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**Proceedings of the Central and Arctic  
Regional Science Advisory Process  
on the Recovery Potential Assessment  
of Atlantic Salmon (Lake Ontario  
Population)**

**March 1- 2, 2007  
Canada Centre for Inland Waters  
Burlington, ON**

**L. Marshall  
Meeting Chairperson**

**K. A. Martin  
Editor**

**Compte rendu du processus régional  
de consultation scientifique du Centre  
et de l'Arctique sur l'évaluation du  
potentiel de rétablissement du  
saumon de l'Atlantique (population du  
lac Ontario)**

**Le 1- 2 mars 2007  
Centre canadien des eaux intérieures  
Burlington (Ont.)**

**L. Marshall  
Président de réunion**

**K. A. Martin  
Éditrice**

Fisheries and Oceans Canada/Pêches et Océans Canada  
Great Lakes Laboratory for Fisheries and Aquatic Sciences/  
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867 Lakeshore Rd./ 867, Chemin Lakeshore  
Burlington ON L7R 4A6 Canada

**August 2009**

**août 2009**

## **Foreword**

The purpose of these Proceedings is to document the activities and key discussions of the meeting. The Proceedings include research recommendations, uncertainties, and the rationale for decisions made by the meeting. Proceedings also document when data, analyses or interpretations were reviewed and rejected on scientific grounds, including the reason(s) for rejection. As such, interpretations and opinions presented in this report individually may be factually incorrect or misleading, but are included to record as faithfully as possible what was considered at the meeting. No statements are to be taken as reflecting the conclusions of the meeting unless they are clearly identified as such. Moreover, further review may result in a change of conclusions where additional information was identified as relevant to the topics being considered, but not available in the timeframe of the meeting. In the rare case when there are formal dissenting views, these are also archived as Annexes to the Proceedings.

## **Avant-propos**

Le présent compte rendu a pour but de documenter les principales activités et discussions qui ont eu lieu au cours de la réunion. Il contient des recommandations sur les recherches à effectuer, traite des incertitudes et expose les motifs ayant mené à la prise de décisions pendant la réunion. En outre, il fait état de données, d'analyses ou d'interprétations passées en revue et rejetées pour des raisons scientifiques, en donnant la raison du rejet. Bien que les interprétations et les opinions contenus dans le présent rapport puissent être inexacts ou propres à induire en erreur, ils sont quand même reproduits aussi fidèlement que possible afin de refléter les échanges tenus au cours de la réunion. Ainsi, aucune partie de ce rapport ne doit être considéré en tant que reflet des conclusions de la réunion, à moins d'indication précise en ce sens. De plus, un examen ultérieur de la question pourrait entraîner des changements aux conclusions, notamment si l'information supplémentaire pertinente, non disponible au moment de la réunion, est fournie par la suite. Finalement, dans les rares cas où des opinions divergentes sont exprimées officiellement, celles-ci sont également consignées dans les annexes du compte rendu.

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## SUMMARY

A regional science peer review meeting was held on March 1-2, 2007 in Burlington Ontario. The purpose of the review was to provide science advice on the Recovery Potential of the Lake Ontario population of Atlantic Salmon (*Salmo salar* L.) including a science-based peer review of the designatable unit assigned by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) and the 16 steps<sup>1</sup> in Fisheries and Ocean's Recovery Potential Assessment (RPA) framework. The advice was intended to feed the recovery process, under Canada's *Species at Risk Act* (SARA), for Atlantic Salmon (Lake Ontario population) which had been designated as Extirpated by COSEWIC. The advice will be provided to the DFO Minister for his consideration in any listing decision under the SARA for this population and for any socio-economic analyses, consultations and recovery planning related to this population. Participants included representatives of DFO Science and Policy sectors from the NCR, Central and Arctic, and Maritimes regions; and, salmon specialists from the Ontario Ministry of Natural Resources and Ontario Federation of Anglers and Hunters. This proceedings report summarizes the relevant discussions and presents the key conclusions reached at the peer review meeting.

Key results of the meeting included that the Lake Ontario Atlantic Salmon population is not currently self-sustaining and agreement that the population should be considered Extirpated. The Recovery Target for the Lake Ontario population should be based on the number of spawners returning each year with a target of 20% of historic levels. The entire wetted areas of the Credit River, Duffins Creek and Cobourg Creek were considered Critical Habitat and participants agreed that Atlantic Salmon redds are Residences. The bottleneck to recovery is in the pre-adult (YOY, age 1+ and smolt) stages and if this bottleneck is dealt with, an Allowable Harm of 2% would not be considered an impediment to recovery for Lake Ontario Atlantic Salmon.

This report will be published in the Canadian Science Advisory Secretariat (CSAS) Proceedings Series. One of the working papers presented at the workshop (Vélez-Espino and Koops 2007) was published in the CSAS Research Document report series. A second Research Document with information on critical habitat and residences will also be published in the CSAS series. The advice from the meeting will be published as a Science Advisory Report.

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<sup>1</sup> In August 2007, the RPA framework was revised to include 17 steps (DFO 2007).

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## SOMMAIRE

Une réunion régionale d'examen scientifique par des pairs a eu lieu les 1er et 2 mars 2007 à Burlington, en Ontario. Le but de cet examen était de formuler un avis scientifique sur le potentiel de rétablissement de la population de saumons atlantiques (*Salmo salar* L.) du lac Ontario, y compris procéder à un examen scientifique par des pairs de l'identification de l'unité désignable par le Comité sur la situation des espèces en péril au Canada (COSEPAC), selon les 16 étapes<sup>1</sup> du cadre pour l'évaluation du potentiel de rétablissement (EPR) de Pêches et Océans Canada. En vertu de la Loi sur les espèces en péril (LEP) canadienne, l'avis servira à orienter le processus de rétablissement du saumon atlantique (population du lac Ontario), laquelle a été désignée disparue du pays par le COSEPAC. L'avis sera présenté au ministre des Pêches et des Océans, qui l'examinera avant de prendre sa décision concernant l'inscription de la population en vertu de la LEP. Cet avis servira également à orienter la tenue d'analyses socio-économiques et de consultations ainsi que la planification du rétablissement de cette population. Parmi les participants, mentionnons des représentants des secteurs des Sciences et des Politiques des régions de la capitale nationale, du Centre et de l'Arctique et des Maritimes du MPO ainsi que des spécialistes du saumon du ministère des Ressources naturelles de l'Ontario et de l'Ontario Federation of Anglers and Hunters. Le présent compte rendu résume les discussions pertinentes tenues et présente les principales conclusions formulées au cours de cette réunion d'examen par des pairs.

Les principales conclusions de la réunion sont que la population de saumons atlantiques du lac Ontario n'est pas auto-suffisante et que celle-ci doit être désignée en tant qu'espèce disparue du pays. La cible de rétablissement pour la population du lac Ontario doit être fondée sur le nombre de reproducteurs qui remontent chaque année, suivant un objectif de 20 % des niveaux historiques. La totalité des surfaces mouillées de la rivière Credit, du ruisseau Duffins et du ruisseau Cobourg sont considérées comme des habitats essentiels, et les participants conviennent que les nids de frai du saumon atlantique sont les résidences de ce dernier. Le moment critique pour le rétablissement a lieu aux stades préadultes (jeunes de l'année, âge 1+ et saumoneaux); après ces stades, un taux de dommages admissibles s'établissant à 2 % n'empêchera pas le rétablissement du saumon atlantique du lac Ontario.

Le présent compte rendu sera publié dans la série des comptes rendus du Secrétariat canadien de consultation scientifique (SCCS). Un des documents de travail présentés à l'atelier (Vélez-Espino et Koops, 2007) a été publié dans la série des documents de recherche du SCCS. Un second document de recherche contenant de l'information sur l'habitat essentiel et les résidences sera également publié dans la série du SCCS. L'avis découlant de la réunion sera publié à titre d'avis scientifique.

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<sup>1</sup> En août 2007, le cadre pour l'EPR a été revisé et contient dorénavant 17 étapes (MPO, 2007)

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## INTRODUCTION

In May 2006, the Committee on the Status of Wildlife in Canada (COSEWIC) designated the Lake Ontario Atlantic Salmon (*Salmo salar* L.) population as Extirpated. As a result, the Minister must decide whether or not to list this population under the *Species at Risk Act* (SARA). To inform this decision and provide the basis for other SARA related functions, a Recovery Potential Assessment (RPA) meeting was held in Burlington on March 1-2, 2007. The (RPA) process was developed by DFO Science to provide the information and scientific advice required to meet the various requirements of the SARA, such as the authorization to carry out activities that would otherwise violate the SARA as well as the development of Recovery Strategies. The information is also used when analyzing the socio-economic impacts of adding the species to the list as well as during subsequent consultations, where applicable.

The purpose of the meeting was to assess and provide advice on the recovery potential of the Lake Ontario population of Atlantic Salmon. The RPA is a science-based peer review of the designatable unit assigned by COSEWIC and included assessing the current status of the population, the scope for human-induced mortality and scenarios for mitigation and alternatives to activities which negatively impact the population. The RPA framework developed by DFO Science includes addressing the 16 steps outlined in Appendix 1<sup>1</sup>.

Terms of reference (Appendix 2) were made available prior to the meeting. Participants (Appendix 3) included DFO Science and Policy sectors from the NCR, Central and Arctic Region, and Maritimes Region; and, salmon specialists from the Ontario Ministry of Natural Resources and Ontario Federation of Anglers and Hunters. The meeting generally followed the agenda as outlined in Appendix 4.

This proceedings report summarizes the relevant discussions and presents the key conclusions reached at the peer review meeting. Several working papers were presented at the workshop and provided the basis for the discussions. One of these working papers (Vélez-Espino and Koops 2007) was published in the CSAS Research Document report series. A second research document with information on critical habitat and residences will be published in the same series. The Science Advisory Report is the synopsis of the advice from the meeting.

## DISCUSSION

### THE SARA AND RPA PROCESSES

Author and presenter – Nick Mandrak

The purposes of the SARA are to protect wild species at risk and their habitats in Canada, and to promote their recovery. The Act stipulates that it is forbidden to kill, harm, harass, capture or take individuals of a species listed under the Act as Threatened, Endangered or Extirpated. The SARA also prohibits damaging or destroying their Residence or any part of their Critical Habitat. The SARA indicates that a Recovery Strategy and Recovery Action Plan must be developed for each species listed on Schedule 1 of the SARA.

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<sup>1</sup> In August 2007, the RPA framework was revised to include 17 steps (DFO 2007)

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Some activities that kill, harm, harass or capture individuals of species may be allowed if those activities are specified in the Recovery Plan (Section 83(4) of the SARA) and are carried out by someone authorized under an Act of Parliament to engage in those activities. Between legal listing and adoption of the Recovery Plan, a permit may be issued under Section 73 of the SARA. This permit exempts prosecution for violating prohibitions on the listed species, as long as the mortality is incidental to pursuit of some other activity for which the permit was issued.

The Minister of Fisheries and Oceans can only issue permits under Section 73 of the SARA if the Minister is satisfied that specific preconditions have been met and these are:

- 73(3)(a) all reasonable alternatives to the activity that would reduce the impact on the species have been considered and the best solution has been adopted;
- 73(3)(b) all feasible measures will be taken to minimize the impact of the activity on the species...; and,
- 73(3)(c) the activity will not jeopardize the survival or recovery of the species.

#### Discussion

(Q) If the Minister accepts the COSEWIC designation for the Lake Ontario population will that affect populations on the East Coast?

(A) No, the designation is based on Designatable Units (DUs) and the Lake Ontario DU is separate from the East Coast DU(s).

(Q) Once the species is listed, would a harvest be allowed?

(A) Prohibitions come into affect right away except under certain circumstances. In the SARA, there are sections on agreements and permits related to incidental harm. This is a potential mechanism to allow the incidental, non-directed harm of a species that is in recovery. The recommendations about what incidental harm is permitted should be in the Recovery Strategy, although the Recovery Strategy is not required for an Extirpated species until two years after it is listed by the SARA. Over the next two days, we will attempt to make an evaluation as to whether or not incidental harm could be allowed for this population of Atlantic Salmon. The Act also has a section on enforcement measures.

