Discussion of the Potential Effects of Catch & Release Angling on Egg Deposition of Atlantic Salmon on The Greater Miramichi River System, and Emphasis of the Importance of Multi-Sea-Winter Salmon in Maintaining the Populations

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The Precautionary Approach (PA) is a method for determining the annual harvest rates for a species to ensure continued health and productivity of Canada's fisheries and healthy fish stocks. All removals of these stocks from all types of fishing must be considered. The three components of the PA are:

1. Defining the so-called Limit Reference Point (LRP) and the Upper Stock Reference (USR) that divide the stock into Critical (dangerously low), Cautious (below desirable, but not dangerous) and healthy zones.
2. Harvest strategy and harvest decision rules within the zones; and
3. Accounting for uncertainty and risk when considering #s 1 and 2.

The PA reference points and zones are illustrated below. The stock status is on the X-axis and the removal rate (harvest) is on the Y. The PA for Atlantic salmon would establish the removal rates within each zone – i.e., draw the removal line with removals increasing with improving stock status. When the stock is in the critical zone, management actions must promote stock growth and removals by all human sources must be kept to the lowest possible level.

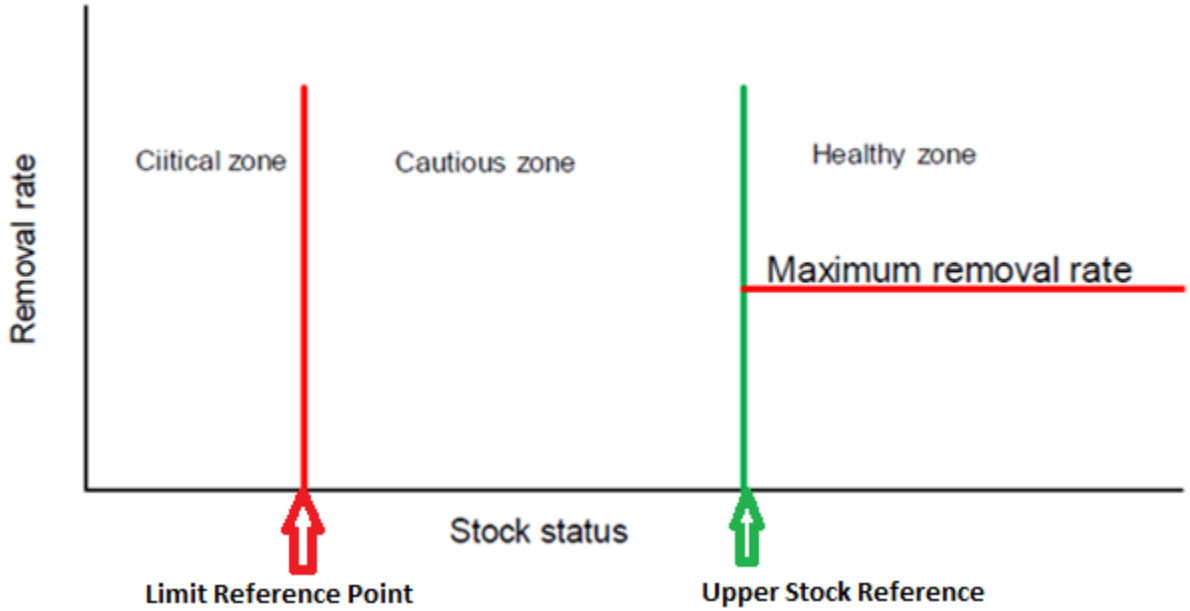

Figure 1. The Zones of the PA as Divided by the Limit Reference Point and Upper Stock Reference

