A Technical Letter Review of the ‘Status Review for Anadromous Atlantic Salmon (*Salmo salar*) in the United States’
April 25-May 15

by

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May 15, 2006

Executive Summary

The 'Status Review for Anadromous Atlantic Salmon (*Salmo salar*) in the United States' (Fay et al. 2006) represents a considerable effort by a number of professionals utilizing their own expertise and scientific information from over 600 literature citations. It is an objective assessment of possible distinct population segments (DPSs), the status of remnant and hatchery supported populations of Atlantic salmon in Maine and an assessment of 48 threats to their existence. Concerns are raised about the utility of some of the genetic material important to the delineation of the northern boundary of the Gulf of Maine (GOM) DPS. A few additional literature citations are proposed to embellish the text and some minor discrepancies were noted between material in the text and the literature from which it originated.

For the most part, the information and analyses within the 'Status Review' supports delineation of the Long Island Sound (LIS), Central New England (CNE) and GOM DPSs. The bounds of the CNE, LIS and southern boundary of the GOM DPS rely heavily on expert opinion; the inclusion of the Penobscot population in the DPS is well founded. There is however, insufficient information to convincingly redefine the northern boundary of the GOM DPS and it is recommended that additional genetics from southwestern and western New Brunswick be obtained to verify the proposed boundary.

Maine populations of wild Atlantic salmon are nearing extirpation; continued changes in land use, climate, marine ecosystem and the level of concern expressed regarding the loss of genetic diversity and fitness within the hatchery program suggest that the time-line for extinction of hatchery and wild components could be less than forecast. The forecast urbanization of southwestern Maine, and the social costs/ obstructions to removing dams/ providing multiple fish passage through less than pristine habitats of large drainage systems suggests that *preservation* efforts for Atlantic salmon as a heritage species focus strictly on the existing refugia in Downeast Maine.

Background

The purpose of this technical review is to ensure that the scientific information presented and analyzed in the Status Review for Atlantic salmon in the United States is the best available scientific data.

On November 17, 2000, the National Marine Fisheries Service and the U.S. Fish and Wildlife Service (the Services) issued a final rule to list the Gulf of Maine Distinct Population Segment of Atlantic Salmon (GOM DPS) as endangered under the Endangered Species Act (ESA). The GOM DPS was defined as all naturally reproducing wild populations of Atlantic salmon, having historical river-specific characteristics found north of and including tributaries of the lower Kennebec River to, but not including the mouth of the St. Croix River at the United States-Canada border and the Penobscot River above the site of the former Bangor Dam. Populations which met these criteria were identified as being in the following rivers: Dennys, East Machias, Machias, Pleasant, Narraguagus, Sheepscot, Ducktrap, and Cove Brook.

In the final rule listing the GOM DPS, the Services deferred the determination of inclusion of fish that inhabit the main stem and tributaries of the Penobscot River above the site of the former Bangor Dam. The deferred decision reflected the need for further analysis of scientific information,

including a detailed genetic characterization of the Penobscot population. In addition, the Services were committed to reviewing data regarding the appropriateness of including the upper Kennebec and other rivers as part of the DPS. In late 2003, the Services assembled a Biological Review Team (BRT) comprised of biologists from the Maine Atlantic Salmon Commission, Penobscot Indian Nation, NMFS, and USFWS. The BRT was charged with reviewing and evaluating all relevant scientific information necessary to evaluate the current DPS delineations and determining the conservation status of the populations that were deferred in 2000 and their relationship to the currently listed GOM DPS.

NOAA Fisheries is required to use the best available scientific and commercial data in making determinations and decisions under the ESA. The first question that must be addressed is what the appropriate species delineation is for consideration of conservation status. The ESA defines an endangered species as "any species which is in danger of extinction throughout all or a significant portion of its range," and a threatened species as "any species which is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range." A species may be determined to be threatened or endangered due to any one of the following factors:

(1) the present or threatened destruction, modification, or curtailment of its habitat or range;
(2) overutilization for commercial, recreational, scientific or educational purpose;
(3) disease or predation;
(4) the inadequacy of existing regulatory mechanisms; and
(5) other natural or manmade factors affecting its continued existence.

The scientific and commercial information contained in the Status Review will likely contain essential factual elements upon which the agency could base its ESA determination. Accordingly, it is critical that the Status Review contain the best available information on the species and the threats, that all relevant information is identified and included, and that all scientific findings be both reasonable, and supported by valid information contained in the document.