Section 73 (2) of the SARA provides the competent ministers with the authority to permit normally prohibited activities affecting a listed species, its Critical Habitat, or its Residence, even though they are not part of a previously approved Recovery Plan. Such activities can only be approved if:

- a) the activities are scientific research relating to the conservation of the species and conducted by qualified persons;
- b) they will benefit the species and are required to enhance its chance of survival in the wild; or,
- c) affecting the species is incidental to the carrying out of these activities.

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The agreement may be entered into, or the permit issued, only if the competent minister is of the opinion that:

- (a) all reasonable alternatives to the activity that would reduce the impact on the species have been considered and the best solution has been adopted;
- (b) all feasible measures will be taken to minimize the impact of the activity on the species, its Critical Habitat or the Residences of its individuals; and
- (c) the activity will not jeopardize the survival or recovery of the species.

Discussion will consider alternatives to activities and feasible measures to minimize impact as well as Recovery Targets and rates of recovery based on science.

(Q) Will this apply to populations that are stocked in the U.S. waters?

(A) They are covered by the SARA when they are in Canada regardless of where they breed or where they came from.

(Q) DFO seems to be struggling with the concept of Residence as it applies to aquatic species. It seems that Residence was designed for lairs, dens, and other real inhabitable spaces used by terrestrial species. Is that the intent?

(A) It is not so much an inhabitable space but something that is constructed by the species. The SARA has quite strong provisions to protect Critical Habitat of the species but there was concern that a bird's nest or something an animal made, might not be considered to be habitat as it is not a natural part of the environment. To ensure that something the animal made for itself would be protected, Residence was identified under the Critical Habitat provisions. It could be argued that a salmon redd could be considered a Residence but anything else is part of habitat.

(Q) Will de-listing be discussed?

(A) Although it is not specifically on the agenda, it is difficult not to think about de-listing in general when thinking about recovery targets.

When talking about recovery under the Act, we are talking about what a recovered healthy Atlantic Salmon population would look like for Lake Ontario and designing a program to achieve that. Somewhere on the path to achieving that, the population will no longer qualify as being at risk and be de-listed. Once it is de-listed, whether to stay on the recovery plan or not is a policy choice. We recover, or try to recover, many fish populations which are not at risk of extinction but are in need of rebuilding to a healthier state than they are in now. So we need to design a program to rebuild what we consider a healthy, recovered Atlantic Salmon population for Lake Ontario, not one that is marginally above a limit that would qualify for a risk of extinction.

If the projected recovery of a species was plotted over time, there would be points along the trajectory when the populations would be considered as being in a critical, cautious and healthy state. The boundaries between these states are reference points. There has been debate about when a population is considered recovered, when it reaches the cautious state or when it reaches the healthy

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state. In the discussion of Recovery Targets for Lake Ontario Atlantic Salmon, we should consider effective population size and attempt to decide what the effective population size would be at the boundaries between the states.

(Q) Are permits restricted to individuals?

(A) Yes. In a marine fishery, if there is a listed species that may be taken as a bycatch at a lower rate, every licence holder in that fishery must have an individual permit to have that species on their deck. If Lake Ontario Atlantic Salmon is listed, and if there are sport fishers in Lake Ontario who could hook an Atlantic Salmon, they must individually have a permit.

Also, directed catch may be allowed if it is conducted under another Act of Parliament; however, the scope of this has not yet been resolved. Directed catch of Aurora Trout (*Salvelinus fontinalis timagamiensis*) is allowed but the support was related to the Ontario Fisheries Regulations supported by the *Fisheries Act* as opposed to the SARA.

In the Inner Bay of Fundy, the only permit issued for Allowable Harm was for science. Fisheries Management advised the Minister, that all reasonable steps had been taken to protect the few hundred remaining fish. One hydroelectric facility was allowed to proceed with a project because of its contribution to minimizing upstream and downstream mortality. Bycatch, including sport fishing, is at a very low level and all fish could be returned alive. Now that the number of animals is increasing because of the input from stocking, 'permitting' may have to be revisited.

Activities may be allowed if they are explicitly described in the Recovery Strategy for the species. In the case of Aurora Trout, fishing is not permitted in their original native habitats but there is stocking of outside lakes, where fishing is allowed (as an activity described in the Recovery Strategy). It is permitted because it is considered to be beneficial to the species from a public education perspective and is viewed as an essential component of the overall species recovery.

(Q) Are we going to talk about how it became designated as Extirpated instead of Extinct?

(A) Yes. This is the designatable unit/genetics discussion that we are going to have.

## **THE RESTORATION PLAN**

Author and presenter – Marion Daniels

Atlantic Salmon was a native species in the Lake Ontario watershed, part of the original fish community, when the early settlers arrived in southern Ontario. It had an important ecological role in the offshore zone of Lake Ontario, and was considered part of the natural and cultural heritage of this area. Atlantic Salmon are considered to be indicators of environmental health and are highly valued as a sport fish. Atlantic Salmon disappeared from Lake Ontario in the late 1800s. A restoration plan was established by the Ontario Ministry of Natural Resources (OMNR) in 1995 with research focused on factors which would enable restoration. The objective of the plan was to restore a self-sustaining population of Atlantic Salmon back to Lake Ontario. Restoration of Atlantic

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Salmon supports the bi-national objectives set for Lake Ontario and for a number of Lake Ontario tributaries and is also consistent with Ontario's new biodiversity strategy.

Research and restoration efforts based on landscape-level analyses were focused on the Credit River, Duffins Creek and Cobourg Creek. Stocking in the three streams has to increase to meet restoration objectives, saturate available habitat and allow detection of returning fish. The current targets, limited by the capacity of the brood stock, are 400,000 fry, 100,000 fall fingerlings, and 50,000 yearlings in total for all three streams. Stocking densities should range from 2-4 fish/m<sup>2</sup>. The hatchery strain currently used is from the LaHave River, Nova Scotia but plans are underway to add two new stocks: the Sebago, a landlocked stock from Maine, and either the Restigouche stock from New Brunswick or the Cascapedia stock from Quebec, both of which are sea-run stocks. The performance of the different strains needs to be assessed.

The benchmark for survival and growth of fry stocked in the spring was 5 fish/100 m<sup>2</sup> by the fall. This was exceeded at over half of the sites studied with the highest density over 120 fish/100 m<sup>2</sup>. There is evidence that fall fingerlings do overwinter and survive to smolt stage and there have been some returning adults to the stocked streams in the past, particularly to the Credit River. Atlantic Salmon can grow and survive well from the fry stage to the fall fingerling stage and, if they are stocked as advanced fry or feeding fry, they survive better than if they are stocked as swim-up fry that had not been fed in the hatchery. Knowledge gaps include what happens to Atlantic Salmon when they smolt, particularly during their first year in the lake, and assessment of adult returns and wild production.

One of the research goals has been to determine if the stream habitat is suitable for producing Atlantic Salmon. They survive best in areas with lots of instream cover, boulders, etc. Although their nursery habitat requirements are known, the quantity and quality of spawning and nursery habitat available to them is not. Research is also underway to look at potential interactions between Atlantic Salmon and Rainbow Trout (*Oncorhynchus mykiss*) which are naturalized in most of the good cold-water streams that flow into Lake Ontario. There was reduced survival of Atlantic Salmon in the presence of Rainbow Trout; however, where there is optimum or good quality habitat and lots of habitat both species did very well.

A small number of Atlantic Salmon are currently harvested by the boat sport fishery on Lake Ontario which mainly targets Chinook Salmon (*Oncorhynchus tshawytscha*). Under the current Atlantic Salmon sport fishing regulations, streams are closed year-round and there is a limited fishery in the lake of one fish over 63 cm (25") in length. Identification of Atlantic Salmon by anglers, however, is poor.

There are challenges to restoring Atlantic Salmon to Lake Ontario. The Lake Ontario ecosystem and aquatic communities have changed dramatically, in response to invasive species and human activities in the basin, since the 1800s. There are naturalized non-native salmon and trout and a non-native prey base. Alewife (*Alosa pseudoharengus*), the dominant prey species for salmon and trout, contain high levels of an enzyme, thiaminase, which can result in thiamine deficiency, causing Early Mortality Syndrome (EMS) in some salmon and trout. Barriers in the streams, although much fewer than in the past, are still an issue preventing adults from reaching suitable spawning habitat.

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### Discussion

(Q) Is there anything known about interactions in the lake between Chinook Salmon and Rainbow Trout?

(A) No. There are plans to look at the fish community structure in the spring to see whether the out-migrating smolts are encountering adult salmon and trout and whether there are any negative interactions occurring.

(Q) Is it clear if there will be a displacement of Chinook Salmon if the Atlantic Salmon become well established?

(A) There is competition for food between the species. Chinook, however, far outnumber Atlantics and would likely out-compete them. It is unlikely that Atlantic Salmon would displace Chinook Salmon. Despite all the wild reproduction initiatives for Chinooks, there is lots of natural production but genetic and stable-isotope analyses show that there is close to zero wild recruitment. There are lots of wild smolts going out into the lake but what is coming back are all fish that were stocked. As long as activities continue the way they are, there will always be a lot more Chinook Salmon. Ontario stocks far fewer Chinook Salmon than the U.S.

The SARA is one of the few Acts in Canada related to the environment that has the reverse burden of proof built into it. The Minister has to be satisfied that an activity poses no threat to recovery before he can allow the activity. So if there is uncertainty, a problem is assumed until we are sure there is not, rather than the other way around. If we are not sure whether the Chinook Salmon present a problem to Atlantic Salmon recovery, then it is an issue that has to be discussed thoroughly and has implications for the Chinook Salmon stocking program.

(Q) Are the Americans stocking Atlantic Salmon?

(A) Yes. They have high stocking rates (several hundred thousand yearlings). They are trying to provide a "put-grow-take" fishery for Atlantics. They are very supportive of the Ontario program and recognize that Ontario has stream habitat that they may be lacking. They have a summer run of Atlantics on the Salmon River which is one of the larger rivers on the south shore.

(Q) Are they stocking the same strain as in Ontario?

(A) They used Sebago Lake (Maine) strain in the past but may now be using a mixture. They were stocking three different strains to look at performance in the fishery; one of which was from Sebago Lake and another from West Grand Lake, also from Maine. Based on clips and returns to the fishery, two predominated in the fishery (in the lake) while the third strain were the ones running up the river. The United States Geological Survey was planning to assess the strains of Atlantic Salmon. Both the U.S. and Ontario jurisdictions would stock one strain in common to compare the results. They are using the Sebagos strain and want to use a strain from the run in the St. Mary's River at Sault Ste. Marie Ont/Michigan) which was founded from West Grand Lake. It is doing quite well in the St. Mary's River, where there is a strong run with a large number of returning adults that is maintained by stocking. It is a very popular Atlantic Salmon fishery but there is no sign of wild reproduction.

(Q) How much is known about the St. Mary's stock?

(A) There are life-history, thiamine deficiency and thiaminase data (EMS).

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Comment.

The important issue is the degree to which there is evidence of natural reproduction and recruitment. Atlantic Salmon are being produced but not recruited. In Pacific salmon there is substantial wild reproduction but no returns, so there is a gap in the life cycle. They are meeting all the characteristics required for the *U.S. Endangered Species Act*. They are meeting all the different benchmarks required for recovery but there is a complete disconnect between the components. The objective is a self-sustaining population but they are not self-sustaining. Rainbow Trout populations, however, are self-sustaining so that stocking seems to have very little contribution to them.

**There appears to be no evidence that hatchery-stocked juveniles are being recruited, suggesting the Lake Ontario Atlantic Salmon population is not currently self-sustaining.**

(Q) Have wild Atlantic Salmon been observed?

(A) There have been a couple of Atlantic Salmon observed in streams that were not stocked, so there is anecdotal evidence for wild Atlantic Salmon. A concerted effort is needed to look at adult returns in the three streams that have been selected.

(Q) How were the benchmarks for success chosen?

