process. It would be useful to have the mating plan explained in full at some point in the future. The algorithm has been developed by the Genetics Technical Committee and a peer review is warranted in the winter of 2003-04 in preparation for planning for the 2004 rearing season.

It was questioned whether a strategy existed for fish release and it includes prioritizing the fish depending on whether they have contributed in the past and if there is already representation from those families. Fish are distributed throughout the river systems, in a manner to maximize their chances for survival. Fish are also marked at various stages.

Some discussion ensued regarding addressing cumulative survival over time. It was felt that COSEWIC would find this information useful. However, it was concluded that this could only be accomplished partially (e.g. size and weight of fish at time stages) due to a lack of data. The release strategy is designed to be able to evaluate this process subject to later monitoring resources and capabilities, because the genetic information can be used to trace future survivors to a certain release stage.

There was some concern in terms of diseases and whether the individuals removed are accounted for? They are not.

A clear objective regarding genetic diversity would be very useful in order to measure how things are going. It is possible to track diversity over time, which could make up its own paper in the future. It is also important to remember that beyond genetics, we are attempting to protect and preserve phenotypes. Historically, we have no idea what these were.

The uniqueness of repeat spawning behaviour of iBoF Atlantic Salmon was questioned. Reconditioning fish to spawn is not unique (e.g., done in Quebec, PEI). However, those fish are sea-run fish that are held for spawning in future years after originally being captured upon return from the sea. In out process, parr captured in the wild are being reared to maturity in freshwater and then spawned multiple times in captivity while being held in freshwater. This has not been accomplished for iBoF fish previously.

There was brief discussion on the fact that the practical reality that resources are an issue.

The issue of fitness was raised, as the goal is to increase fitness in the future by reducing family interactions now. Perhaps they may lose fitness in the future though since we are not permitting them to choose their own mates. It was suggested that a document outlining the rational behind fitness in the long-term would be useful.

There was some concern regarding the Gasperaeu River stock and whether the current story is correct. Some are not convinced that they are not a result of introgression. They exhibit migration traits that are more typical of other salmon strains. Although they are different phenotypically, there is no reason to think that they are different genetically. However, they do contain the haplotype unique to Inner Bay of Fundy Atlantic salmon. It is unique among all other stocks even those examined from other Bay of Fundy rivers such as the Saint John River.

Recommendations for the Research Document

It was felt that some of the headings for the tables contained in the working paper were unclear and depended on terminology. The suggestion was made to make the table headings consistent to reflect the year/age so that it does not depend on 'lingo'. Some of the tables have this and some do not.

A recommendation was made to flesh out the cumulative mortality so that disease mortality and accidental mortality are specified.

It was noted that the contractor who is writing the updated status report for COSEWIC will be most interested in Tables 1-4 and 8-10. The author should ensure that these tables are clear and explained well in the text (e.g. who, what, when, where).

There was a recommendation to add a paragraph on the differences and commonalties of the biodiversity centres and the hatcheries. The philosophy has changed over time and this should be illustrated clearly.

There was a suggestion that a table of release sites by stage either instead of or in addition to the existing Figure.

The objectives of this working paper are not clearly stated and should be included. It was recommended that the author also provide an update of the progress to date.

There was a suggestion to add a paragraph on genetic diversity. Patrick O'Reilly will provide this.

REVIEW OF INDICATORS TO INFER STOCK STATUS AND RECOVERY OF THE STEWIACKE RIVER

Working Paper: Gibson, A.J.F, and P.G. Amiro. 2003. Abundance of Atlantic salmon (*Salmo salar*) in the Stewiacke River, NS, from 1965 to 2002. RAP Working Paper 2003/13.