Description of Review Activities

The report (Fay et. al. 2006) was reviewed from the perspective of addressing the Terms of Reference (TOR) provided in the Statement of Work. A contextual feel for the up-to-datedness of the document was first gained from a review of the references and an analysis of the distribution of their dates of publication. (Citations between 2001 and 2005 were the equal of the previous 5-year period). The appendices, were also viewed with respect to their mix of historical data and analyses e.g., App.8, which lists factors and stressors affecting GOM DPS salmon at each life stage. While the matrix is a laudable extract of about 100 pages of text, the method of numerical categorization/ risk assessment was unclear. The reviewer was left to assume that they were 'expert opinions'.

The given order of the TOR contributed to some uncertainty as to the best manner of maintaining a flow and linkage between assessment, conclusions and opposing ideas. That is, one could have addressed the conclusions (TOR 3) and the acknowledgement of opposing studies (TOR 4) following each of the assessment of the information presented on species delineation (TOR 1), inclusion of the best information on the species (TOR 2a), and the best information regarding

threats to species and habitat (TOR 2b). After much consternation it was decided to address them in the sequence provided.

TOR 1. Is the species delineation supported by the information presented?

To assist in the delineation of DPSs for Atlantic salmon in Maine, particularly those in which the populations had been extirpated, the 2005 BRT considered a number of classification systems used in defining terrestrial ecosystems. They included ecological provinces, spatial arrangements of river systems, as well as Olivero (2003) defined Ecological Drainage Units (EDUs), aquifer structures, ground water temperatures, and near shore marine community structure. The BRT concluded, as did the 1999 BRT, that there were likely two DPSs of sea-run Atlantic salmon (now extinct) additional to the GOM DPS for which life history and genetic characteristics constitute the core of the defining criteria. The difficulty from the perspective of this reviewer is the certainty now expressed in the southern and northern boundaries of the GOM DPS.

The southern boundary of the GOM DPS was delineated by the 2005 BRT on the basis of a number of physiographic and climatic features which are supported by Olivero's (2003) southern bound of the Penobscot-Kennebec-Androscoggin EDU (which does appropriately include both the Sheepscot and Ducktrap populations). However, the Sheepscot and Ducktrap are coastal drainages with populations genetically similar to the other six listed populations, which are in fact in Olivero's Downeast+ EDU. The argument that the Kennebec and Androscoggin are large rivers with physiographic features like the Penobscot and therefore likely to have had salmon of similar genetic characteristics would be more palatable if the genetics of the current Penobscot population were known to represent survivors of the nearly extirpated large basin populations in the first half of the 20th century (Baum 1983). They may in fact be remnants of only the lower/ coastal region, i.e., large basin populations of the Penobscot may have been genetically different enough to have challenged their (and other large basins) inclusion in the GOM DPS. Arguments presented for the exclusion of the Royal, Presumpscot and Saco drainage unit on the south are supported by the ecodrainage concept, but not by the presumed biological characteristics (low smolt age and predominantly 2SW age at maturity) that these populations would have exhibited or the adjacent marine conditions.

The data and analyses on genetic similarities of populations within the existing GOM DPS, including the Penobscot and 'outlier' Cove Brook populations (which may be unique because of traits lost rather than retained, i.e., bottlenecking), are credible albeit singular in their origins, i.e., King and Spidle. The genetic distinctiveness of the GOM DPS from the New Brunswick populations sampled and which presumably could have influenced the Penobscot genetics through past stocking (King et al. 2001 [makes no mention of St. Croix anadromous populations per Fay et. al. 2003 p 51; which are found in King et al. 2000] and Spidle et al. 2003) is unquestioned and the science supports the inclusion of the Penobscot population in the GOM DPS (version 2000). As to whether or not the 'New Brunswick' populations examined were appropriate for validation of the northern bound of the GOM DPS is perhaps another question.

The northern bounds of the GOM DPS and convenient delineation for management purposes were previously successfully defined by the use of EPA's international boundary criteria. This document proposes that the genetic distinctiveness from the Canadian populations (Nashwaak and Miramichi rivers in New Brunswick; King et al. 2001), and life history characteristics (grilse: salmon ratios

and age at smoltification) substantiate the case for the Dennys River being the true northern boundary of the DPS. The exclusion of the St. Croix is based on the genetics of salmon parr collected in 1995 from Dennis Stream, a small river flowing into the lower tidal portion of the St. Croix River. On these issues a few points are worthy of consideration.

First, the Nashwaak River population, which is presumed to be representative of the Saint John (and interestingly, within Olivero's 'Downeast' inclusive EDU), is in fact biologically different from the population on the mainstem at Mactaquac (Marshall et al. 1999), which would have been more representative of the stocks that were translocated to Maine. The wild Nashwaak population is approximately 60% grilse of which 30-40% are females; their drainage abuts that of the Southwest Miramichi. The wild Mactaquac 'population' is comprised of at least three run-time components, which on average consist of approximately 50% grilse and, like the Penobscot, a low proportion of females (10%). Populations upriver of Mactaquac would have included the Aroostook, which abuts on to the East Branch Penobscot, but now are restricted to the Tobique, Shikatehawk and Becaguimec in particular.