In terms of the Atlantic salmon fishery, it is "egg deposition", the number of eggs per unit area of stream bottom that is the "currency" (Stock Status) by which the PA will be implemented. The greater the anticipated egg deposition in any year, the more salmon (in terms of the number of eggs they carry) can be removed. DFO is currently in discussions as to what regulations under the PA will govern the Atlantic salmon fisheries on the greater Miramichi River drainage. The NB Salmon Council (the NBSC) has been included among groups that have input to discussions on the recreational fishery rules. The NBSC has teamed with the Atlantic Salmon Federation, the NB Wildlife Federation, the Miramichi Salmon Association, and the Miramichi Watershed Management Committee to lobby for the role of anglers in salmon conservation at various levels of predicted egg depositions. The major argument of this group is that Catch & Release (C&R) angling has little-to-no effect on egg deposition and in fact, the presence of anglers on the water deters and reports poaching. The following are arguments

that were made by the NBSC internally within the group of five conservation organizations as well as to DFO, which is leading the consultation process. First Nations' representatives are also participating in the recreational fisheries consultation process under the PA.

The Limited or Virtually Zero Effect of C&R Angling on Egg Deposition: The initial assumption of the Precautionary Approach exercise in the context of the recreational salmon fishery is that Catch & Release (C&R) angling may cause irreparable harm to salmon populations by decreasing egg deposition, particularly at low rates of adult return. The assumptions are:

1. 30% of the salmon run is caught and released. This may have been true in the past; however, licence sales are now far lower (Figures 2 and 3). Relative to the peak year sales of 1989 through 1993, New Brunswick resident salmon licence sales have decreased by two thirds. Unfavourable water conditions, grilse retention prohibition and salmon scarcity have contributed to less participation, even among those who do purchase licences (personal observation). Debbie Norton, a lodge owner, and outfitter has seen far fewer anglers on the water since mandatory C&R was implemented in 2015. Mark Hambrook of the Miramichi Salmon Association stated during consultations that fishing effort is regulated by the number of fish, with fewer fish resulting in less effort. Considering that mortality from C&R, and therefore the egg deposition loss, is very insensitive to the percentage of salmon and grilse that are captured and released the 30% figure would seem to be an acceptable acquiescence to those favouring a more conservative (higher) rate of catch.