(A) They were based on observations from elsewhere. Several benchmarks have been tested and the results were in the right ballpark for the benchmarks that were set.

(Q) Were the stocking rates chosen from past experience, theoretical rates or what the hatchery could produce?

(A) The three streams were assessed for the quantity and quality of habitat that can be managed for Atlantic Salmon. A stocking target of about two million fry equivalents has been set but that will be refined as more is learned about the supply of habitat. For now, stream kilometres and average width of the stream is used. Cut-offs such as maximum water temperatures are set. There are expectations for salmon and trout production based on the Rainbow Trout work. Habitat quantity and quality has to be ground-truthed.

Stocking densities of 2.4 eggs/m<sup>2</sup> provides optimal growth and survival rates based on 15 years of stocking data.

(Q) What is the rationale for the 63 cm limit in the lake fishery?

(A) In the mid-1990s the New York State regulations were adopted to be consistent. The intent was also to develop a trophy fishery. That size may have to be revisited as stocking increases.

(Q) Would fish that are 63 cm in length be pre-spawning based on the returns from the Credit River?

(A) It is unknown whether there are biological data from the Credit River.

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## **SPECIES STATUS**

Author and Presenter – Nick Mandrak

A draft RPA document was provided to participants prior to the meeting. The material in the species status section comes from the COSEWIC status report.

The first sentence should be changed to read, “Lake Ontario population” rather than, “populations in Ontario”. In the last part of the paragraph it says “it is probable that the Lake Ontario Atlantic Salmon population was geographically and reproductively isolated from other Atlantic Salmon populations in North America. Ongoing genetic studies to test this hypothesis are constrained by small sample sizes (COSEWIC 2006)”. This will be discussed in detail.

(Q) Atlantic Salmon were distributed all along the north shore of the St. Lawrence and in the Gulf of St. Lawrence. Most of the rivers had Atlantic Salmon including the Ottawa River and all the suitable streams all the way to the north shore of Lake Ontario. How could they be isolated prior to the dams on the St. Lawrence in the 1930s? Did Lake Ontario Atlantic Salmon remain in the lake or move down the St. Lawrence? There should have been nothing to prevent them from going to the ocean as there were no barriers on the St. Lawrence, just rapids. Many other salmonids will make use of opportunities when presented with them. Should the sentence read “it is possible” that Lake Ontario strain was isolated from other populations instead of, “it is probable”?

(A) The wording will be addressed if there is new evidence to suggest it is required.

## **POPULATION STATUS**

Presenter – Nick Mandrak

Much of the material for this section of the RPA came from the COSEWIC report. There are no early population estimates for Atlantic Salmon in Lake Ontario. Anecdotal accounts suggest that Atlantic Salmon were abundant in the lake and its tributaries during colonial times. Although no records of salmon catches are available, it appears that the population declined steadily through the middle of the 1800s reaching a low in the 1860s. A brief recovery was observed in the 1870s. In the 1940s, Atlantic Salmon were re-introduced to tributaries of Lake Ontario and an experimental stocking program began in 1987.

The last paragraph on Trout Lake should be removed because it is not part of this designatable unit. The Trout Lake population resulted from an introduction in North Bay.

## **DESIGNATABLE UNIT**

Presenter – Chris Wilson

### **Evidence for Distinctiveness**

In order to establish the appropriate status, an attempt is being made to determine the genetic relationship of the population which disappeared over a century ago. When the provincial restoration plan for Lake Ontario was started, there were widespread rumours that there were surviving Lake Ontario fish in Patagonia (southern South America).

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There were some records suggesting that Lake Ontario fish had been stocked into inland lakes in New York and that inland New York populations were used to introduce Atlantic Salmon in Patagonia. Data from the historical population were needed to test this theory. An attempt is being made to extract genetic data from taxidermy mounts in the Royal Ontario Museum (ROM) collection from some of the last fish caught in Lake Ontario.

There is little direct evidence with which to characterize Lake Ontario Atlantic Salmon and compare them with other populations in North America. There is strong evidence that there were separate North American and European refugia during the last glaciations, though within North America there is no evidence for more than one refugium. This species is thought to be comprised of two evolutionary significant units: a European group and a North American group. Within North America, there are designatable units in Canada recognized by COSEWIC. There are also several distinct population segments, based on a mix of ecology and genetic evidence, under the *U.S. Endangered Species Act*.

A general pattern has been identified on the basis of multiple lines of genetic and biogeographic evidence using several different approaches to analyse the data (allozymes, mitochondrial DNA, microsatellites, etc.). Although there are populations throughout the entire extant North American range, there is very little variation present within North America (i.e., much less than 1% divergence among almost all the populations). There is a lot more variation present in European Atlantic Salmon. The only evidence for substructuring is found within the populations which may have received some European input (northern Labrador and Newfoundland). Lac St. Jean, which is the only known large freshwater waterbody supporting Atlantic Salmon, has a population that is distinct from other river populations with both inlet and outlet spawners.

There is little support for genetic distinctiveness of the Lake Ontario population. They differ from the other Atlantic Salmon because they live in a large freshwater lake. COSEWIC considered them a Designatable Unit (DU) based on the aquatic ecozone in which they live and potentially their ecology. The ecozone covers Lake Ontario and the St. Lawrence as far as Quebec City.

(Q) Where did the Patagonia fish come from?

(A) They were not from Lake Ontario but were likely from West Grand Lake in Maine.

(Q) Are Lake Ontario Atlantic Salmon a DU or at one end of a continuum?

(A) Looking at the multidimensional scaling plot only the Inner Bay of Fundy appears to be distinct. This suggests that there is a continuum and gene flow between all the tributaries in Lake Ontario. There is basically one core North American group, there is Newfoundland and Labrador with varying degrees of European input and then there is eastern Nova Scotia. So maybe there is an ecological argument, as opposed to a genetic one, for Lake Ontario Atlantic Salmon being a DU.

### **Extirpated versus Extinct**

In general, a designation of Extinct is applied to species or higher taxonomic classifications although some might consider the subspecies or species level appropriate

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for either Extirpated or Extinct. It is meant to address the evolutionary significance or the unique evolutionary history or adaptive resources of a species. How unique was the Lake Ontario population? If something is extinct it is an irreplaceable loss, you cannot get it back no matter how hard you try. If something is extirpated, it is gone locally but it is potentially a replaceable loss. So it really depends how unique Lake Ontario Atlantic Salmon were from an ecological standpoint. There is no support for the population being unique from all other North American populations based on the genetics data but if they were the only freshwater population from a truly landlocked large waterbody that may well have been a unique ecological element for the species unless it is parallel with those in Lac St. Jean. Was the loss of the Lake Ontario population a permanent irreplaceable loss or a case where restoration could bring back a functioning member of that ecological community?

#### Comment

How does a group decide in a consistent way whether to apply the label Extirpated versus Extinct when a species is no longer present in an area? The precautionary approach is meant to guide decision making and is referred to in the SARA. In this situation, the precautionary approach would be to make the decision that will guide conservation in the most constructive way possible. If there is no convincing evidence that the unit was distinct enough, that there is no chance to replace it, the precautionary approach would be to assume there may be and try. If a species is extinct, nothing needs to be done, it's gone for ever.

(Q) What is the COSEWIC definition of Extirpated?

(A) The designatable unit no longer occurs in the area where it was defined but the genome itself may be replaceable from somewhere else.

(Q) Is the spirit of the Extirpated designation intended to facilitate conservation and recovery efforts?

(A) That was the logic. In cases where, on the basis of genetic evidence there is uncertainty about the uniqueness of the entity that is no longer present, the conclusion would be that it is extirpated so that conservation measures can be taken, just in case. It guides conservation in a more constructive way and sets higher standards for it.

(Q) What were COSEWIC's criteria? If it was genetically distinct, it would have been designated Extinct. What was the basis for the Extirpated designation, its geographic isolation or ecological distinctiveness?

(A) The majority of information available on life-history differences suggests that the salmon that originally inhabited Lake Ontario were most likely a non-anadromous (freshwater) form which would be distinct from all the other sea-run populations.

(Q) So it was different/distinct life histories, not geographic isolation, which made them decide that Lake Ontario Atlantic Salmon are distinct from other populations?

(A) Yes.

#### Comment

It is likely that if fish from other populations of Atlantic Salmon were introduced into Lake Ontario they would likely adopt the unique life history of the Lake Ontario population even though they are not currently exhibiting those traits. They are not currently in a body of water big enough where they can complete their whole life-history and mature

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without going to sea. There are other landlocked populations of Atlantic Salmon but what makes Lake Ontario so distinct is its sheer size. In the other landlocked populations, there are spawning runs up into streams that then smolt out into the lake the way they would have done in the Lake Ontario population. In the landlocked populations, there is a mixture of inlet and outlet spawners.

#### Comment

Does it matter whether the Lake Ontario population is called Extinct or Extirpated, or is it more important to bring back a functioning self-sustaining population of Atlantic Salmon in the lake? What is the best way to go about restoring the ecological function of this population and its former membership in the native fish community? From a scientific perspective, the evidence suggests this population is Extirpated, and that they weren't unique enough to qualify for a designation of Extinct. Based on the evidence, Extirpated is the correct designation but could cause problems for on-the-ground recovery efforts. Maybe the Lake Ontario population should be recognized as Extirpated and not listed.

(Q) Is there an opportunity to discuss the advisability of listing from either a scientific perspective or a conservation perspective?

(A) No. The decision on listing must take into account socio-economic issues that are part of the RPA discussions. The ecological and biological consequences of listing or not listing can be discussed as are the consequences of the two choices from an ecological perspective without passing judgment on them because they are not the whole part of the decision.

(Q) It is paradoxical if listing under the SARA would actually impede the recovery effort. Can recommendations on designation as well as recommendation of whether or not to list be made?

(A) No. That is going beyond our mandate because the listing decision is not based solely on what we do unless there are ecological reasons why listing is a bad choice. The public consultations and the comments on the SARA registry have to be considered in listing decisions and socio-economic assessments would consider other non-biological issues.

**Participants agreed that the best conservation approach would be to treat Lake Ontario Atlantic Salmon as a Designatable Unit and Extirpated.**

## **RECOVERY TARGET**

Discussion Leader- N. Mandrak

The goal of restoration is to re-establish a self-sustaining population of Atlantic Salmon in Lake Ontario and its tributaries but it is not usually defined as a quantitative Recovery Target. Maybe population size is not the best Recovery Target for this population. On the East Coast, a minimum effective population size for Atlantic Salmon has not been established although the theoretical minimum *effective population size* ( $N_e$ ) for freshwater fishes ranges from 50 to 500 spawners per year per river. It has been suggested that 500 is a more cautious target. The total number needed is extrapolated using the *effective size:census size* ratio which ranges from 0.26 to 0.88 for salmonids on the East Coast. Each selected river in Ontario should have a Recovery Target of, from 500 to close to 2000, adults in total.

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The important issue with *effective population* size is that just having the numbers you can see is not sufficient to sustain the population. The *effective population* size considers spawners which are contributing effectively to the next generation. The 50-500 census range would be much larger than this in reality. The number needed must over-ride genetic drift and resist environmental stochasticity (changes). These targets can be influenced by things like habitat supply, and meta-population dynamics if gene flow takes place between streams. So there are other things that influence minimum effective population size. With a fry-to-adult survival rate of 0.0008 (i.e., 1,250 fry to get 1 adult return), 2.5 million fry per stream are needed.

(Q) What is the census ratio?

(A) It is the number of adult individuals that can be seen and counted.

(Q) Has a Recovery Target for Inner Bay of Fundy salmon been accepted?

(A) No.

It is assumed that recovery is feasible. To put the Recovery Target into context, DFO concluded that a recovery target does not simply mean that a population is no longer at risk of extinction. To say a population is recovered, is to say that population is at a state where a group of scientists doing an assessment would conclude that the population is healthy and there is no ecological reason why you would want to rebuild it further. This would put the population into the healthy zone not just at the point where you are beginning to see some acceleration up the cline.