At Mactaquac there are two early and one late run salmon components of note. These differences may be reflected in the allozyme variation detected in four 'replicate' samples from the Saint John River stock (Verspoor et al. 2005a). The earliest residual run, known as the "Serpentine" (a tributary of the Tobique some 350 km from the Bay of Fundy) has a life history strategy currently unique to North America, i.e., it returns as a 1SW fish to the lower estuary in the fall of the year, over winters there and ascends in June to its' tributary of origin to spawn that fall. The same run could historically have ascended the Aroostook River (harvest of 336 'salmon' in 1873, (Baum 1982)). Perhaps the same strategy could have been equally plausible in the adjacent Penobscot watersheds prior to European colonization. A similar argument could be made for the late June early-July predominately 2SW returns to Mactaquac that almost surely would have included Aroostook migrants with freshwater growth and age (including age-3 smolts) possibly characteristic of the original populations in the East or West Branch Penobscot. These thoughts raise two possibilities: (1) that historically there were other run/ drainage components of salmon within the Penobscot population with perhaps a closer genetic and life history similarity to the Saint John, and (2) that had the former been true, that the upper Saint John - Aroostook EDU (Olivero 2003) might have been considered by the BRT for classification of headwater branches of large drainages such as the Penobscot and Kennebec.

Second, the Dennis Stream (not "river") parr populations analyzed by Spidle (2003) as being unlike those of the Downeast populations may not have been representative of Dennis Stream or of the St. Croix River. Fay et al (2006) and Marshall, (1976), note that the population of the St. Croix was likely extirpated by the early 1900s and that limited restoration efforts used salmon of non local origins. Thus it is not difficult to suggest that a Dennis Stream salmon might be as much an outlier to local area stocks as is the Cove Brook sample to other Downeast populations. More likely is the possibility that the 1995 parr collections were influenced by several years of farm escapes (predominantly of Saint John River lineage), which are known to have ascended the neighboring St. Croix and Magaguadavic rivers (Marshall et al. 2000) in significant numbers relative to 'wild' fish.

Interestingly, Verspoor et al. (2005b) analyzed mitochondrial DNA from a small number of Narraguagus, St. Croix and Waweig (draining to the St. Croix estuary) samples (collection dates and locations not provided), which to this reviewer suggests a reasonable affinity between all three populations and possibly, the nearby Digdeguash and Hammond river (the later draining to the

lower Saint John River estuary). At the same time, Verspoor et al. (2005a) show that GOM and Outer Bay of Fundy stocks do cluster independently with regard to their genetic character as defined by allozyme variation. This suggests that while it is reasonable to conclude that the GOM represents a DPS distinct from most Canadian stocks, the data are insufficient to conclude that the DPS to which the GOM stocks belong, ends at the Dennys River. Thus, on the basis of existing data it would seem difficult to dismiss the idea that GOM populations belong to a geographically more extensive DPS that may encompass Outer Bay of Fundy rivers.

In response to the specific question, "Is the species delineation supported by the information presented" the overall response is for the most part "yes". The inclusion of the Penobscot in the DPS is well founded. The qualifications are associated with the subjectivity in the delineation of the Central New England (CNE) and Long Island Sound (LIS) DPSs, and a mixture of subjectivity and objectivity in the delineation of the southern bound of the GOM DPS. The genetics argument for the delineation of the northern boundary of the GOM does not seem as clear as was presented and is deserving of additional investigation including a greater representation of stocks from southwestern and western New Brunswick. This reviewer would therefore reserve judgment on changing the northern boundary of the GOM DPS designation from that of the 2000 ruling

TOR 2. Does the Status Review include and cite the best scientific and commercial information available on the species and threats to it and to its habitat?

The literature contributory to the assessment (600^+ citations) is vast and in the limited time allowed for reviewing can be termed reasonably comprehensive and relatively complete. A few of the glitches are inherent to reports prepared by a 'committee' comprised of individuals of varied backgrounds, operating in isolation and for only short bursts of time. The following points detract only slightly from the quality and make little if any impact on the outcome. Some of the points will be carried forward to responses for TORs 3 and 4.

P15, para 3: '1SW and MSW salmon are thought to behave….moving through the top three meters of the water column (Reddin 1985)." Recent information provided by Reddin and others at the ICES WGNAS (which the authors reference for other reasons), using new temperature data logging tags, indicates that salmon dive to significant depths (presumed feeding forays) with great frequency during their sojourn at sea.

P16, para 3: Text could have referred also to Verspoor (2005 and 2005a; App.1) I believe these documents were available prior to Jan 2006.