Presentators: J. Gibson and P. Amiro
Rapporteur: A. McPherson

Abstract

Atlantic salmon of the Stewiacke River, NS, are a part of a larger population assemblage, known as "inner Bay of Fundy Atlantic salmon" that were designated "endangered" by COSEWIC in 2001. Data for Stewiacke River salmon consist of catch-effort data from the recreational fishery (27 years), estimates of juvenile density obtained by

electrofishing (23 years), an index of adult abundance obtained by electrofishing by boat (10 years) and counts of adults bypassing a fence (4 years). Our purpose here is to use the data to estimate abundance of salmon in the Stewiacke River from 1967 to 2001. We used maximum likelihood to model the catch-effort, juvenile electrofishing, adult electrofishing and fence count data, to obtain estimates of the annual spawning run size during this time period. Results indicate a population size in the range of 2,000 to 8,000 during the late 1960's and early 1970's. Maximum likelihood estimates of the number of fish in the spawning run did not exceed 50 during the last 5 years, and are less than 10 since 1999. Markov chain Monte Carlo methods were used to derive Bayesian posterior distributions for the model parameters. The analyses indicate a 90% probability that the population has declined by more than 99.5% during the last 30 years and by more than 87% since the early 1990's. During the last 11 years, the estimated population size was less than during the preceding year in all but 2 years.

Discussion

There was considerable discussion on the calibration of the indices of abundance used in the model. It was suggested that indices be calibrated to "true" abundance, as fence information is a proxy of census population in the model. The authors responded that the model was designed to do exactly that.

The authors were questioned about the impacts of poorly defined model indices. The authors responded that all indices are well defined, although the accuracy of some indices (e.g. recreational fishing effort) might be questionable. This would only be a problem if there were biases in the index that changed through time. The influence of each dataset was evaluated by changing the respective weightings in the objective function, but that the results did not change substantially as when this was done.

It was noted that catch limits prior to 1984 were not two per day; therefore q is not constant but is considered as so in the paper. The authors responded that the catch limit was implemented after abundance had decreased, so that it may have been difficult to catch more than 2 fish a day, in which case q may not have changed that much. In reality, q will be related to the management strategy being used.

In the model, the authors assumed that the catch and release rates prior to 1983 were similar to those from 1983 onwards. There was consensus at the meeting that a better assumption would be that all fish caught were kept in the earlier years, although the truth is probably somewhere between these assumptions.

The authors were questioned about whether catch proportional to effort was a better assumption than fishing mortality proportional to effort. This is, if effort is a good measure of catch. The authors responded that catch was a function of both effort and abundance, not just effort. The assumption of fishing mortality proportional to effort is commonly used in fisheries models. Effort estimates are provided by regional fishery officers and are therefore associated with a number of assumptions that should be documented. The authors were questioned on how the assumption of a constant *q* affect the outcome of the model. It was recommended that the paper consider and recognise the consequences of a non-constant *q* when estimating the rate of return. Adding a random walk (where *q* changes slowly each year but is tightly constrained) to this part of the model was suggested. The authors thought this could be difficult given the limited amount of data for the earlier time period but agreed it was worth examination in future assessments.

Clarification was requested for how the Juvenile estimates shown in Tables 4 and 6: were derived. Sampling stations were selected so that habitats were sampled representatively, and that abundance at a station was estimated using mark-recapture methods. The number of fish caught was standardised to the number per 100 m^2. The author stated that exactly the same portion of each habitat type was not sampled each year, although differences were minor. Standardization by habitat rather than averaging the densities was suggested in consideration in future work.

The relative survival of egg-fry and fry-parr was discussed and it was noted that there is non-equal survival across life stages. The authors pointed out that this was not an assumption of the model.

There was discussion on the assumption of stationarity of the model: e.g. the catchability does not change through time within groups, but changes between groups.

The contribution of each index within an objective based function was discussed and the author noted that it is difficult to quantitatively assess the contribution of each index but can assess how the function responds to a change in a parameter value by fixing it as a constant. The influence of each index could and had been assessed by changing their weightings in the objective function.