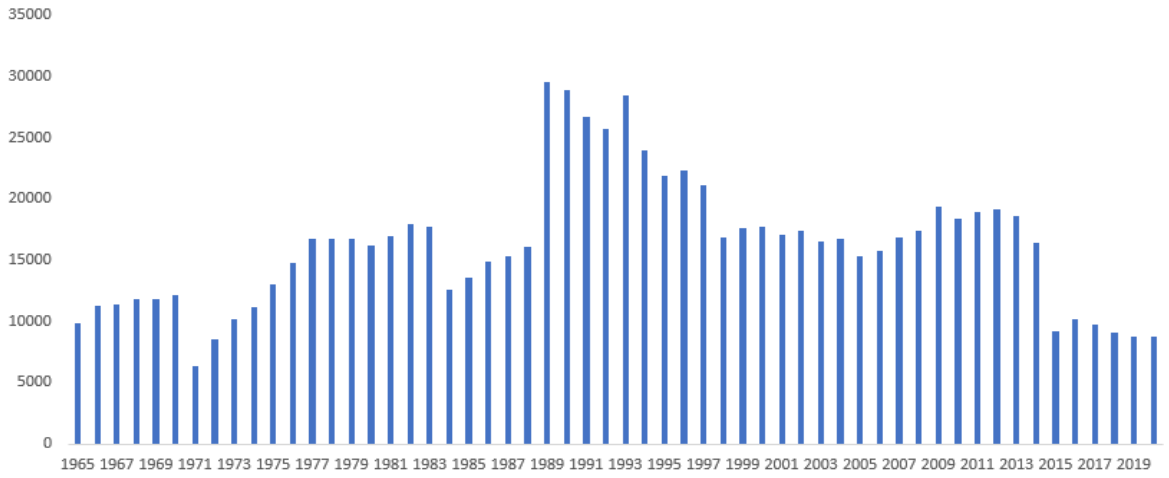

Figure 2. NB Resident Atlantic Salmon Licence purchases – 1965 to 2019

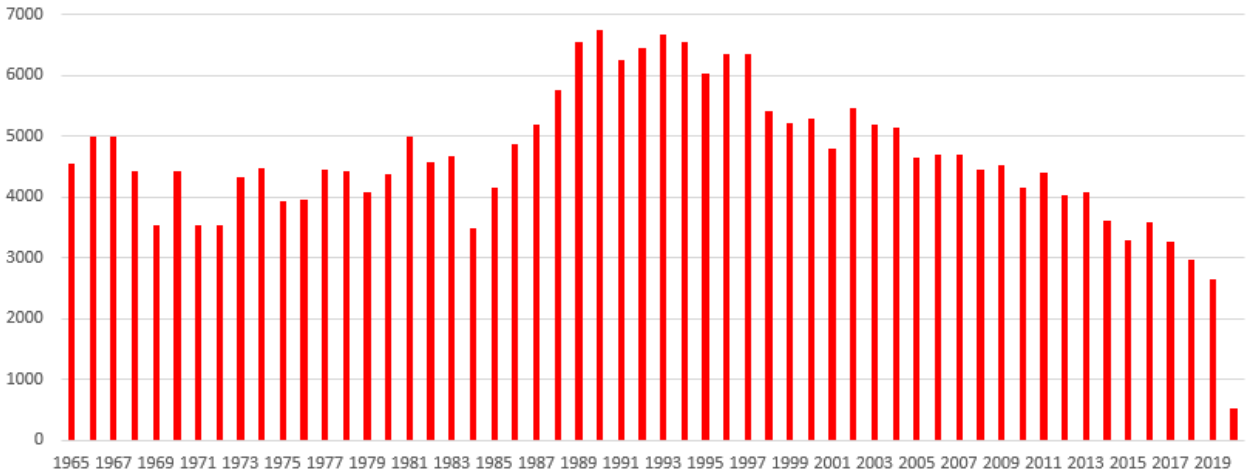

Figure 3. NB Non-Resident Atlantic Salmon Licence purchases – 1965 to 2019

Source: NB Natural Resources and Energy Development

2. The second assumption is that there is a 3 to 5% mortality rate among salmon that are caught and released by anglers. This range seems to have been drawn from Upsalquitch observational data from 1992 and 1993. Madden (2004) contends that these fish were infected with furunculosis, a disease that would at least lead to an inflation of these mortality rates. A 4% figure for cold water was published by Lennox et. al. (2017). This paper was a meta-analysis of various papers on catch & release survival of salmon. Many of these component studies involved catching salmon, then anaesthetizing them, forcing a transmitter down their throats, or attaching a receiver to them, holding them for a period, then releasing them. The studies were therefore analyzing the mortality rates from not only C&R, but in addition, handling, tagging, holding etc. The additional stress would have caused incremental mortality. In addition, the natural mortality rate in the period from tag application to the ultimate decision on survival / mortality is not accounted for (no control group – salmon do die from effects other than those of C&R angling). Madden gives a more realistic number for C&R mortality – 0.5% or less, granted, on a cool stream. An excerpt:

> Ample studies indicate that, when played and properly handled and released, fish survive. From 1982 to 1987, DNR biological staff documented extremely low mortality of salmon hooked and released in the North Pole Stream, a major tributary of the Miramichi. As the name indicates, the North Pole is cool all summer, not exceeding 21° C during 1982 to at least 1985. In the first two years of the study, even though all angled fish (95) were held in boxes for 24 hours to monitor survival, only 2.1 per cent died there. From 1984 to 1987, anglers released all salmon directly into the stream, i.e., no boxes. For the years 1982 to 1985 inclusive, and 1987 combined (the 1986 report was unavailable), anglers released a total of 590 fish, but only 0.5 per cent (3) died, based on reports by anglers, wardens and rangers. In fact, for three consecutive years (1983-1985), not one dead fish was reported.