P20, para 1-2: Reference to Kircheis (2004). The BRT review reads as though lamprey populations were declining or possibly extirpated or excluded from areas where salmon now exist. I could find no mention of same within Kircheis (2004).

P23, para 2: References here as elsewhere for the Penobscot use Baum (1997). I prefer the original reference Baum (1983) (see App. 1) and for that matter, the use of the entire set of nine river management reports when referring to the other salmon rivers of importance in Maine.

P40 Fig 6.2b: Postglacial distribution of Atlantic salmon is unlikely to have included the Saint John River NB/ME above Grand Falls NB. It was certainly never "historic". (Also note that 'Androscoggin' is misspelled in Fig. 6.2a (p39).

P46, para 2: Atkins (1874), Kendall (1935) etc. I did not look at these references but was always disappointed with the term "Canadian" stocks when highlighting differences from populations within the GOM. The real issue for the document should be stocks proximate to the GOM DPS. I provide reference to two documents (Marshall et al. 1999 and Marshall et al. 2000, see App. 1) the source of which would have been known by at least one or two of the BRT. This point has particular sensitivity in the section on genetics where, for example, the "St. Croix" is in fact Dennis Stream, (not Dennis Creek, see below) which in a list of salmon rivers in North America would be listed separately because it flows into salt/ estuarial water. I believe that is why Cove Brook carries its own identity in most of the listings debate.

P 47, para 1: The last two sentences which extend from Bernier et al. (1995) and Baum (1997) that the "increase in grilse rate" is the result of constant grilse returns and increasing interception of 2SW salmon. I believe that the evidence would bear out that interception of 2SW salmon has been <u>decreasing</u> for nearly two decades. (see for example WGNAS 2004b)

P51 para 3: Dennis "Creek" is, I believe, Dennis Stream as cited in King (2000) and incorrectly labeled in Spidel (2003) and in the BRT report; <u>also</u> same paragraph bottom of the page and mentioned in TOR, I have a concern with using the Nashwaak as a surrogate for the Saint John. I don't know where anybody got the idea that the St. (Saint) John mainstem populations were extirpated! Further, I would have thought that the allozyme work of Verspoor et al. (2005a) might have been mentioned somewhere in the mix.

P 54 para 2: I couldn't access Colligan et al. (1999) to verify the inference that the habitat of the Androscoggin was the equal of the St. John. This may be in an ICES report from 15 or so years ago but I didn't search it out. The number of accessible $100m^2$ units for the Saint John that would support spawning and rearing in NB was once listed at 281,980 (Marshall and Penney, 1983). This excluded the Aroostook, Prestile, Meduxnekeag and over 75,000 units of free flowing main stem upriver of the Mactaquac and Beechwood dams. The Penobscot is only listed in the BRT report at 100,000 units.

P60 para 2: "North American Salmon Working Group (NASWG)" I believe this is a misnomer. It had to be a "Study Group" under the Working Group if it was addressing a Commission Area, i.e., NAC. Interestingly, it is not cited.

P98 para 4 and p 99 para 4: "decline and extirpation of Atlantic salmon populations". These citations for Nova Scotia are 25 years out of date. The most current estimate of extirpations would be found in DFO 2000 (see App. 1). I am surprised that there is no mention of the modeling (MAGIC in particular) pioneered by Cosby out of Charlottesville to forecast recovery of acid leached soils coincident with scenarios in reduction of acid rain emissions e.g., Clair et al. (2004) (See App. 1). I would have thought that there was some modeling done on New England land forms if not on rivers where there is water chemistry data. Nevertheless, the Clair et al. reference would probably have rounded out para 4 on p 99. Clair and Hindar (2005), "Liming for the mitigation of acid rain, effects in freshwaters: A review of recent results" (see App.1) might also have been a useful addition.

P112 para 3: Genetic analyses and catch estimates of US salmon harvested at St. Pierre et Miquelon will be made available at the NASCO meeting June 7-9.

P119 last para: I was expecting to see a statement regarding deleterious effects of electrofishing accompanied by actions taken in at least some California drainages to limit/ dispense with the activity in favor of snorkeling to assess abundance of endangered juvenile salmon.

P121 last para: "The mortality rate of a fish is inversely related to its weight (Matthews and Buckley 1976)" This is the model that has been applied to Atlantic salmon. However, the last decade[+] of increased marine mortality, the demonstrated survival of postsmolts and their relative paucity for large predators during their early months at sea (Lacroix and Knox, 2005 App 1; Beland et al. 2001(?) and others(?)) and the tripling of harp and possible quadrupling of harbour and gray seal populations proximate to the adult migratory routes offer an opportunity to speculate on the need for an adjustment to the inverse weight hypothesis.