The authors were questioned about why no age-2 fish were shown in the early electrofishing surveys in Figure 6. The authors explained that the researchers did not separate age classes of parr in the 1960's. As mentioned in the text, ages one and two were combined for these early surveys. These points did not have a large influence on the results. It was suggested that the authors consider leaving these points out. The authors had run the model with different age classes removed but didn't find the results changed appreciably.

The authors were encouraged to replace the Beverton-Holt function with a simpler function for the model. The authors responded that the Beverton-Holt function contained only two parameters and that other functions that included density dependence would not be simpler.

The period of 1992 to1995 could be used to anchor the model. It was noted that fence counts can be used to anchor points, but there are no anchors in the data from the 1960s. It was suggested that this might under- or over-estimate the returns during the early time period if the fishing catchability had changed. Issues associated with the distribution of the anchor points could be added to the paper. Another suggestion was to increase the weighting factor for the fence counts to a very large value to force the model to match this component of the model. It was suggested that this might affect abundance estimates generated by the model.

There was some discussion about whether constants were needed in the likelihood functions. Although the issue was not resolved, there was a consensus that adding the constants would ensure the objective function was appropriate irrespective of whether they were necessary.

Because both CPUE and fence count data are available for 1992 to 1995, they may be compared. However, CPUE is also a function of abundance so CPUE and fence counts need not correlate. It was suggested that the relationship between fishing mortality and effort may not be linear. The authors responded that they tested this assumption using the Big Salmon River data, but did not find evidence of a substantial deviation from a linear relationship. It was also noted that comparisons of Table 2 and 3 show that the electrofishing boat catchability varies. The authors responded that the catchability coefficients estimated in the model were random variables with associated means and variances. Variability was only an issue if it was systematic (e.g. through time). Otherwise its effect was captured in the uncertainty associated with the abundance estimate.

The authors noted that during the adult electrofishing surveys, the river was surveyed between one and three times and the number of times varied between years. However there does not appear to be a trend in the adult electrofishing catchability. It was also suggested that the adult electrofishing data might not be contributing anything meaningful to the model. It was suggested that perhaps the author could consider setting weighting factor for the boat electrofishing component of the model to see if the results changed. The use of priors in the model was discussed. The authors stated that priors are uniform and bounded on the scale of the parameter. Theoretically, a prior of some type is needed for the application of Bayes theorem.

The issue was raised that this model assumes that survival is constant through time. As currently written, escapement decreases through time because survival is constant but conversely, survival may change while escapement remains constant. However, spawning escapement could not remain high if juvenile survival was so low that no juveniles were present. It was suggested that a paragraph be included to discuss these points.

Recommendations for the Research Document

It was recommended that the author correct or add any missing information/data or inconsistencies (e.g. whether aquaculture salmon were included in 1995 fence counts). The data in Table 3 needs to be clarified and any typos identified (e.g. in the 1992-93 data) and corrected.

Table 6 was a duplicate of Table 6 and could be deleted. A paragraph discussing the design of the juvenile electrofishing surveys should be added to the manuscript. It was suggested that CPUE estimates be added to Table 2.

It was suggested that the authors add a schematic describing the steps of the model, and that the authors change the "projection" wording in the 1st paragraph on page 4.

It was suggested that the authors clarify that the fry abundance estimates were obtained through methods not designed for fry collection (the authors believe that because habitat types were sampled representatively this was not an issue). It was also recommended that the authors add a qualifying statement to conclusions on pg 11: "90% probability of less than 2 returns in 2000"

The authors were encouraged to describe (in detail) the assumptions of the model (e.g. assumptions of stationarity through time, management plans, effort, reliability, mortality) and comment on the validity of those assumptions.

Constants should be added to the likelihood functions.