The following table presents an analysis of the effects of the three C&R mortality rates (i.e., 5, 3 and 0.5%) on egg deposition. Even if the 30% run-capture and the 3% mortality rates are accepted, the table demonstrates, the predicted egg deposition losses are minimal – fewer than 2 eggs per 100 m^2 unit at the Limit Reference Points[1] (LRPs - the points in the PA at which an egg deposition produces one half the maximum number of smolts for that river) for the SW and NW systems, and fewer than 1 egg per unit at predicted deposition levels of 50% or less of the LRP Restricting C&R would only minimally decrease these losses because there is virtually no scope for improving egg deposition by employing these restrictions. The minimal incremental losses would be easily compensated through the "eyes-and-ears" benefits of having salmon anglers on the water. The initial assumption of this Precautionary Approach exercise (i.e., that C&R angling may cause irreparable harm to salmon populations by decreasing egg deposition, particularly at low rates of recruitment) is invalid. Subjecting the recreational C&R fishery to limitations under the PA is a waste of time.

[1] LRPs as determined by DFO are, for the Northwest Miramichi, 1.74 eggs per 100 m^2 of stream bottom, and for the Southwest Miramichi, 1.54 eggs per 100 m^2 of stream bottom

Table 1. Theoretical Egg Deposition Losses from the C&R Fishery at Various Ratios of LRP Achievement

NW LRP	174	eggs/ 100 m^2				
SW LRP	154	eggs/ 100 m^2				
Ratio Run Caught	30%					
System	Ratio LRP	Predicted Deposition	Calculations	C&R Mort 5.0%	C&R Mort 3.0%	C&R Mort 0.5%
NW	100%	174	Deposition after C&R....	171.4	172.4	173.7
SW	100%	154	Deposition after C&R....	151.7	152.6	153.8
NW	100%	174	Loss in Deposition NW (eggs/100 m^2)	2.61	1.57	0.26
SW	100%	154	Loss in Deposition SW (eggs/ 100 m^2)	2.31	1.39	0.23
NW	10%	17.4	Loss in Deposition NW (eggs/100 m^2)	0.26	0.16	0.03
SW	10%	15.4	Loss in Deposition SW (eggs/ 100 m^2)	0.23	0.14	0.02
NW	25%	43.5	Loss in Deposition NW (eggs/100 m^2)	0.65	0.39	0.07
SW	25%	38.5	Loss in Deposition SW (eggs/ 100 m^2)	0.58	0.35	0.06
NW	50%	87	Loss in Deposition NW (eggs/100 m^2)	1.31	0.78	0.13
SW	50%	77	Loss in Deposition SW (eggs/ 100 m^2)	1.16	0.69	0.12
NW	75%	130.5	Loss in Deposition NW (eggs/100 m^2)	1.96	1.17	0.20
SW	75%	115.5	Loss in Deposition SW (eggs/ 100 m^2)	1.73	1.04	0.17

Admittedly, there are “hot” spots where fish are being played too long, and not being immediately released after capture. Fisheries officers would know where these spots are. The lodge owners in the camps should be approached and effective C&R techniques explained to them so that the information can be passed on to their guides and guests.

Historical Effect of Management Measures Restricting the Recreational Salmon Fishery Harvest on the Miramichi: Table 2 presents an analysis of the effects of eliminating the MSW harvest by anglers (as occurred in the 1980s), the elimination of the grilse harvest as occurred in 2015, and the proposed elimination or scale-back of Catch & Release angling. Using the LRP for each river as the base case, the elimination of the MSW harvest had a huge effect, the elimination of the grilse harvest had minimal effect, and the proposed scale-back of C&R would have virtually zero effect.