P135 para 3: "Maguadavic" should be 'Magaguadavic" (this is not the only misspelling noticed; e.g., "Merrimac" elsewhere)

P139-140: Brown trout. I was looking for a lead off sentence that reminded us that brown trout and Atlantic salmon co-exist in North East Atlantic countries. The casual reader might miss the point given the concerns/ risks to salmon and weight of the text relative to the text for brook trout.

P156, Section 8.4.3.1: This paragraph paints a rather idealistic picture i.e., State authorities (in 2001 there were Commissioners for <u>each</u> of the Department of Marine Resources (LaPointe) and Inland Fish<u>eries</u> and Wildlife (Perry)) working together in the interest of fish restoration. Experience dictates otherwise. In 1995 IF&W introduced and successfully passed in the legislature, "An Act to Stop the Alewives Restoration Program in the St. Croix River". This was in the interest of protecting, (in the absence of scientific validation) a recreational bass fishery from 'competing' alewives. By 2001 the alewife run was virtually exterminated and lobbyists backed by the DMR, MASC, USFWS, (and DFO) gained enough support in 2002 to raise a Bill in the legislature to repeal the 1995 Act. Opposed by the IF&W and enough State representatives, the Bill to repeal was defeated. This episode speaks heavily against a grass roots acceptance of an ecosystem approach in the restoration of Atlantic salmon, the ability of State agencies to work cooperatively and the ability of the US federal government to appropriately influence State politics.

P164 para 3-4: In reading these two paragraphs it is hard to distinguish between current practices, what the Recovery Plan is, and what the NRC suggests are best hatchery practices. The suspicion that recommendations have been for a full pedigree-based mating plan a la *live gene banking* and *living gene banks,* which have not been adopted, is given credence by virtue of the highest-across-the-board grading given in App. 8 p 264. The paragraphs on p 164 would benefit from a clear description of what is currently being done, what is proposed to be done and compare the later with a full scale pedigree-mating plan that would, over many years, minimize the accumulation of inbreeding and loss of genetic variation. It would as well be appropriate to mention the benefits of sperm cryopreservation from the 'founding' adults for reintroduction to the population at/ near the completion of the program. The above elements/ approaches are not new to the BRT and might have been summarized as pers. comm.(s) based on the multi authored and long circulated draft

chapters in Verspoor, E., L. Stradmeyer and J. Nielsen, (eds.) (in press). "The Atlantic Salmon: Genetics, Conservation and Management. London. Blackwell".

P165 'Aquaculture': Information on hybridization between European aquaculture salmon and endangered inner Bay of Fundy Atlantic salmon was first tabled at the Annual meeting of the American Fisheries Society in Quebec City. It is now "in press" (O'Reilly et al. 2006 see App. 1). It is highly probable that the source of the European alleles was the same industry that threatens the Downeast populations.

P168 'marine survival'. The most recent literature citations in this section are older than a decade; many are two decades old. While updating will not change the outcome it could minimally cast survival rates of the last 15 years in the context of the earlier described 1991 'regime shift" referred to in the PVA simulations on p 65. Data, e.g., survival/ return rates from a number of North American wild and hatchery stocks are available in the previously cited reports of the ICES WGNAS.

P172, para 2: Nislow et al. (2004): This work was done on the River Bran in Scotland, not Nova Scotia.

TOR 3 Are the scientific conclusions sound and derived logically from the results?

With respect to TOR 1 and Summary 6.3.1.4, this reviewer credits the BRT 2005 with synthesizing a large volume of information at hand and drawing reasonably logical conclusions. The inclusion of the Penobscot in the DPS is well founded on genetic analyses and the indirect delineation of the CNE and LIS DPSs (save the northern boundary of the latter) are logically deduced on a zoogeographical basis. Without the insight to question the appropriateness of the genetic material from populations in southwest New Brunswick, the analyses of Verspoor et al. (2005a) and the teasing out of specific life history characteristics, the BRT assumes that their conclusions regarding the northern boundary of the GOM DPS are logical and correct. Boundaries aside, it is clear that the loss of the currently defined GOM DPS would be a significant loss to both the United States and likely, North America.

The current distribution and abundance of Maine populations is well documented and in danger of extirpation, particularly if marine survival should continue at the current low values. The projections of the long term sustainability and determination of extinction risks (hatchery fish included) are telling and optimistic given (1) the continued environmental changes such as the 'regime shift' (~ 1991) may not be exclusive to the 90's, (the abundance of some predators continues to escalate) and (2) ongoing loss of genetic diversity and fitness within the hatchery program.