Although the authors had performed sensitivity analyses, they were not presented in the manuscript. It was recommended that the authors include these results in the document. The following issues could be considered during the sensitivity analysis:

- functions other than the Beverton-Holt in egg-juvenile relationships
- setting lambda to a very high value on fence counts in the 1990s
- setting lambda to a very low value on boat electrofishing data
- applying a changing survival rate for egg-fry and fry-parr
- removing different age-classes from the electrofishing data
- the consequences of different management strategies and how they would affect *q*

For sensitivity analysis, it was recommended that the author explain how these changes affect abundance estimates and decline trajectories. A table showing the mean population sizes and percent declines in population size for each model run would be a good way to express the results.

REVIEW OF INDICATORS TO INFER STOCK STATUS AND RECOVERY OF THE BIG SALMON RIVER

Working Paper: Gibson, A.J.F., R.A. Jones, P.G. Amiro, and J.J. Flanagan. 2003. Abundance of Atlantic Salmon (*Salmo salar*) in the Big Salmon River, N.B., from 1951 to 2002. RAP Working Paper 2003/12.

Presentators: J. Gibson and P. Amiro
Rapporteur: K. Robichaud-LeBlanc

Abstract

Atlantic salmon of the Big Salmon River, New Brunswick, are part of a larger population assemblage, known as "inner Bay of Fundy Atlantic salmon", that is currently listed as endangered by COSEWIC. The Big Salmon River population has been impacted by human activities for over 1.5 centuries and has been the focus of recovery efforts intermittently for more than 70 years. Here, our purpose is to compile data collected since 1951 and use these data to assess changes in population size since that time. We used maximum likelihood to model the catch-effort, juvenile electrofishing, adult fence, stream-side and dive counts, and redd count data, to obtain estimates of the annual spawning run size during this time period. While none of the four models presented are entirely satisfactory, all indicate a spawning run size in the range of 1,000 to 4,000 during the 1960's and early 1970's, and a spawning run size of less than 150 fish since 1997. Estimates of the percent decline from the early 1990's ranged between 69.8 and 87.0%, and between 93.2 and 97.1% over the last 30 years. Enhancement of the population through the release of captive reared parr and smolt in the late 1950's and early 1960's appeared at least partially successful, although fry releases did not appear to affect adult population size. Estimated return rates of captive reared smolt in the late 1980's and early 1990's suggest that stocking during this time period had negligible effect on population size.

Discussion

Some discussion centred on the data outliers in Table 1. A question was asked about what to do with the high effort recorded in 1983, whether to leave it in, remove it or average it over recent years. The remark was made that there were problems with catch and effort reporting in 1983 in many iBoF rivers, however it is not sure if this included the Big Salmon River or not. It was suggested to look in FISHSYS report for NBDNRE data. It was also suggested that the low small salmon catch in 1980 could be related to forest spraying events and that this could be examined.

The was discussion about adjustments to the fence count information (1964 to 1973) presented in Table 1 as being those from B. Jessop's report. It was suggested to check J. Ritter's adjustments to estimates of count data.

The observation was made that the 1988, 1997 and 1998 adult estimates by stream-side observation and dive survey presented in Table 2.1 were not included in the analysis of the current paper but will be included in final model.

Discussion centred around the efficiency of the dive count estimates and the question was raised as to whether or not the *q* parameter can be transported from other rivers, because exchangeability of data sets is questionable. The parameter could differ substantially between rivers. This would produce a prior with a wide variance. However, it might be useful to include some reference to other efficiency numbers to get a sense for the Big Salmon River data.

There was uniform agreement that redd count data is difficult to interpret and this should be reflected in the document (with a reference to Table 2.2).

There was some discussion around the high fry density estimated for 1982 in Table 3 (electrofishing juvenile estimates). One possible explanation presented was the stocking at Schoal's Dam, but this did not explain high densities in other year classes that year. Closer scrutiny of this data set is warranted with narrative to describe any investigation into apparent outliers. For example, there was some discussion as to the inclusion or exclusion of the electrofishing data set. That the age-0 parr densities in a given year were higher than age-1 parr densities the following year. It was stated that not all numbers (years of potential hatchery stocking influences were not used) were put in the model and that these could be highlighted in the table as they were in the figures. The authors pointed out that in the final version of the model, the juvenile electrofishing data was not included.