## **EFFECTIVE POPULATION SIZE**

Discussion Leader – J. Rice

(Q) Does effective population size apply to every river regardless of size? What about smaller rivers? The three rivers chosen will not support the number of fish required according to the effective population size yet they supported healthy populations of Atlantic Salmon.

(A) Yes, it is per river regardless of the size of the river. Maybe habitat supply is no longer the same as it was historically.

The idea of local effective population sizes has a terrestrial perspective. Aquatic species don't necessarily stay in one place. For example, one population of Brook Trout in Lake Superior use multiple tributaries. The fish go out in the lake and when they are ready to spawn, they pick a convenient tributary. If this applies to Atlantic Salmon in the lake, then local numbers may not represent the true effective population size or gene pool or number of fish that are potentially interacting and reproducing. They may be spread across a number of tributaries. On the north shore of the St. Lawrence, where the genetics evidence shows there is massive movement going, it is not reasonable to treat the different spawning runs as separate populations and expect several thousands of fish per habitat.

(Q) Historically, was there an effective 500 spawners in every single tributary to Lake Ontario?

(A) The unit is the whole interbreeding population. If a particular river had been the only source, it might be the Lake Ontario Atlantic Salmon would have been teetering

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on a conservation crisis for most of its history. And the reason there is a healthy spawning population year after year after year, even though individually it didn't have an effective population size greater than 500 spawners, was because the pool from which it drew was larger.

The fish that will be stocked in the rivers will come from a common background. If several reproductive runs, natural reproduction and natural recruitment are successfully established, they will have recent shared ancestry and will be the same gene pool. It would take hundreds of generations for them to significantly diverge to the point where they will no longer mix. So from an evolutionary perspective, effective population size is a useful concept.

The assumption has been made that the self-sustaining population is at the level of the lake. Atlantic Salmon will exploit any river that is suitable and the three rivers that have been identified now for Recovery Plans are basically the first three rivers. A self-sustaining population is not being defined for the three rivers. It is the entire lake and any potential river that can be used. If the three rivers are the only ones seeded, then determining how many rivers have Atlantics after five generations will provide an indication of the importance or significance of gene flow.

**The Recovery Target should be considered on a lake basis not a tributary basis.**

(Q) What of fish that return to the U.S. side to spawn, in terms of population size? Is the domain to include all potential spawning habitat that is available to the fish or just the Canadian spawning habitat?

(A) Based on other COSEWIC reports, the Canadian population would be the focus with the U.S. populations providing a potential rescue effect.

(Q) If the Americans don't do anything with their potential Atlantic Salmon spawning streams, then would they ever be de-listed regardless of how successful their reintroduction is on the Canadian side?

(A) In that case one may conclude that Atlantic Salmon in Lake Ontario are no longer at risk of extinction and could be de-listed but achieving a biologically based Recovery Target of a healthy population in Lake Ontario may never be possible. Recovery is not about de-listing; recovery is about recovering a population to a healthy state.

(Q) What criteria are used to de-list then?

(A) COSEWIC assesses risk based on the set of criteria (available on their website) to list; once the population is listed, the Act requires a reassessment a minimum of every ten years and sooner if a scientifically sound status report is submitted by an expert who feels there is cause to look at it even sooner. There are no separate criterion for de-listing, only criteria for listing and they have to be applied at a minimum every ten years once as species is listed. As soon as it doesn't qualify, the jurisdictions have the right, following consultation, to de-list (not be listed or listed lower). There is a contradiction in the Act for a population that has qualified on the basis of the decline criteria and that is the key reason why it is listed; it never has to increase one fish. After 30 years or three generations if it does not decline further, then it would fail to qualify, as it has shown it is not at risk of extinction at that level. It will be de-listed in due course.

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The criteria for Special Concern are so loose, that things can be Special Concern in perpetuity. They are not based on quantitative criteria, but on threat or perceived threat.

One of the things that must be done under the Act is to specify the Recovery Target in terms of population size or abundance and range and there is no discretion there. The Act is silent on describing how to get there. The targets are needed for the consultations on what recovery would mean in terms of socio-economic impacts. What is proposed on a science basis to fulfill those provisions of the Act (section 41.(1)(d)) becomes part of the overall strategy of how to recover the population and the Action Plans describe the plans for each phase.

Recovery in the whole lake (Canadian side) may not require spawning populations in every stream that ever had Atlantic Salmon in it, but would want naturally-spawning populations in enough streams that risk to some wouldn't jeopardize survival of the whole population. In certain years some streams are going to do well while others will not.

(Q) How is range defined for a spawning fish? Does it have to be defined by the spawning habitat or the lake habitat?

(A) COSEWIC defines two levels: the Extent of Occurrence (EO) which is the convex polygon of the extreme points in the distribution and the Area of Occupancy (AO) which would theoretically be the habitat level measurement.

(Q) The Recovery Target and range needs to be identified in the Recovery Plan but do they need to be identified in the RPA or is the assessment whether the population can be recovered?

(A) Yes, it needs to be identified in the RPA because the product of this meeting is to provide everything that DFO Economics Branch needs to go to the public with. When they consult, they must indicate what it would mean for the public if the species is listed and what it will mean if it is recovered.

The Minister wants a science basis for the choice of a Recovery Target. The Recovery Team may or may not use the same Recovery Target. They may choose to aim higher but the Department would be vulnerable if the Recovery Team chose a lower Recovery Target than what was recommended by Science in an RPA. The RPA is the chance to provide advice on what the Recovery Team should use as a starting point for the Recovery Target in a Recovery Strategy. The RPA would be the primary mechanisms for developing science advice to the Recovery Team. All Sectors have a chance to review and provide comment on the Recovery Strategy.

## **ALLOWABLE HARM**

Authors - Antonio Vélez-Espino and Marten Koops

Presenter – Antonio Vélez-Espino

Principle reviewer – J. Gibson

Atlantic Salmon were extirpated from the Lake Ontario basin by the end of the 19<sup>th</sup> century. Continuous restocking attempts have been unsuccessful in establishing self-sufficient populations. Efforts to restore self-sustained Atlantic Salmon populations in

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Lake Ontario have triggered an initiative to conduct a Recovery Potential Assessment (RPA) by Fisheries and Oceans Canada (DFO). An RPA consists of three phases: species status, scope for human-induced harm (Allowable Harm), and mitigation.

We provide a demographic perturbation analysis to assess the maximum Allowable Harm (AH) and minimum recovery targets for Lake Ontario Atlantic Salmon (LOAS). Our results indicate three main points. Firstly, the existence of a recreational fishery for LOAS and management efforts to improve population performance can coexist through the simultaneous implementation of effective fishing regulations and recovery strategies. This is because the most sensitive stages of the species are the YOY, age 1+ and smolt stages, not adults. Secondly, the most effective and feasible way of improving population fitness is through the survival rates of pre-maturing individuals. Thirdly, the current catch size limit of 63 cm is a conservative, risk-adverse regulation when matched with a maximum allowable fishing mortality of 28% (or 2% taking the precautionary approach) through control of the annual number of permits with the concession of keeping one fish per day.

(Q) Do each of the perturbation rates alone assume the other perturbation rates are zero, so if you added them all together the population would crash?

(A) Yes, the elasticities are cumulative. For example, if you add the positive perturbations together (an increase in juvenile survival by 10% plus an increase in fecundity plus a decrease in angling pressure), in theory you will reach your Recovery Target faster.

(Q) How does the model take into account the fact that for the next decade or so we're going to be stocking a large number of these fishes in the streams; that is to say we are going to be saturating habitat?

(A) Any stocking produces an artificial increase in population growth but it depends on how they survive after stocking.

(Q) How do you interpret the 0.37 on the habitat side?

(A) This is the effect of the ratio of habitat supply to demand on survival rates i.e., if there is a 37% loss in habitat for these age individuals there will be a decline in survival rates.

(Q) What do those numbers in the circles mean in the maximum Allowable Harm table?

(A) From a precautionary approach, we choose the one that causes the least amount of harm.

(Q) Is the biggest issue for Atlantic Salmon in the lake/ocean? Is it their first year or two in the lake or ocean and not in the streams?

(A) This presentation is based on Maine landlocked populations. Different results are seen if it is based on an anadromous population. The first three stages that are most sensitive to mortality are YOY, age 1+ and smolts, which is consistent with work that suggests that smolting stages are very sensitive to increased predation, etc., as they make their way to the lake/ocean.

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(Q) I always thought the early life-stages are compensatory, more YOY are produced than adults, etc. so juveniles are less sensitive than older life-stages, but it looks like the opposite in your calculation.

(A) The example does not take into account the effects of density. The elasticities would change substantially if density were taken into account.

#### Comment

In order to build a density-dependent equation you need very good data, (i.e., time series data), but we have poor data so we didn't do it. Our model is based on the precautionary approach.

(Q) How would you interpret the numbers you presented (i.e., a 7% decrease would be enough to jeopardize the population for that life-stage) to get a self-sustaining population given that it is a population already in decline without the stocking?

(A) We would reduce lambda (the rate of growth or decline) to less than 1. This would change the numbers in the table dramatically such that it would take less harm to jeopardize the population.

(Q) When Lake Ontario data are compared to the data from Maine, there seems to be a big difference with size at age and very different consequences with hooking and fishing mortality.

(A) Yes, but it doesn't have an effect on survival rates, whereas, a change in fecundity might have an effect.

#### Comments

The growth rates of Lake Ontario Atlantic Salmon are probably different now compared to the 1980s and 1990s.

The suggestion that the 28% Allowable Harm for fish 63 cm in length could be controlled through the number of permits issued to anglers may not be an option in Ontario as there is no control on the number of permits issued in Ontario right now. It may require changes in fishing season, closures, fish sanctuaries, etc.

(A) It is not Science's role to give management options. Science's role is to emphasize the amount of harm that is allowable and then managers must make a decision on how to manage it.

(Q) Should density dependence be included? Density dependence is typically built into the fisheries models used on the East Coast. Once density dependence is included, the vital rates (i.e., YOY survival, age 1+ survival, fecundity, etc.) change as a function of the population size.

(A) The model can incorporate density dependence and many other things if you have the data for it. We don't have those data for Lake Ontario Atlantic Salmon.

(Q) Could Rainbows be used as a surrogate species? There are 15 years of data including good time series of data for spawners, etc.

(A) We have to consider what some of the implications are here and what conclusions would change if density dependence was included in the model.

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- (Q) I have a problem with the idea that the mortality of older fish doesn't really have an effect: if these are fish that spawn, their removal would affect the recruitment rate. If density dependence was included there would be a different outcome.
- (A) There is strong density dependence between age 0 and 1.

- (Q) At what sort of population density do you see this happening?
- (A) It is a curve, so there is always some level where it applies.

- (Q) Have you been modeling it such that if you have two fish, and onwards, there is a density-dependent effect?
- (A) Yes, that is basically the idea. This is worth thinking about and discussing but the question is, is this the analysis upon which to base recommendations about fisheries?

#### Comment

It is difficult to make a convincing case that density dependence is acting on adults in the lake when so few are surviving. In the short-term, it's not a major problem, but in the future it might be worth thinking about. No matter how we look at the model there is not a lot of room for Allowable Harm regardless of density dependence.

#### Comment

In other RPAs where the goal is to attain a healthy, self-sustaining population, consideration is given to the historic information that exists. A population is not considered healthy until it reaches about 20% of its historic abundance. There are no data for Lake Ontario Atlantic Salmon historical numbers but there is a lot of anecdotal evidence. The minimum that can be inferred from this information is that a target of a few hundred adults is going to be difficult to reconcile with a vision of what a healthy population would be. If there are 40 or 50 thousand individuals coming back to spawn, the population may be considered recovered. The public may not consider a few thousand as recovered but they may consider a few tens of thousands sufficient. What to expect tributary by tributary needs to be known. If, for example, the goal is to have 30 thousand Lake Ontario Atlantic Salmon adult spawners survive each year basin-wide, taking into account mortality from fishing, spawning, etc., how many productive rivers are needed? Would six rivers (i.e., approximately 20% of 27 known Ontario Atlantic Salmon rivers) give the number of spawners needed for this example? Is there some biological reason why these numbers are unrealistic?