The scientific conclusions or expert opinions on the magnitude of the various stressors (Appendix 8) associated with each of the 'Listing Factors' and their text analysis, number 336. There are few if any additional insights from an individual external reviewer that could alter the conclusions, i.e., by-and-large, the conclusions appear sound and logical. More generalized comments follow.

Land use (8.1.1.4). The projections of urbanization over the next 45 years as portrayed in Fig 8.1.2 present a compelling argument that Atlantic salmon populations will have opportunity at best to persist in only the Dennys, East Machias, Machias, Pleasant, and Narraguagus *refugia*. While

urbanization may not severely impact the East and West Branches of the Penobscot, dams will. The urbanization of Maine has the potential to contribute to a whole suite of stressors: reduced ground water, point source contaminants, endocrine disruptors; altered thermal regimes, altered hydrological regimes, diminished passage by roads and culverts and the introduction of invasive species, among others. Elevated water temperatures will as well be driven by changing climate (Section 814) and result in further reductions of capacity for production of salmon in freshwater. Increased warming resultant of multiple sources and changing demographics in Maine are likely to be the driving force in the consolidation of *preservation* efforts for Atlantic salmon in the more rural refugia. In combination it would seem that these stressors, about which little can be done and which were recognized as only modest stressors on an individual basis, should be recognized in combination as drivers for planning, and preservation of the wild Atlantic salmon as a heritage species.

Seals: The BRTs conclusion regarding potentially significant impact of marine mammals on Atlantic salmon is well founded despite the lack of solid evidence in the literature. Factors contributory to reduced marine survival are numerous, but mounting evidence of early marine survival leads one to speculate that increasingly abundant mammals could be foraging more so on adults than on postsmolts.

Inadequate regulatory mechanisms: Although not listed among the rated stressors, the reviewer strongly agrees with the conclusions of the BRT regarding a number of regulatory mechanisms that are inadequate or inadequately enforced. This is in part a product of the democratic process, and balancing of biological and socio-economics issues. It would seem improbable that the habitat of an endangered species could ever be preserved outside a park–like setting.

Artificial propagation: Based on the across-the-board 'high' values for artificial selection and domestication, effective population size, maintenance of all stocks at a few sites and lack of hatchery stocks, there is more concern among BRT members than is readily apparent in the text p163-164, i.e., the conclusions are not completely apparent from the 'results'. Knowing that maintenance of genetic diversity, minimization of inbreeding and loss of fitness are concerns in this program; it would, as suggested above, have been advantageous to have expanded the text on these points.

Aquaculture: Despite text that conveyed a number of worst case scenarios, e.g., 25-40% of the fish in the North Atlantic were of farm origin (Jonsson 1997) and that in Norway there were thought to be more salmon of farm origin in the wild than wild salmon in the wild (Gausen and Moyen 1991), the BRT appeared to base their judgment of moderate or less stressor severity on the North American experience. This conclusion is realistic. That would include local estimates of farm salmon among river escapes relative to reported escapes from the industry. More science, including evidence of mating in the wild, particularly crosses of foreign ancestry farm salmon and near-by (inner Bay of Fundy) endangered salmon may elevate the concern. (see above).

TOR 4. Where available, are opposing scientific studies or theories acknowledged and discussed?

With respect to the species delineation in TOR 1 this reviewer is unaware of opposing scientific studies/ theories in the literature that actually address the questions examined by the BRT. This

reviewer's suggestion that southern boundary of the GOM may be over extended, that the northern boundary may be underestimated and that likely extirpated headwater tributary populations of the Penobscot and Kennebec could have demonstrated different life history characteristics and possibly genetics than a potentially "residual" population is largely speculative. However the premise for a somewhat alternate hypothesis is rooted in the concern that the few 'Canadian' populations for which genetics data are presented are inadequate to redefine/ better define the northern bound of the existing GOM DPS.

I am unaware of studies suggesting that the Atlantic salmon populations in the southern portion of their North American range are not in danger of extirpation. This includes the adjacent outer Bay of Fundy populations in New Brunswick, the populations of the entire Atlantic coast of Nova Scotia and the designated and 'listed' (endangered) inner Bay of Fundy populations of New Brunswick and Nova Scotia. Designation of the outer Bay and Atlantic coast populations is more than warranted but steps to do so have been resisted by federal authorities.

I am also unaware of additional scientific studies that oppose or downplay the threats to the maintenance and restoration of Atlantic salmon. In the opinion of this reviewer the threats were treated objectively and fairly from all sides. Where there was uncertainty in the data or information, the BSR 'reserved' judgment on the severity (e.g., diseases in particular), qualified their judgment, e.g., "potentially" significant (climate change and predation by marine mammals) and in many cases acknowledged on the basis of the information that there was low or negligible to no threat (beaver dams, over utilization for commercial, scientific purposes, several predation issues, competition, some diseases and some educational/outreach and scientific activities).