It was proposed that additional methodology type information on electrofishing be provided in the text of the document. And for future reference, it was recommended that there be some follow up discussion on electrofishing survey design for monitoring recovery of the iBoF populations. There was a suggestion that redd surveys with genetic analysis of emergent fry could also provide additional information.

The question was raised as to whether age-2 fish include all fish age-2 and older, and to recheck the data to clarify this. The authors responded that Jessop (1986) found very few age-4 smolt in the BSR, suggesting that very few age 3 and older parr were present, so any resulting bias would be small.

There was some discussion about the absence of data points in the age-2 plots of Figure 7. The authors stated that this was the result of excluding electrofishing data that was potentially confounded by stocking, although the model had been run with the stocked years both included and excluded from the data.

It was suggested to run the model for Big Salmon River the same as for the Stewiacke River with the electrofishing data in, redd and swim counts out.

There was a brief debate on the reasons for breaking up the estimate of R_0 in the two different time periods (1954-1980 and 1981-2002). This allows the researcher to evaluate whether carrying capacity has changed between the two time periods. If the researcher had evidence that it hadn't changed, the model could be fit with one R_0 for both time periods.

Some comments were made on the effects of stocking, and the mention of the construction of the causeway on the Petitcodiac River increasing population size in adjacent rivers. It was suggested that density dependence could be considered in the stocking component of the model, although the number of stocked fish was low relative to the carrying capacity, and including density dependence would require some assumed interaction between wild and stocked fish. A recommendation for the future was made to consider density dependence in stocking component of model.

There was a suggestion to have some follow up discussion on electrofishing survey design for monitoring recovery of the iBoF populations (for resources distributed in various habitats). It was noted that there is a need for broader discussion on how to track these populations.

Recommendations for the Research Document

The suggestion was made to look in FISHSYS report for NBDNRE recreational catch data to resolve 1983 outlier and as a general check on angling catch data.

It was suggested to check J. Ritter's adjustments to estimates of count data.

A recommendation was made that the final analysis should include 1988, 1997 and 1998 streamside observations and dive count estimates.

The numbers in Table 2.1 need to be re-verified.

It was recommended that the authors provide a better description in the text of dive counts efficiency.

A suggestion was made to highlight in Table 3 which electrofishing data points were and were not put into the model.

The authors needs to check on the absence of age-2 parr by location in Figure 7.

It was suggested that the authors run the model the same as for the Stewiacke River (electrofishing in, redd and swim counts out).

It was suggested that the spawning escapement targets be added to the paper.

REVIEW OF SUMMARY STATUS OF ADDITIONAL 40 INNER BAY OF FUNDY RIVERS

Working Paper: Gibson, A.J.F., and P.G. Amiro. 2003. Densities of Juvenile Atlantic Salmon (*Salmo salar*) in inner Bay of Fundy Rivers during 2000 and 2002. RAP Working Paper 2003/11.

Presentators: J. Gibson and P. Amiro
Rapporteur: K. Robichaud-LeBlanc

<u>Abstract</u>

Inner Bay of Fundy (iBoF) Atlantic salmon are presently listed as endangered by COSEWIC. During 2002, an extensive electrofishing survey was undertaken to estimate the abundance of juvenile Atlantic salmon in iBoF rivers. Four organizations contributed to the survey: the Department of Fisheries and Oceans, the Nova Scotia Department of Agriculture and Fisheries, Fort Folly First Nation and Parks Canada. During the survey, a total of 233 sites were electrofished in 41 rivers. During the first pass of these surveys, a total effort of 152,106 seconds of shocking time was applied over 129,298 m^2 of habitat, resulting in the capture of 8,495 fish including 1,361 Atlantic salmon. Of 32 rivers without living gene bank (LGB) support, fry were not found in 27 of these rivers and parr were absent in 20. Where salmon were present in rivers without LGB support, mean densities of fry and parr were low relative to past surveys. In New Brunswick rivers, mean fry and parr densities in each river were less than 4.5 and 4.2 fish per 100 m^2 respectively, and in Nova Scotia rivers were less than 0.15 and 2.6 fish per 100 m^2 respectively. At this time, estimates of densities of wild juvenile salmon in rivers with LGB support are confounded by the presence of captive reared fish, although densities at sites within these rivers that are distant from LGB release sites are also low.