- (Q) This is based on a 1:1 sex ratio but this may not be the case.
- (A) For a very coarse recovery target a 1:1 sex ratio can be used. However, recommendations can be based on only the number of female spawners as all the demographic modeling was done using numbers of females.

How many fish would have to be stocked to get 30 to 40 thousand spawners? We want spawners produced naturally. Stocking is a route to get there, but as long as they are stocked they are not included in the population estimates for spawning adults.

- (Q) Are these numbers comparable to what is being done for Rainbow Trout?
- (A) Yes, they are close to what was seen for Rainbows.

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(Q) Does the lake have the productive capacity to support Lake Ontario Atlantic Salmon?

(A) Yes, but it is going to come at a cost to other species.

Comments

There is a bi-national stocking limit of 6 million fish for Lake Ontario. There are a lot of other salmonids now that were not there historically so 20% of Atlantic Salmon historic levels will not be reached because of the other pelagic salmonids now present. Lake Ontario Atlantic Salmon would never reach their carrying capacity now. Co-habiting species in the streams will also reduce the carrying capacity for Lake Ontario Atlantic Salmon.

It is feasible to aim for 20% because stocking of Chinook Salmon could be stopped or reduced and will open up the carrying capacity for pelagic salmonid species including Lake Ontario Atlantic Salmon. We should assume that 2.4 eggs/m<sup>2</sup> is related to historic numbers and go from there.

Participants had no strong opposition to using 20% of historic abundance as a target although they expressed some uncertainty with where the value came from.

**The consensus from the meeting participants was that the Recovery Target should be based on the number of spawners returning each year with a target of 20% of historic levels.**

(Q) When you don't have much of a population to begin with how can you have 2% allowable harm for adult fish longer than 63 cm? Shouldn't there be no allowable harm at all?

(A) The bottleneck is getting the juveniles out into the lake. The difference between 0% and 2% allowable harm of adult fish is not going to change the bottleneck. It won't make a difference to population recovery if the real problem is not dealt with. That is extremely important to put into the consultation dialogue. With the information available, the low level of allowable harm would not jeopardize the survival but it won't guarantee recovery without dealing with the real problem.

(Q) What does the 63 cm limit amount to in terms of a projected mortality rate? It's much higher than 2% isn't it?

(A) This is unknown since harvest levels are unknown. Based on the Maine data, if the Lake Ontario Atlantic Salmon did grow at comparable rates and sizes, you could have a little over 28% allowable harm on the adults. The problem is the historic fishes were not growing at the same rate and size at age. In addition, because of identification issues there is mortality on younger fish (all the way down to age 4 fish). Then allowable harm would be 4% fishing mortality.

(Q) Is 2% as much as 200 or 500 fish, and how does that compare to the returns that we're seeing?

(A) It was assumed that mortality was 1% per month and that not every female spawns each year.

(Q) Can you tell how many spawners would result from the number of smolts stocked last year?

(A) Yes, with some caveats.

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**The consensus from the meeting participants was that an allowable harm of 2% would not be an impediment to recovery, though the bottleneck to recovery is in the pre-adult (YOY, age 1+ and smolt) stages which must be dealt with in order to reach that level of allowable harm.**

## **TIME TO REACH RECOVERY**

There was discussion about when the Lake Ontario Atlantic Salmon population could be expected to be recovered. Since this is the first time an extirpated population is being restored, it is difficult to predict how long it will take to establish a self-sustaining population. Once the first three rivers are self-sustaining, everyone agreed that it would take a few decades to reach a self-sustaining population for the whole system, unlike Rainbow Trout that had perfect conditions to become established. It is already evident that Lake Ontario Atlantic Salmon will not become established as quickly as Rainbow Trout.

## **CRITICAL HABITAT AND RESIDENCE**

Author and Presenter – Bob Randall

Historically, in the 1700-1800s, a large number of tributaries in Lake Ontario supported Atlantic Salmon on both the Canadian and U.S. sides of the lake. The Atlantic Salmon Federation website listed 47 tributaries although COSEWIC listed fewer. The OMNR decided to focus restoration on three specific tributaries (i.e., the Credit River, Duffins Creek and Cobourg Creek) which were selected using comprehensive criteria, including suitable habitat for Atlantic Salmon. The three tributaries were the starting point for the discussion of Critical Habitat.

The tributaries vary in size from the Credit River, the largest, to Cobourg Creek, the smallest. All support a large number of fish species. Community structure is very different from the situation on the East Coast where anadromous salmon are native. The Credit River has at least 57 species including five other salmonids, Duffins Creek has 33 species and Cobourg Creek has 28. There are many more cohabiting species than what is seen in the anadromous native range. Potential competition with other salmonid species may be considered an important threat.

Conservation egg deposition targets required to fully seed the tributaries with Atlantic Salmon would have to be determined. Targets were estimated based on a number of assumptions including 1) a similar proportion of rearing area to drainage area in Ontario to that found in the Inner Bay of Fundy rivers; 2) the conservation target of 2.4 eggs/m<sup>2</sup> used for anadromous salmon applies to Ontario; 3) a relative fecundity of 1.2 eggs per g female based on a landlocked population from Maine applies to Ontario salmon. Returns to date (Credit River) indicate that most salmon that move into the lake stay for one year (one lake-winter) and return at a body size of 1.8 kg. A smaller proportion of salmon stay for two winters and return at 5.1 kg on average. For the Credit River, assuming all females mature at 1.8 kg, it would take 3,600 adult females to fully seed this habitat, using the conservation target of 2.4 eggs/m<sup>2</sup> (smaller numbers of female spawners would be needed for the other two tributaries). If fish are larger and it is assumed all eggs come from 2 lake-winter salmon it would take fewer fish. For

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comparison, the Credit River, based on estimates of rearing habitat, is similar to the Margaree River on Cape Breton Island, Nova Scotia which is quite a large system in that province.

Critical Habitat is the habitat necessary for survival or recovery of a listed wildlife species. Since Atlantic Salmon are extirpated, it is the habitat needed for recovery. Habitat needs are determined by considering the function of the habitat for all life-stages of Atlantic Salmon (reproduction, feeding, overwintering and refugia). Since recovery effort is being concentrated on only three out of the 47 historic tributaries, the entire tributary could be considered critical habitat rather than subsections. The rationale is that threats to survival are significant in the tributaries, the viability of the population is sensitive to survival during the early life stages, and it is consistent with the proposed Inner Bay of Fundy strategy for determining critical habitat (proposed). Greater than 7% reduction in survival of juvenile salmon would jeopardize the survival and future recovery.

It is difficult to identify critical habitat within the lake. It would require knowledge of migration routes and feeding areas, where salmon aggregate within the lake. The large spatial scale of Lake Ontario is a challenge, it is an international waterbody and it would have to be considered in the context of Allowable Harm, permitting, and fisheries management (OMNR). The lake may be a bottleneck (i.e., a determinant of carrying capacity) to the survival of the species. There are also concerns about high egg and alevin mortality (Early Mortality Syndrome) which is known to be significant in other salmonids in Lake Ontario and is related to the forage base. Competition for prey and food supply sets an upper limit to how many salmonids can be supported in Lake Ontario.

(Q) What about nearshore habitat?

(A) Currently nearshore lake habitat use by Atlantic Salmon is largely unknown.

A Residence is a dwelling place such as a den, nest or other similar area or place that is occupied or habitually occupied by one or more individuals. This definition within the SARA has been discussed in the context of Atlantic Salmon on the east coast of Canada. Three types of habitats for different life-history stages were discussed as being potential residences: redds (egg stage); home stones (salmon parr); staging pools (adult salmon). However, recent discussion has focused on residence as being a 'constructed' structure. If confirmed, home stones and staging pools would not be eligible for consideration. Redds, as potential residences, applies to tributaries and not to the lake. Atlantic Salmon have been observed digging redds in Lake Ontario tributaries (Credit River). The DFO policy on Residence is still being developed. Identifying Residence will be deferred until a policy is finalized.

Based on available habitat, recovery is biologically and ecologically feasible in Ontario. Threats to habitat in tributaries and Lake Ontario must be effectively managed. There are areas where research could be focused, including: migration and feeding areas in Lake Ontario, productivity in Lake Ontario, habitat use and survival in the tributaries and potential Residences. Suitability of overwintering habitat may also be an issue.

(Q) Why eliminate staging pools?

(A) Based on earlier discussion, a Residence is a physical habitat that is constructed.

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(Q) When talking about lake habitat, could something be done similar to what was done for Walleye (*Sander vitreus*) in the Bay of Quinte where bathymetric data were combined with temperature and oxygen preferences and water clarity to get that 3D volume-weighted analysis to define Critical Habitat in the lake? What about temperature survival or critical volume? There has to be some critical narrow band that is the first preference for survival.

(A) Possibly, yes. Critical habitat in the lake should be considered part of the Recovery Strategy, as part of the schedule of studies needed for defining Critical Habitat.

The question is whether or not all of the lake is Critical Habitat? You can define what habitat is used by adults in the lake but is it all critical? There appears to be an upper limit, in terms of carrying capacity for salmonids in the lake and it may be predator-prey related. If the prey base is limiting, then this would not necessarily be Critical Habitat issue.

(Q) What about changes to physical habitat in the nearshore?

(A) In the past, stone-hooking and the removal of material that would have provided structure and shelter has changed the habitat quite dramatically.

(Q) On the precautionary approach graph (DFO 2005 Figure 2) where would the minimum biomass be located versus the conservation targets?

(A) A minimum effective population size ( $N_e$ ) of 50-500 would be located at the reference point between the critical and cautious zones whereas the conservation target would be located at the reference point between the cautious and healthy zones.

On the East Coast, the conservation limit of 2.4 eggs/m<sup>2</sup> would be the point of a healthy sustainable population.

(Q) Looking at the graph between rearing and drainage area, the first assumption is that the relationship holds for tributaries of Lake Ontario the same as it does for the tributaries on the East Coast, but we know it does not. Is this a reasonable assumption or does it have a serious flaw?

(A) There are a lot of things that potentially affect this relationship: geology, gradient, nature of drainage basin, etc. The very strong relationship in the Bay of Fundy is based on seven data points; if more watersheds were used there likely would have been more scatter in the drainage/rearing area plot. However, the Fundy data provide a reasonable first approximation for rearing area, pending more accurate information. The OMNR may have an estimate of rearing area which may be more accurate; if this is the case, this value should be used to estimate egg deposition requirements (i.e., 2.4 eggs x rearing area).

(Q) Does it assume that all available habitat is high quality habitat?

(A) No. It includes both high and low quality habitat; the targeted egg deposition would be higher if only high quality habitat is included.

(Q) So the rearing area is really a small percentage of the total drainage – is this because the headstream areas are not being accessed properly?

(A) Rearing area is wetted stream area, while the drainage area is the land area of the entire watershed.

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(Q) How far up the streams do Atlantic Salmon spawn? Is it necessary to designate the whole watershed as being Critical Habitat, or can there be some refinement (i.e., there will be some areas that will definitely not be used)?

(A) This is where the uncertainty of the proportion of rearing area to drainage area applies. In the Inner Bay of Fundy, the rearing area is the actual measured area that salmon use. On the East Coast, as a rule, they move up as far as possible to spawn, so the majority of the wetted area in the river could be used, with exception of first order trout streams and headwaters. It should be noted that all actions in the watershed could affect the spawning habitat, even if the action is in the unused area.

(Q) Did you use the mean age of maturity or the first age of maturity?

(A) First age of maturity was used assuming either average size of one lake-winter salmon or the average size of two lake-winter salmon. The sample size of returning adults to the Credit River was too small to determine mean age at maturity.

(Q) Would there be any use in looking at data for brood-stock hatchery fish, or is that too artificial in terms of fecundity or age of maturity?

(A) Hatchery data would be valuable in terms of fecundity, but it would probably not be in terms of size or age at maturity.

(Q) Would the relationship between rearing and drainage area be a better fit with Lake Ontario tributaries that existed 200 years ago, since the Lake Ontario tributaries have gone through a lot of habitat alterations in the last 200 years? Are the East Coast tributaries comparatively unaltered?