I was somewhat surprised however on at least one conclusion: the "low to negligible/ no threat" accorded "dams--alter native resident aquatic communities". Evidence was presented regarding changes in water temperatures behind impoundments, and changes in fish community structure through the spread of exotics (bass and chain pickerel in particular). The development of a lentic (non native) community with demonstrated capacity to prey on Atlantic salmon and the reduction/ elimination of the lotic and native fish community and habitat and production capacity would seem to this observer to be of at least moderate severity.

Summary of Analyses and Comments

For the most part, the information within the 'Status Review' supports delineation of the LIS, CNE and GOM DPSs. The bounds of the CNE, LIS and southern boundary of the GOM DPS rely heavily on expert opinion; the inclusion of the Penobscot in the DPS is well founded. The genetics argument for the delineation of the northern boundary of the GOM is appropriate if the evidence is accepted at face value. However, given the uncertainty of the representativeness of the genetic samples used in delineating the northern boundary of the GOM DPS and the interpretation possible from 'new' materials, the genetics of other samples from southwestern and western New Brunswick should be examined before making a judgment to alter the northern boundary ruling of 2000.

The 600^{+} citations background to the assessment constitutes a comprehensive background of largely up-to-date information on the species and threats to it and its habitat. Another six or seven references were provided that would embellish individual cases but would not affect the outcome to

any significant extent. A few of the citations were as well misread/ misquoted but this also did not affect the outcome.

The conclusions are as a rule sound and derived logically from the results. This is true for the DPS delineation question given that none of the BRT had enough insight to question the appropriateness of the genetic material, digest new literature or evaluate specific life history characteristics of salmon populations neighboring the GOM DPS in southwest New Brunswick. The current distribution and abundance is well documented and, based on abundance of wild fish, is in danger of extirpation, particularly if marine survival should continue at the current low. The projections of the long term sustainability and determination of extinction risks (hatchery fish included) are revealing and perhaps overly optimistic in the light of ongoing environmental changes and absence of a pedigree mating program within the hatchery.

The scientific conclusions or expert opinions on the magnitude of the various stressors on Maine salmon populations are drawn from a wealth of literature and concisely summarized. This reviewer had no insights that could alter the conclusions but did offer the following comments:

- *Land use/ climate change:* The projections of urbanization over the next 45 years present a compelling argument that Atlantic salmon populations will at best persist in only the Dennys, East Machias, Machias, Pleasant, and Narraguagus refugias. Climate change will elevate temperatures and result in further reductions of capacity for production of salmon in freshwater.
- *Seals*: The BRTs conclusion that marine mammals could have a potentially significant impact of on Atlantic salmon is reasonable despite the absence of solid evidence.
- *Artificial propagation*: The 'high' stressor severity grades assigned by the BRT to the hatchery program present a compelling case for concern over the present program to maintain genetic diversity, minimize inbreeding and halt the loss of fitness.
- *Aquaculture*: The BRT judged the aquaculture industry to be of moderate or low stressor severity perhaps because they anticipate the removal of all farm escapes from river spawning escapements. Evidence of mating in the wild, particularly crosses of farmed salmon with foreign ancestry and local endangered salmon may elevate the concern.

The delineation of the DPSs for the species (genetic inputs aside) appeared to be 'original', perhaps developed in committee, i.e., opposing scientific studies/ theories at least in the literature were unavailable. Similarly there are no opposing studies on the status of stocks in Maine. A cross - section of scientific studies were presented on 48 identified threats to the maintenance and restoration of Atlantic salmon. These were reported objectively and assessed fairly.

Conclusions/ Recommendations

The Status Review represents a considerable effort in the provision of an objective assessment of possible DPSs, stock status, and threats to its habitat. Conclusions/ recommendations may be summarized as follows:

- The inclusion of the Penobscot in the GOM DPS is well founded.

- There is insufficient information to convincingly redefine the northern boundary of the GOM DPS and it is recommended that additional genetics from southwestern and western New Brunswick be obtained to confirm the proposed boundary.
- The southern boundary of the GOM DPS is based on expert opinion and is unlikely to be improved upon.
- Maine populations of wild Atlantic salmon are nearing extirpation; continued changes in land use, climate, marine ecosystem and the level of concern expressed regarding the loss of genetic diversity and fitness within the hatchery program suggest that the time line for extinction of hatchery and wild components could be less than forecast.
- The forecast urbanization of southwestern Maine, and the social costs/ obstructions to removing dams/ providing multiple fish passage through less than pristine habitats of large drainage systems suggest that *preservation* efforts for Atlantic salmon as a heritage species focus strictly on the present refugia in Downeast Maine.