The results of this survey are placed in context by comparison with results of previous electrofishing surveys and catches in the recreational fishery. These comparisons, together with the analyses of temporal trends for the Stewiacke and Big Salmon Rivers clearly indicate that the decline is not limited to just a few rivers. Additionally, data collected during the last few years imply that the declines that lead to the listing of this complex by COSEWIC are continuing.

Discussion

There was some speculation on the possibility of aquaculture fish in the Harrington River. The possibility of people releasing juvenile salmon was also suggested.

Results from genetic testing of juvenile salmon have revealed the successful spawning of aquaculture fish in the Upper Salmon River. This information is going to come out in a report being prepared by P. O'Reilly's lab for presentation at an upcoming ASF meeting.

Some discussion revolved around the documentation of information with regards to barriers on individual rivers (i.e., type, location in relation to habitat, when existed, etc) as being useful, but representing a substantial amount of work. It was debated whether or not to have a separate document to cover the broader description of habitat and fish passage in iBoF rivers. The consensus was that this information should be summarized in a separate document.

There was some discussion on electrofishing catchability. The concern was raised that wild and hatchery fish have different behaviour thus maybe different capture probabilities. Additionally, trout and salmon may have different capture probabilities.

It was also suggested that information about other salmonids (brown trout) and rainbow trout, in Crooked Creek for example, be included in a river by river discussion.

Pooling salmonids to calculate capture efficiency estimates was discussed. It was suggested to present data for salmonids separately but in a situation of small sample size to examine whether pooling the species affected estimates.

There were comments on the last paragraph in the document and a request to clarify the meaning. The purpose was to point out that fish are present in many rivers in the Inner Bay, even those previously dammed, for reasons other than stocking. The final consensus was to remove paragraph.

Recommendations for the Research Document

It was suggested that it would be useful to include information on origin of salmon found in the Harrington River. For future reference, it was suggested that it would be useful to generate information regarding presence of tidal barriers on individual rivers, but not in this document. It was also suggested to restrict the river by river discussion to the salmonid data.

Documenting presence of other salmonids was recommended (e.g. brown trout, and presence of rainbows in Crooked Creek). It was also recommended to investigate whether the differences in the catchability of salmonids (eg. speckled trout versus

Atlantic salmon) could be evaluated with the data presented (very few Atlantic salmon were captured).

The authors need to verify that the data set for 2000-2002 in table 1 is complete. Whereas electrofishing data compilations are ongoing, it was recommended to make sure the historical information contained in the Appendix is as up to date as possible. It was also suggested to carry the page header over on each page in Appendices.

There was a suggestion to change title of the working paper to ‘Synopsis of ….’. It was also suggested to delete the last paragraph of document but include a commentary similar to last paragraph of the abstract.

It was recommended that, as much as possible, the authors point out where and when densities reported are for wild fish only, and when they may also include stocked fish.

The suggestion was made to restrict the descriptive narrative in this document to catch and effort, juvenile electrofishing, and availability of counts and also to provide references for the narrative.

In the methods, describe how the rivers sampled in 2002 were selected.

It was suggested that the authors delete table 6 and make reference in text to its availability in the Stock Status Report.

It was also suggested that table 7 be deleted and make reference in text to its availability in Amiro’s 2000 Tech report.

There was a suggestion to include a map of the iBoF showing the locations of the rivers.