(A) The ones that are used in modelling here may not have been greatly affected by urbanization.

(Q) There has been a suggestion that Hurricane Hazel fundamentally changed the streams because it wiped out the large rocks that the young salmon like to hide behind.

(A) Streams are dynamic and probably would not be changed forever but maybe urbanization is worth considering.

#### Comment

In the landscape analysis, patterns of urbanization were looked at to understand what systems might be impacted in the future. There are improvements in some of the watersheds over time as well. Agriculture has decreased and people are using best management practises. Material that was deposited when the cover was removed initially during settlement is still being moved out of the streams. The point of the streams being dynamic is a good one. The focus should not necessarily be on urbanization, especially for the west end of the lake where agricultural development is far more significant. Fourth order streams are all agricultural drainage.

(Q) Is there any information on whether the size and quality of smolts needed to complete their life cycle in the lake are the same size and quality of smolts that are needed off the Atlantic coast to produce adults, which will swim to Greenland and back? The 2.4 eggs/m<sup>2</sup> is the optimum number to produce sufficient fry for

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productivity of smolts adapted to go to sea for at least one winter. Is that the same number of smolts needed to go to the lake for a winter or two or three?

(A) The target of 2.4 eggs/m<sup>2</sup> applies to anadromous salmon. It is assumed that this target egg deposition would apply to Lake Ontario salmon as well, but the assumption needs to be tested.

(Q) Are those smolts adapted for a sea-going lifestyle?

(A) Yes, the return rates would be some function of anadromy. A 2% return rate was described earlier as a stocking benchmark. It may not be viewed as being sustainable on the East Coast but it might be in Lake Ontario.

(Q) Must Critical Habitat and Residence be defined for the RPA or is that something that can be deferred?

(A) Consultations should include information on the costs to the public to recover the species if it is listed. So if there are things that degrade habitat quality and would have to be managed, or investment would have to be made to make more suitable habitat, then it has to be part of the consultation with the public.

If this was a marine fish where habitat is just not an issue then an extremely vague definition of Critical Habitat would be good enough because there would be no social or economic cost incurred in doing anything about habitat. If, however, recovery of Atlantic Salmon could reasonably be expected to incur a social or economic cost then we are obligated to include it in the RPA, to the extent possible, to inform the consultation process.

#### Comment

Not enough is known anywhere to subdivide a stream into segments of Critical Habitat. The fall-back position is to identify the whole tributary. Some information on habitat suitability is known and the expectation is that it would apply to both landlocked and sea-going systems.

It appears that habitat is available and restoration is feasible. In the discussion of habitat so far, cohabiting species have been included so one of the considerations for designating whole tributaries as being Critical Habitat is to identify that those tributaries would have to be managed differently than they are now. Management may need to favour Atlantic Salmon and disfavour some of the cohabiting competing species. Activities that would impede achievement of the recovery goal in numbers or range would need to be managed. The same would apply to ongoing point sources. Although not compelled to go back and fix those, what new things would be done in the systems would be considered.

(Q) Would farmers be disfavoured?

(A) That would be left to habitat managers to consider.

(Q) If the entire Credit River is considered Critical Habitat and most of it is used by Rainbow Trout and is important for Chinook Salmon, what is the implication of what is being suggested to other species like Chinook and Rainbows?

(A) The details would be part of the Recovery Strategy and an Action Plan. Maybe some of the tributaries would have to be designated for Atlantic Salmon restoration and you would have to manage away from other salmonids.

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- (Q) What happens next if all three streams are designated as Critical Habitat?  
(A) A Recovery Strategy and an Action Plan have to be developed in that context.

- (Q) If in five years time, strays are found in six other tributaries, do they have to be protected to the same degree as was done for the first three tributaries?

- (A) Not necessarily, as long as the case can be made that activities in those tributaries where Atlantic Salmon are moving into (whether they do not spawn, are not allowed to spawn or spawn unsuccessfully there) are not impeding achieving the Recovery Target.

#### Comment

This is why it is important to identify the Recovery Target in terms of both range and abundance. Suppose the Recovery Target, the point at which it can be concluded there is a healthy population of Atlantic Salmon that does not need further increase, is described as the number of adults needed for a self-sustaining population, which equates to the amount of egg deposition needed, the number of smolts needed, etc. How much habitat would be needed for that many eggs and juveniles, etc. and how much is available right now? Right now, there are three rivers that become essential habitat particularly because they happen to be the three rivers where salmon are being added. When the Recovery Target is reached, how much more habitat (how many more rivers) will be needed? This doesn't have to be specified but during the consultation process it is important people are aware, as the Recovery Strategy and sequence of Action Plans is produced, over time, that more spawning and rearing habitat for Atlantic Salmon will be needed, on the path to the recovery goal. A clear indication of what will eventually be asked for is needed before the consultation process. The consultation process needs to discuss whether the target is reachable without getting to the point that society will choose not to pay the costs. Critical Habitat, if not available now, will jeopardize progress towards reaching the Recovery Target. Beyond that, the features of the habitat which are necessary, and what we know of where they are, should be described.

- (Q) So should we be focusing on the three tributaries and whether or not we also need the lake environment?

- (A) Will three tributaries be enough spawning and rearing habitat for the population to achieve the Recovery Target? Are three rivers that each has a self-sustaining population sufficient to conclude it is a healthy population? If not, then more tributaries are needed and the habitat characteristics that are needed should be described. As long as there is a lot of the appropriate habitat available then the specifics are not needed. The habitat in the three tributaries is critical because salmon are using it right now. And habitat of this type will become critical as the population grows. So the Recovery Team needs to make sure that as more habitat is needed, they have plans to ensure it exists and is accessible. If not, then it must be created faster than the growing salmon population that will need it.

- (Q) Do we need to think of the healthy population in terms of historic population or number of streams required?

- (A) A healthy population should be one that could withstand stochastic events and not impede recovery. That would suggest more than one stream. Three may be good enough. The key thing is there is no guidance on how big a recovered population has to be relative to the historic size before it can be concluded it is

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recovered. It just has to be big enough for any reasonable assessment to conclude there is no reason to rebuild the stock any larger.

The fundamentals of the framework is that management should take every feasible measure to eliminate human-induced mortality on the stock if the population is at a size that all of its productivity is going to rebuilding the population, and not supporting social and economic benefits. At this point, it is not a recovered population and the basic fish management principle is that everything the stock can produce should be put into the growth of the stock. If it is directed fisheries then all directed fisheries are closed at that point. It should be a societal choice to put surplus production into human use or increasing population, and not a biological rationale. Then habitat needs to be looked at to ensure that the stock never gets to the point where habitat is a limiting factor. The areas it is using now is protected and society can decide what other areas need protecting.

(Q) What about the Chinook stocking program?

(A) It should be considered here.

(Q) How many years are needed to see that population number ( $N_e$ ) before the population is secure?

(A) It depends on the life-history of the species. Most guidelines that deal with that issue suggest three generations. If they can maintain that level for three generations, it is adequate demonstration.

#### Discussion

The participants discussed using a different approach to determine how much tributary habitat is needed by first deciding what level of fishing mortality is wanted, then determining how many adult salmon would be needed to support this and have a healthy sustainable population, and finally determining how much habitat would be needed in the tributaries to generate this. However, there was concern about using this approach and having to understand, quantify and partition all potential sources of mortality.

#### Comment

Atlantic Salmon disappeared as a result of habitat alteration, land clearing, hydro power development, etc. Fishing pressure was not the main cause. Now there are other issues and threats to the population. It is not likely that fishing would be considered a major source of mortality now, but it may be a politically sensitive issue. Thiaminase is a problem and is linked to the domination of the prey base by Alewife primarily, but secondarily by Smelt (*Osmerus mordax*). The feasibility of reintroducing Deepwater Cisco (*Coregonus johannae*) is being investigated.

What does the RPA need in terms of Critical Habitat? In the lake there is a certain habitat required based on the species physiology, however that is not likely to be the bottleneck. The definition of Critical Habitat should be more explicit in the lake and it could be the physiological definition; it may be sufficient to say they require water within a specific temperature range in summer. Do we need to be more specific on stage-based Critical Habitat descriptions in the streams? The rationale behind the description should be explicit. What is the habitat, why it is critical and what is the pathway that has to be protected?

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The population dynamics of Atlantic Salmon are going to be very sensitive to mortality of the stream-resident stages. The equivalency between the sensitivity to mortality between juveniles and adults is three times larger in stream residents than adults using the lake. So just in those terms, conserving whole streams is going to be critical for the survival of the species. This should be abstracted down to the physical requirements of the animal.

With regard to the stream habitat for spawning and rearing prior to smoltification, there seems to be pretty good agreement at the table that the best that can be said is all stream habitat is essential. In addition, a description of the features of the habitat that make it suitable for spawning and the different rearing stages prior to going into the lake is needed. Then, if it turns out that more habitat will be needed before the ultimate Recovery Target is reached, guidance has been given on the type of habitat that needs to be present. Of all the other rivers that can be part of the Recovery Plan, it doesn't matter which rivers, with no salmon, get picked as long as they have the features that are suitable for spawning and rearing. So some description of what those features are in the document is needed and not just a list of the three rivers.

(Q) How does the Chinook stocking program fit into the equation? Is Chinook stocking a threat that would have to be addressed?

(A) It may be considered a threat but it could be argued the Chinook stocking program is a carrying capacity issue not a direct mortality issue. Chinook can contribute to direct mortality as they prey on Atlantic Salmon smolts. If it is a predator-prey relationship, it is a direct mortality. If Chinook monopolize the food supply that the Atlantic Salmon would need as the population expanded, then I would argue it is a carrying capacity issue. Carrying capacity is often put into the habitat section rather than the mortality section. Habitat rehabilitation is really raising carrying capacity, not dealing with mortality.

(Q) There are large portions of the stream that are used for migratory purposes, which is one use of habitat. The type of habitat you need for that is different then what is needed for rearing and spawning. Is this being taken into account?

(A) Yes, this supports the argument that you have to protect the whole river, as you need to have a healthy watershed to make this work. You have migration corridors between those habitats that are used by different life-stages. The description of "what" and "why" needs to be more explicit so people understand the rationale.

(Q) How do you manage other salmonids?

(A) The three streams were chosen with the potential to mitigate competition using barriers. For example, on Duffins Creek, by moving Atlantic Salmon over one barrier, they have access to competitor-free waters. All five species of salmonids don't have access all the way up these rivers, they are differentially blocked by barriers. That has been dealt with in the extensive fisheries management planning process with the thought of restoring Atlantic Salmon. That would be a methodology within the Recovery Plan which would be supportive of the listing.

(Q) If there is a carrying capacity issue in the lake, should it be considered and what should be said about it?

(A) Yes. What is known or not known about the carrying capacity in the lake? Physiological limits for the species are known. The interactions with other

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salmonids in the lake are unknown as all information relates to stream populations (i.e., competition for spawning habitat or interactions with young). Recently there has been some thought that perhaps the Pacific salmon are preying on out-migrating smolts at the mouths of rivers.

(Q) Can it be indicated Critical Habitat cannot be defined in the lake further without a schedule of studies that is actually carried out?

(A) No. This issue has to be discussed in the advisory document. In the consultation process, the public has to be informed that this is one of the things that needs to be considered now. There is an opportunity for a schedule of studies but the consultation process must be informed that this is an issue.

We are satisfied in the short term that there is no competition for breeding sites because management actions can insure this in the three rivers. Whatever carrying capacity impact there may be from these stocked salmon, the density of naturally produced Atlantic Salmon in the lake is not high enough in the short term that progress toward a Recovery Target will be impeded by competition. We have to highlight the fact that this is a consideration that must be taken into account in overall recovery planning. It is a source of uncertainty. If the species is listed there may be in a situation sometime on the path to recovery when recovery has not progressed. If that happens and we think there may be a carrying capacity issue, the Minister, given uncertain science, would have no choice but to insist that the Chinook or Rainbow stocking program be cut back in case that is the factor impeding recovery. In the face of uncertainty, the Minister has to take the actions that favour the listed species. He has no discretion there. He can choose not to list but if he lists he must take action in the face of uncertainty.