Appendix 1

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Appendix 2

Statement of Work

Background

The purpose of this technical review is to ensure that the scientific information presented and analyzed in the Status Review for Atlantic salmon in the United States is the best available scientific data.

On November 17, 2000, the National Marine Fisheries Service and the U.S. Fish and Wildlife Service (the Services) issued a final rule to list the Gulf of Maine Distinct Population Segment of Atlantic Salmon (GOM DPS) as endangered under the Endangered Species Act (ESA). The GOM DPS was defined as all naturally reproducing wild populations of Atlantic salmon, having historical river-specific characteristics found north of and including tributaries of the lower Kennebec River to, but not including the mouth of the St. Croix River at the United States-Canada border and the Penobscot River above the site of the former Bangor Dam. Populations which met these criteria were identified as being in the following rivers: Dennys, East Machias, Machias, Pleasant, Narraguagus, Sheepscot, Ducktrap, and Cove Brook.

In the final rule listing the GOM DPS, the Services deferred the determination of inclusion of fish that inhabit the main stem and tributaries of the Penobscot River above the site of the former Bangor Dam. The deferred decision reflected the need for further analysis of scientific information, including a detailed genetic characterization of the Penobscot population. In addition, the Services were committed to reviewing data regarding the appropriateness of including the upper Kennebec and other rivers as part of the DPS. In late 2003, the Services assembled a Biological Review Team (BRT) comprised of biologists from the Maine Atlantic Salmon Commission, Penobscot Indian Nation, NMFS, and USFWS. The BRT was charged with reviewing and evaluating all relevant scientific information necessary to evaluate the current DPS delineations and determining the conservation status of the populations that were deferred in 2000 and their relationship to the currently listed GOM DPS.

NOAA Fisheries is required to use the best available scientific and commercial data in making determinations and decisions under the ESA. The first question that must be addressed is what the appropriate species delineation is for consideration of conservation status. The ESA defines an endangered species as “any species which is in danger of extinction throughout all or a significant portion of its range,” and a threatened species as “any species which is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range.” A species may be determined to be threatened or endangered due to any one of the following factors:

(1) the present or threatened destruction, modification, or curtailment of its habitat or range;
(2) overutilization for commercial, recreational, scientific or educational purpose;
(3) disease or predation;
(4) the inadequacy of existing regulatory mechanisms; and
(5) other natural or manmade factors affecting its continued existence.

The scientific and commercial information contained in the Status Review will likely contain essential factual elements upon which the agency could base its ESA determination. Accordingly,

it is critical that the Status Review contain the best available information on the species and the threats, that all relevant information is identified and included, and that all scientific findings be both reasonable, and supported by valid information contained in the document.

Objectives of the CIE Review

As stated above, the Status Review has been prepared by the BRT. The Center for Independent Experts (CIE) shall review the Status Review Report to ensure that its contents can be factually supported and that the methodology and conclusions are scientifically valid.

There are several primary issues related to this species that must be addressed, and, therefore, reviewers with the following expertise are required to ensure the best available information has been utilized:

1. Life history and population dynamics of Atlantic salmon;
2. Atlantic salmon genetic, physiological, behavioral, and/or morphological variation throughout the species' range;
3. Habitat requirements;
4. Predation and disease;
5. Regulatory mechanisms for managing the species;
6. Other natural or manmade impacts affecting Atlantic salmon;
7. Aquaculture; and
8. Conservation actions including restoration efforts and recovery activities (including the conservation hatchery program).

Familiarity with ESA is also highly desirable. Each reviewer will be supplied with the Status Review Report prepared by the BRT. Any of the reports and papers cited in the Status Review Report will be made available to the reviewers upon their request.

Specific terms of reference for the CIE review:

a. Is the species delineation supported by the information presented?
b. Does the Status Review include and cite the best scientific and commercial information available on the species and threats to it and to its habitat?
c. Are the scientific conclusions sound and derived logically from the results?
d. Where available, are opposing scientific studies or theories acknowledged and discussed?

Specific Activities and Responsibilities

The CIE shall provide four reviewers to conduct a letter review of the Status Review Report. Each reviewer's duties shall not exceed a maximum of five work days. Each reviewer shall analyze the Status Review Report and develop their report in response to the above terms of reference. The reviewers shall conduct their analyses and writing duties from their primary locations. Each written report is to be based on the individual reviewer's findings, and no consensus report shall be accepted. See Annex I for additional details on the report outline.

No later than May 15, 2006, each reviewer's report shall be submitted to the CIE for review[1]. The reports shall be sent to Dr. David Sampson, via email at david.sampson@oregonstate.edu, and to Mr. Manoj Shivlani, via email at mshivlani@rsmas.miami.edu.

[1] Each written report will undergo an internal CIE review before it is considered final.