Appendix 1. List of Participants

Participant	Affiliation/Address	Telephone	E-mail
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Appendix 2. Letter of Invitation

Fisheries and Oceans / Pêches et Océans

Fisheries & Oceans Canada
Bedford Institute of Oceanography
1 Challenger Drive, P.O. Box 1006
Dartmouth, Nova Scotia B2Y 4A2

26 May 2003

Dear Invitee:

As mentioned April 29-30th at Planning/Advisory Group in Amherst, Dept. of Fisheries & Oceans investigators will be presenting internal information collected and analyzed since the initial inner Bay of Fundy (iBoF) Salmon Status Report provided to COSEWIC in 2000. You are invited on 11-12 June 2003 to assist in the peer review of that information under the leadership of our Regional Assessment Office. Our purpose is to ensure that the best products are available for possible use in COSEWIC's re-evaluation of the status of the iBoF populations in April/ May 2004, and to form the basis of a DFO iBoF salmon Research Document for Planning Groups' use and public dissemination. The review will take place in the Veterans' Affairs Board Room, Belmont House, 33 Alderney Drive, Dartmouth (beside Queens Square and kitty corner to the ferry terminal), commencing at 9:00am, Wednesday, June 11th. Details are provided in the attached 'Agenda' and 'Remit'

To assist in our planning of room configuration and health breaks we ask that you notify Lynn at <CullenLM@mar.dfo-mpo.gc.ca> of your intention to attend.

Regards,

Original signed by V. Myra for:

Larry Marshall and Roddie MacDonald
Co-Chairs, iBoF Salmon Recovery Team

Attachment

Cc: R. O'Boyle
M. Sinclair
V. Myra
A. McPherson
L. Cullen

Inner Bay of Fundy Salmon
RAP Meeting
Veterans' Affairs, Belmont House
33 Alderney Drive, Dartmouth, NS
11 - 12 June 2003

Remit

Background

Inner Bay of Fundy (iBoF) salmon have been shown to be genetically distinct. It is assumed that habitat degradation, commercial fishing and natural processes, have led to a significant decline in population abundance, despite control efforts (e.g. fishing was ceased in 1990). In May 2001, the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) undertook an evaluation of the status of this population (to 1999) and an "endangered" designation resulted. The Committee is to re-evaluate this designation as early as April 2004 and the status report (draft) is due from the COSEWIC contractor in September 2003. In preparation for this evaluation, DFO has undertaken to assess all (new) relevant information. In addition, DFO is committed to informing clients and stakeholders on trends of iBoF salmon population abundance. As such, the current meeting will serve a dual purpose: to peer review the information to be provided to COSEWIC and to generate a peer reviewed stock assessment document for public dissemination.

Objectives

- To ensure that new information /analyses on iBoF salmon held by DFO is available to COSEWIC
- To inform clients and stakeholders on recent trends in inner Bay of Fundy salmon abundance
- To consider the resources, prospects for recovery, management options (harvest control and gene banking) and make recommendations on these

In support of these objectives, the following will be considered:

- Stock integrity (specifically genetics)
- Current status of salmon in Stewiacke River, Big Salmon River, and 40 other rivers

Products

1. Proceedings summarizing the discussion of the meeting

2. A report summarizing the main conclusions of the meeting, including sections on Stock Structure, Habitat Considerations, Resource Outlook, Management Considerations, and encompassing the findings of the following working papers:

- Hatchery stocking history of iBoF rivers (Gibson, Bryan and Amiro)
- Gene flow within the iBoF salmon (O'Reilly)
- Live Gene Banking iBoF salmon populations, 1998-present (O'Neil and Goff).
- Multiple index procedures to infer stock status and recovery of iBoF rivers (Gibson and Amiro)
- Stock status of an additional 40 iBoF rivers (likely qualitative based on genetics, fishery performance and historic data) (Gibson and Amiro)