(Q) Are we still struggling with feasibility? If I am looking at habitat in the tributaries or the lake I think it is feasible. But when you start talking about carrying capacity and threats in the lake, my take-home message is that we are still not sure whether it is feasible or not.

(A) If it is an issue of thiamine deficiency due to the thiaminase in the Alewife, and we think that there is nothing management can do to encourage reestablishment of traditional native forage species, then it must be concluded it is not feasible. If there are feasible things that management could be doing to shift back from an Alewife-dominated prey base and they just cost too much, then that becomes part of the social and economic consultation process so that society can decide whether it is willing to pay the price or not. If it is a carrying capacity issue and Lake Ontario has changed sufficiently that there is no longer a niche for Atlantic Salmon, and there is nothing that can be done about it without destroying some other native part of the ecosystem, then it is not feasible. If there is an activity that is already being managed, that could be managed in a different way to change the niche composition, it is feasible but again it is a social and economic decision. We have to make what we are saying, and their implications, explicit in the document.

#### Comment

If the recovery of Atlantic Salmon is based on the premise that you can recover lake herring (*Coregonus artedii*) then I would really question whether recovery of Atlantic Salmon is feasible.

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**Participants agreed to include redds as Residences.**

**There was consensus that the entire wetted areas of the three candidate rivers were to be considered as Critical Habitat. A narrative identifying physical characteristics of the habitat, including corridors, and its use by Atlantic Salmon should be included. In the future, it is possible that additional rivers will be necessary to attain recovery and would be identified through Recovery Team initiatives.**

**The participants also agreed that the entire lake should be considered and that physical characteristics important to survival should be identified. Knowledge gaps requiring further investigation should also be described.**

### **POTENTIAL SOURCES OF MORTALITY (PAST, PRESENT AND FUTURE)**

Presenter – Nick Mandrak

The RPA document should include a summary of the threats that are crucial to recovery and not everything on the list. This is one of the most sensitive salmonids in the region of highest human population in the fastest growing area of Canada.

The information in the draft RPA has largely come out of the COSEWIC report and is included in the section titled “Potential Sources of Mortality and Aggregate Harm”. The intention is to deal with each of the current threats and provide some indication of the magnitude and probability of each through discussion and consensus. Magnitude refers to the potential extent of the impact (harm/mortality), while probability means the probability of occurrence. A subjective rating of high, medium and low will be used and considers the threat if it were not mitigated. This information informs the RPA but also helps Habitat Management consider how to deal with habitat threats. There are five basic threats that have been identified in the COSEWIC report which will be the starting point. The discussion will only address threats to the three proposed study areas. Threats need to be considered under current regulations and conditions. With existing practises are they still a threat? The starting point to rank the threats was the consensus approach.

(Q) Should specific life-stages be targeted?

(A) Yes.

#### Invasive/non-native species

Negative interactions with Aquatic Invasive Species (AIS) is probably the most important threat because of Early Mortality Syndrome (EMS) related to the AIS Alewife, predation on Lake Ontario Atlantic Salmon juveniles by Chinook, competition for space and food and trophic disruption.

Trophic disruption (e.g., Zebra Mussels, (*Dreissena polymorpha*) potential AIS) could explain why Lake Ontario Atlantic Salmon don't reach the same size they did historically due to the following factors.

- Growth effects, adult mortality, reduced migratory potential of adults, increased susceptibility to predation, feeding impacts – resulting from EMS.

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- Direct predation in stream and lake – resulting from increased number of species.
  - Competition for space (spawning) and food in stream and lake. Less chance for competition when young occupy different parts of the stream at different times of the year (Chinook, not Rainbow). Rainbows and Atlantics have closest requirements and can displace each other depending on density and hydrology. Less information is available for Brown Trout (*Salmo trutta*) though they do coexist in Europe. [magnitude is Low, probability is Low].
  - Disease and parasites [magnitude is Low to High, probability is Unknown due to insufficient information]
  - Fishing mortality – as sometimes these non-native species support a fishery in which Atlantic Salmon will be a bycatch and subject to high hook-and-release mortality and misidentification.
  - Zebra Mussel and *Bythotrephes* (a predatory planktonic cladoceran) are potential Aquatic Invasive Species (AIS) which impact productivity – resulting in returns by altering trophic dynamics particularly in the planktonic food web. [magnitude is High, probability is High].
  - Direct predation – by Round Goby (*Neogobius melanostomus*).

### Dams

Dams were considered the second most important threat to the recovery of Lake Ontario Atlantic Salmon behind AIS. Impassable dams occur on all three of the tributaries. For the most part, dams prevent spawning rather than being a direct source of mortality. Dams could cause mortality if it involves handling as in the case of bypassing (i.e., - truck and transferring). However, if dams are preventing migration to the spawning grounds, and spawning doesn't occur, it could affect fecundity so it could be assumed to be a source of egg mortality. This would be considered aggregate harm. It is a source of harm or potential source of harm. Dams with trap-inserted or specifically designed fishways can be used to selectively pass salmon while preventing upstream access by other species. They also can potentially reduce negative interactions. Another consideration is that dams may maximize the competitive interaction for downstream migrating smolts seeking passage at dams and predators such as Bass (*Micropterus* and *Ambloplites* spp.), Pike (*Esox lucius*) and Walleye, etc. stationed in flat water proximate to the dam. There may be water temperature issues resulting from dams such as warmer downstream temperatures associated with top-draw dams. Downstream migration issues might include damage to the fish rather than delays.

- Prevent migration – [All Streams: magnitude is High, probability if it is not mitigated is High]
- Maximize competitive interactions in smolts – [All Streams: magnitude is Low, probability is Low]. The number of predators stationing was not considered to be enough to rate this any higher.
- Increased temperatures in tributaries from top-draws – Cobourg: magnitude is Low, probability is Low as there are no real impoundments upstream; Credit: magnitude is High, probability is High as this is occurring and has raised the temperature 1°C; Duffins: is Unknown. [Overall magnitude is Medium, probability is Medium].
- Potential for mortality from deliberate movement over dams – Cobourg magnitude is Low, probability is Medium; Credit: magnitude is Low; probability is Low; Duffins: magnitude is Low, probability is Medium. The potential exists and Atlantic Salmon are sensitive to handling but the moves are not far and the temperature when they occur is low. [Overall magnitude is Low, probability is Low].

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- Potential for delays and physical harm with downstream migration – Cobourg unknown but the potential to occur exists; Not an issue for Credit and Duffins. [Overall magnitude is Low, probability is Low].

#### Land-use practices

Natural Resource Extraction/Exploration (i.e., deforestation)

After discussion it was agreed that land-use is the third most important threat to recovery, particularly during the overwintering stage which is most critical, and survival can be reduced by increased sedimentation. Land-use practices that increase sedimentation are considered a serious threat. Historically, deforestation contributed to the extirpation of the species. Currently, urbanization is an issue. Changes in base-flows, stream temperatures, sedimentation, flashiness (i.e., the frequency and rapidly of short-term changes in stream flow, especially during runoff events) and projected growth of the Greater Toronto Area are ongoing threats.

- Urbanization –Upper Credit: magnitude Medium, probability High; Lower Credit: magnitude Low, probability High; Duffins: more agricultural issues. The growth of the Greater Toronto Area has an impact on the Credit River.
  - base flow (quantity) [magnitude is High, probability is Medium]
  - water temperature [magnitude is Medium, probability is low/medium]
  - sedimentation [magnitude is High, probability is High]
  - flashiness [magnitude is High, probability is Medium]

#### Exploitation

After much discussion and debate about how much harm should be allowed in terms of exploitation, it was ranked as only the fourth most important threat to recovery. Directed mortality or harvest is included here and is generally hooking mortality and catch-and-release mortality. If fishing is directed for Lake Ontario Atlantic Salmon, or if it is directed towards other salmonids but Atlantics are caught by accident and kept, then it would be considered a targeted fishery. If fishing is directed for Chinook and Rainbow Trout, thereby reducing the catch of Atlantics, then it would be considered bycatch. If fishers can't differentiate between the salmonids then it is a targeted fishery for a mix of salmonid species. The charter boat fisheries are able to target Chinooks, Rainbows and Browns, but it is not know if they can avoid Atlantics. It was expected that Atlantics are generally not targeted because of their low numbers but are taken incidentally in the sport fishery. If they are over 63 cm in length, they can be kept. This suggests the sport fishery should be considered as a directed mixed stock fishery.

Atlantics may also be bycatch in the commercial fishery. They are still fishing coldwater fishes like Cisco and Whitefish (*Coregonus clupeaformis*) and, although bycatch in these fisheries is a remote issue now, it may become a more important threat as Atlantic Salmon increase.

Poaching is an issue. Some radio-tagged fish stocked for research were taken by poachers in Bronte Creek and the Credit River. Atlantics could be harvested and stripped of eggs to use for bait. Eggs currently sold for bait are supposed to come from aquaculture. Atlantics have been misidentified as all other salmonid species, which is a problem.

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If Atlantic Salmon are listed, they will have protection in Canada but not once they cross the border into the U.S. In addition, the Americans are stocking Atlantic Salmon with the intention of a put-and-create fishery. So, if their regulations don't prohibit the take or are promoting it, then they may be impacting the Canadian Atlantic Salmon. They could be considered as IUU fishing (Illegal, Unregulated and Unauthorized). They currently have the same regulations as in Canada.

- recreational harvest (directed above 63 cm, bycatch) [magnitude is High, probability is Medium] – fishers may be catching the majority of Atlantics, at least they could be catching more than originally thought; therefore, the probability was changed from low to medium.
  - Recreational harvest (bycatch) streams smolts [magnitude is Medium, probability is High]
  - Recreational harvest (bycatch) streams adults –[magnitude is High, probability is High]
- Poachers (flesh, eggs) – [magnitude is Unknown, probability is High]
- American fishery unknown
- Canadian commercial fishery (whitefish) [magnitude is High, probability is Low]

#### Pollution

There was some discussion that PCBs and other chemical contaminants should be considered here but the other sources should be considered under land-use practices.

- Sewage Treatment Plant effluents (e.g., pharmaceuticals) –[magnitude is High, probability is Low]
- Storm-water discharge –[magnitude is Low, probability is High]
- Increased surface runoff (urban) –[magnitude is Low, probability is High]
- Rural non-point source (nutrients) –[magnitude is Medium, probability is High]

#### Climate change

The impact of climate change is not well understood but may be considered a future threat though Atlantic Salmon can tolerate warmer temperatures.

#### Cormorants

Cormorants (*Phalacrocorax auritus*) are a threat to smolts which may be vulnerable in nearshore waters. They are much more abundant now than historically. The threat is greatest near their colonies and the Toronto colony is expanding.

- Cormorants –[magnitude is Low, probability is Low]

### **ALTERNATIVES TO ACTIVITIES AND MITIGATION MEASURES**

Discussion Leader – Nick Mandrak

Participants discussed and developed a list of alternatives to activities and feasible mitigation measures which could be used to reduce the impact of threats to Lake Ontario Atlantic Salmon. Only the four main threat categories were discussed.

#### Invasive /non-native species

Participants noted that Lake Ontario Sea Lampreys are not interfering with the recovery objectives for Lake Ontario Atlantic Salmon. There was an increase in Sea Lamprey

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(*Petromyzon marinus*) scars on Rainbow Trout in the Ganaraska region suggesting an increase in Sea Lamprey but the reasons for this are unknown.

Alternative to activities (Non-native species)

- reduce exotic stocking
- increase native stocking

Mitigation measures (Invasive species/Non-native species)

- prevent further AIS entering ecosystem (implement fully AIS implementation strategy; implement new AIS legislation)
- stronger AIS regulations (e.g., ballast water, baitfish, other vectors)
- various EMS treatments – treat adults with thiamine (injection)
- prevent colonization of streams (e.g., barriers)
- prey fish community diversification (e.g., deepwater sculpin, other native species reintroductions)
- outreach and education

Dams

Dams are of cultural value as some have been around for a hundred years. One of their benefits is that they may minimize competition among fish species. The instillation of a dam is a response to, or an outcome from, potential mitigation or management. Removal of dams can be very costly, and another more serious problem with taking them out is that it provides access to unwanted species (i.e., AIS). If prevention of migration is mitigated for Atlantic Salmon, there is a large effect for adults because they are separated from their competitors. For the three tributaries where reintroduction is being considered, some of the alternatives or mitigations do not apply (e.g., alternate methods of electricity generation and flood control), so they were removed from the list.

Alternatives to activities

- alternate methods of Sea Lamprey control
- alternate recreational activities
- natural channel design is an alternative to traditional fishways and stream channelization

Mitigation measures

- seasonal operation/alteration of the operating regime (doesn't work for Sea Lamprey control)
- dam removal
- provision of two-way fish passage e.g., fishways, fish ladders, notch dams for migratory fish passage
- convert dams from top-draw to bottom-draw
- take on-line ponds off-line

Land-use practices

Alternatives to activities

- better or alternate zoning measures, better municipal planning
- protected areas (e.g., floodplains, wetlands, etc.); for example there could be a protected area for Lake Ontario Atlantic Salmon spawning.
- don't change land use

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- outreach and education

#### Mitigation measures

- riparian zones
- reforestation
- agricultural non-point source control (cattle fencing; best management practices)
- urban non-point source control (storm waters, sewage treatment plants, etc.)
- urban design guidelines, e.g., guidelines regarding impervious surfaces, or guidelines around lot areas, densities, etc.
- restoring natural design, drainage guidelines
- land acquisition
- stream restoration, habitat enhancement
- water removal permits to control base flows
- outreach and education

#### Exploitation

##### Alternatives to activities

- closed harvest/fishing areas (applies to all three stages: smolts, adult in lake, adult in stream)
- promote alternate species

##### Mitigation measures

- live release
- gear restrictions (barbless hooks, no live bait, tackle restrictions e.g., fly fishing in streams)
- outreach education particularly for identification of Atlantic Salmon
- size limit increase
- control effort through conservation permits or salmon tags, etc.
- seasonal closures (all three stages)
- fish sanctuaries (all three stages)

#### Pollution

##### Alternatives to activities

The meeting participants did not discuss the alternatives to activities related to threats from pollution.

##### Mitigation measures

Participants did not discuss the mitigation measures associated with pollution but there are likely standard solutions that could be listed (e.g. scrubbers, reduction of point source inputs, sewage treatment and control, etc.).

Although old mine sites could be cleaned up, as they may be contributing toxins, etc. to watershed this likely doesn't apply to the streams where Lake Ontario Atlantic Salmon are going to be stocked.

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### **Output of the meeting**

The output of the meeting will be a proceedings document and a Recovery Potential Assessment Science Advisory Report. In addition, the working paper on allowable harm will be published as a research document (Vélez-Espino and Koops 2007) as will the critical habitat working paper.

### **REFERENCES**

- COSEWIC. 2006. COSEWIC assessment and status report on the Atlantic Salmon, *Salmo salar*, (Lake Ontario population) in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. vii + 26 pp.
- DFO. 2005. A Framework for Developing Science Advice on Recovery Targets for Aquatic Species in the Context of the Species At Risk Act. DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2005/054.
- DFO. 2007. Revised Protocol for Conducting Recovery Potential Assessments. DFO Can. Sci. Advis. Sec. Advis. Rep. 2007/039.
- McCrimmon, H.R. 1950. The reintroduction of Atlantic Salmon into tributary streams of Lake Ontario. Transactions of the American Fisheries Society 78: 128-132.
- Scott, W.B. and E.J. Crossman. 1998. Freshwater fishes of Canada. Galt House Publications, Oakville, Ont. 996 pp.
- Vélez-Espino, L.A. and M.A. Koops. 2007. Assessing allowable harm and recovery efforts in Lake Ontario Atlantic salmon (*Salmo salar*). DFO Can. Sci. Advis. Sec. Res. Doc. 2007/083.

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## APPENDIX 1: Recovery Potential Assessment Topics<sup>1</sup>.

*The list below will be the subject soon to a review by a national working group with the objective of improving the actual framework for the provision of recovery potential assessments.*

The topics (from the national framework) for which an assessment should be done for any species/designatable unit is as follows:

### *Phase I: Assess Current Species Status*

1. Evaluate present species status for abundance and range
2. Evaluate recent species trajectory for abundance and range
3. Estimate **amount of Critical Habitat** currently available (using Critical Habitat descriptions defined in the pre-COSEWIC RAP, and considering information in COSEWIC Status Report).
4. Evaluate expected **population and distribution targets** for recovery, according to DFO Guidelines
5. Evaluate expected **general time frame for recovery to the target**, assuming only natural mortality, and estimate how time to Recovery Targets would increase at various levels of human-induced mortality
6. Evaluate **Residence Requirements**, if any.

### *Phase II: Scope for Human – Induced Mortality*

7. Evaluate **maximum human-induced mortality** which the species can sustain without jeopardizing survival or achievement of Recovery Targets for the species.
8. **Quantify** to the extent possible the magnitude of each major potential source of mortality/harm identified in the pre-COSEWIC RAP, and considering information in COSEWIC Status Report.
9. **Aggregate total mortality**/harm attributable to all human causes and contrast with that determined in tasks 5 and 7.
10. Evaluate to the extent possible the likelihood that Critical Habitat is currently limiting to the species' abundance or range, or would become limited before the Recovery Goals were reached.
11. Inventory to the extent possible the **threats to Critical Habitat**, and estimate their current levels of impact on habitat quantity and quality

### *Phase III: Scenarios for Mitigation and alternative to activities*

To the extent possible with the information available,

12. Develop an inventory of all feasible measures to minimize the impacts of activities in task 8 and 11.
13. Develop an inventory of all reasonable **alternatives to the activities** in tasks 8 and 11, but with potential for less impact. (e.g., changing gear in fisheries causing bycatch mortality, relocation of activities harming Critical Habitat)
14. Document the expected harm after implementing **mitigation measures** as described in 12 and determine whether survival or recovery is in jeopardy after considering cumulative sources of impacts

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<sup>1</sup> In August 2007, the RPA framework was revised to include 17 steps (DFO 2007).

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15. Document the expected harm after implementing alternatives to the activities as described in 13 and determine whether survival or recovery is in jeopardy after considering cumulative sources of impacts
  16. Recommend parameter values for population productivity and starting mortality rates, and where necessary, specialized features of population models that would be required to allow exploration of additional scenarios as part of the assessment of economic, social, and cultural impacts of listing the species.

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## **APPENDIX 2: Terms of Reference**

### **Recovery Potential Assessment of Atlantic Salmon (Lake Ontario Population)**

Regional Peer Review Meeting – Central and Arctic Region

Canada Centre for Inland Waters  
Burlington, ON  
March 1<sup>st</sup> and 2<sup>nd</sup>, 2007

Chair: Larry Marshall

#### **A. Background**

In May 2006, the Committee on the Status of Wildlife in Canada (COSEWIC) designated the Lake Ontario Atlantic Salmon as Extirpated. Assuming that an extended listing process needs to be undertaken for this taxon, the Minister will be required to decide whether or not to list it under the *Species at Risk Act* (SARA) by Fall 2007. In the interim, a Recovery Potential Analysis (RPA) and subsequent socio-economic and listing consultations need to be conducted.

The purposes of the SARA are to protect wild species at risk and their habitats in Canada, and to promote their recovery. The Act stipulates that it is forbidden to kill individuals of a species listed under the Act as Threatened, Endangered or Extirpated or to harm, harass, capture or take them. The SARA also prohibits damaging or destroying their Residence or any part of their Critical Habitat. Furthermore, the SARA provides for the preparation of a Recovery Strategy for species listed as Threatened, Endangered or Extirpated. The provisions of these Recovery Strategies must ensure that any possible threat to a given species and its habitat does not jeopardize its survival and recovery.

Section 73 (2) of the SARA provides the competent ministers with the authority to permit normally prohibited activities affecting a listed species, its Critical Habitat, or its Residence, even though they are not part of a previously approved Recovery Plan. Such activities can only be approved if: 1) they are scientific research relating to the conservation of the species and conducted by qualified persons; 2) they will benefit the species and are required to enhance its chance of survival in the wild; or, 3) affecting the species is incidental to the carrying out of these activities.

The decision to permit Allowable Harm and the development of a Recovery Strategy must take into consideration the species' current situation and its Recovery Potential, the impacts of human activities on the species and on its ability to recover, as well as the alternatives and measures to reduce these impacts to a level which will not jeopardize the survival and recovery of the species.

Therefore, a species Recovery Potential Assessment (RPA) process was developed by DFO Science to provide the information and scientific advice required to meet the various requirements of the SARA, such as the authorization to carry out activities that would otherwise violate the SARA as well as the development of Recovery Strategies. In the case of a species that has not yet been added to Appendix 1 of the SARA, the

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scientific information also serves as advice to the DFO Minister regarding the listing of the species under the SARA. Consequently, the information is used when analyzing the socio-economic impacts of adding the species to the list as well as during subsequent consultations, where applicable.

## **B. Objectives**

The intent of this meeting is to assess the Recovery Potential of the Lake Ontario population of Atlantic Salmon. It is a science-based peer review of the designatable unit assigned by COSEWIC and the 16 steps in the RPA framework outlined in the Appendix. The advice will be provided to the DFO Minister for his consideration in any listing decision under the SARA for this population.

## **C. Products**

The meeting will generate a proceedings report summarizing the deliberations of the participants. This will be published in the CSAS Proceedings Series. There may be a CSAS Research Document(s) produced in relation to the working paper(s) presented at the workshop. The advice from the meeting will be published in the form of a Science Advisory Report.

## **D. Participants**

Participants will include representatives of DFO Science and Policy sectors from the NCR, Central and Arctic Region, and Maritimes Region; and, salmon specialists from the OMNR and Ontario Federation of Anglers and Hunters. Participants will not exceed a maximum of 20 people.

## **E. Timetable for FY 2007/08**

Draft proceedings will be circulated to participants for comments in Spring 2007 and a final proceedings document is expected to be submitted to CSAS for publication by the end of Spring 2007.

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**APPENDIX 3: List of Participants**

<b>Name</b>	<b>Affiliation</b>	<b>e-mail address</b>
D. Brown	Ontario Federation of Anglers and Hunters	dave_brown@ofah.org
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C. Wilson	OMNR	chris.wilson@ontario.ca

\* workshop steering committee

(proceedings prepared by K. Martin, DFO Science, Kathleen.Martin@dfo-mpo.gc.ca)

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## **APPENDIX 4: Agenda**

### **Recovery Potential Assessment of Atlantic Salmon (Lake Ontario Population)**

Regional Peer Review Meeting – Central and Arctic Region

Canada Centre for Inland Waters

Burlington, ON

March 1<sup>st</sup> and 2<sup>nd</sup>, 2007

Chair: Larry Marshall

#### **Day 1: Thursday March 1, 2007**

- 9:00 Welcome and Introductions (Marshall)
- 9:15 Objectives (Marshall)
- 9:30 The SARA and RPA Processes (Mandrak\*)
- 9:45 Restoration Plan (Daniels\*)
- 10:15 Break
- 10:30 Species Status, Population Status
- 10:45 Designatable Unit (Genetics) (Wilson\*)
- 12:00 Lunch (Provided)
- 1:00 Recovery Target
- 2:00 Critical Habitat and Residence (Randall\*)
- 3:15 Break
- 3:30 Potential Sources of Mortality (Past, Present and Future) (Mandrak\*)
- 5:00 End of Day 1

\* Presentation and Discussion

#### **Day 2: Friday March 2, 2007**

- 8:30 Recap of Day 1 (Marshall)
- 8:45 Allowable Harm (Vélez-Espino\*)
- 10:00 Break
- 10:15 Alternatives to Activities, Feasible Mitigation Measures
- 12:00 Lunch (provided)
- 1:00 Contingency Time/Tidy up Loose Ends