Participation

Chair:	R. O'Boyle
iBoF Planning Group:	L. Marshall, Fred Whoriskey, Charles Ayer, Tim Nye, Ross Jones, Trevor Goff, Peter Amiro, Patrick O'Reilly, Jamie Gibson, Renee Wissink, Alain Caissie, Don MacLean, John MacMillan, Greg Stevens, Stephen Lanteigne, Peter Cronin, Mike Sullivan, Murray Hill, Mark Elderkin, Stephen Chase, Roger Doyle, Christopher Herbinger, Gilles Lacroix, Dave Meerburg, Chris Connell, Rick Cunjak, Pam Seymour, Doug Aitken, Darryl Murrant
Additional DFO Personnel:	K. Drinkwater, A. McPherson, K. Querbach, L. Cooper
External Reviewers:	G. Chaput (DFO) P. Bentzen (Dal Univ.) C. Legault (NMFS)

References (to be finalized)

Amiro, P.G. 2000. Population Status of inner Bay of Fundy Atlantic salmon (*Salmo salar*), to 1999. Can Tech Report Fish. & Aquat. Sci. (in prep: former COSEWIC Status Report).

DFO, 2003. Atlantic Salmon Maritime Provinces Overview. Stock Status Report 2003/026.

Verspoor et al. 2002. Restricted matrilineal gene flow and regional differentiation among Atlantic salmon (Salmon salar L.) populations within the Bay of Fundy, eastern Canada. Heredity, Vol 89, Part 6: 465-472.

Regional Advisory Process
on Inner Bay of Fundy Salmon
11 - 12 June 2003
Veterans' Affairs, Belmont House
33 Alderney Drive, Dartmouth, NS

Agenda

Wednesday, 11 June 2003

09:00	Introduction (O'Boyle) and Meeting Background
09:15	Hatchery stocking history of inner Bay of Fundy rivers (Gibson, Bryan and Amiro)
10:00	Break
10:30	Gene flow within the iBoF salmon (O'Reilly)
12:00	Lunch
13:00	Live Gene Banking of iBoF salmon populations, 1998-present (O'Neil and Goff)
15:00	Break
15:30	Multiple index procedure to infer stock status and recovery of Stewiacke River population (Gibson and Amiro)
Thursday	**12 June 2003**
09:00	Multiple index procedure to infer stock status and recovery of Big Salmon River population (Gibson and Amiro)
10:30	Break
11:00	Summary status of an additional 40 iBoF rivers (likely qualitative based on genetics, fishery performance and historic data) (Gibson and Amiro)
12:00	Lunch
13:00	Synthesis
17:00	Adjournment

Appendix 3. List of Working Papers

Gibson, A.J., and P.G. Amiro. 2003. Densities of Juvenile Atlantic Salmon (*Salmo salar*) in inner Bay of Fundy Rivers during 2000 and 2002. RAP Working Paper 2003/11.

Gibson, A.J., and P.G. Amiro. 2003. Abundance of Atlantic salmon (*Salmo salar*) in the Stewiacke River, NS from 1965 to 2002. RAP Working Paper 2003/13.

Gibson, A.J., P.G. Amiro, and J. Bryan. 2003. Release of Hatchery-Reared Atlantic salmon (*Salmo salar*) into Inner Bay of fundy Rivers from 1900 to 2002. RAP Working Paper 2003/17.

Gibson, A.J., P.G. Amiro, R.A. Jones, and J.J. Flanagan. 2003. Abundance of Atlantic salmon (*Salmo salar*) in the Big Salmon River, NB from 1951 to 2002. RAP Working Paper 2003/12.

O'Neil, S., T. Goff, S. Ratelle, S. McBride, C. Harvie, and D.A. Stewart. 2003. Live gene banking of Atlantic salmon (Salmo salar L.) as a component of the maintenance and recovery of the populations of salmon in Inner Bay of Fundy. RAP Working Paper 2003/14.

O'Reilly, P. 2003. Patterns of genetic variation among Atlantic Salmon (*Salmo salar*) of the inner Bay of Fundy. RAP Working Paper 2003/16.