Table 2. Value of Effectiveness of Elimination of 1. MSW Harvest, 2. Grilse Harvest, and 3. Catch& Release Harvest (LRP as base case)

Basic Assumptions

River	Prop. Large	Prop. Small	Prop. Female Lg.	Prop. Female Sm.	Fecundity Lg.	Fecundity Sm.	Eggs/ Fish Lg.	Eggs/ Fish Sm.	Total Eggs	Prop. from Grilse
Northwest Miramichi	0.34	0.66	0.81	0.24	7427	3612	2045	572	2618	21.9%
Southwest Miramichi	0.45	0.55	0.81	0.11	7508	3651	2737	221	2958	7.5%

From: DFO Can. Sci. Advis. Sec.Sci. Resp. 2018/015

Northwest Miramichi

Scenario	Scenario NW	Management Action	Prop. Lg. Harvested	Prop. Sm. harvested	Eggs Lost Lg.	Eggs Lost Sm.	Total Eggs Lost	Prop. Eggs Lost	LRP (eggs/ 100 m^2 Unit)	Eggs Lost from Angling	Resultant Egg Dep.	**Verdict on Effectiveness of Management Action**
1	MSW + Grilse Harvested	MSW Harvest Eliminated	30.0%	30.0%	614	172	785	30.0%	174	52.2	121.8	**Very Effective**
2	Grilse Only Harvested	Grilse Harvest Eliminated	0.9%	30.0%	18	172	190	7.3%	174	12.6	161.4	**Maybe**
3	Catch & Release	C&R Eliminated	0.9%	0.9%	18	5	24	0.9%	174	1.6	172.4	**Ineffective**

Southwest Miramichi

Scenario	Existing Situation	Management Action	Prop. Lg. Harvested	Prop. Sm. harvested	Eggs Lost Lg.	Eggs Lost Sm.	Total Eggs Lost	Prop. Eggs Lost	LRP (eggs/ 100 m^2 Unit)	Eggs Lost from Angling	Resultant Egg Dep.	**Verdict on Effectiveness of Eliminating**
1	MSW + Grilse Harvested	MSW Harvest Eliminated	30.0%	30.0%	821	66	887	30.0%	154	46.2	107.8	**Very Effective**
2	Grilse Only Harvested	Grilse Harvest Eliminated	0.9%	30.0%	25	66	91	3.1%	154	4.7	149.3	**Ineffective**
3	Catch & Release	C&R Eliminated	0.9%	0.9%	25	2	27	0.9%	154	1.4	152.6	**Ineffective**

Importance of Protecting Multi-Sea-Winter Salmon on the Miramichi System: Calculations presented in Table 3 demonstrate that multi-sea-winter (MSW) salmon on both major Miramichi drainage composites are vital to maintaining egg deposition, and that grilse have little effect on salmon population maintenance. The calculations use data from DFO (2018) to determine that, on average, 78.1% of the annual egg deposition on the Northwest (NW) Miramichi is from MSWs, and this value is 92.5% on the Southwest (SW) Miramichi (green text in calculation).

Atlantic Canadian rivers with higher proportions of egg deposition by MSWs have lower LRP values than those with a high percentage of female grilse. This concept is an important component in the establishment of the LRP for different salmon rivers, and is graphically represented in Figure 4 (copied from Chaput, 2018). This is thought to be because MSW eggs, and therefore fry are bigger and consequently have a survival advantage over fry produced from grilse eggs (Chaput, pers. comm., 2018). In a river with 0% egg deposition from MSW salmon, the 75% confidence LRP would be ~304 eggs per 100 m^2 unit. At 100% egg deposition from MSWs, the LRP is ~152.

This relationship indicates that eggs produced by female grilse are "effectively" only ~50% (152/304) as valuable as those spawned by MSWs. Therefore, eggs deposited by grilse for each river can be discounted by that amount. So, the "effective" value of an egg spawned by an MSW female salmon is 1.0, and the "effective" value of a grilse egg is 0.5. For every 100 eggs deposited on the NW Miramichi, 78.1 would come from MSWs, and the "effective" deposition would be 78.1 (78.1 × 1.0). 21.9 of the 100 eggs would be spawned by female grilse, but the effective deposition would be only 11 (21.9 × 0.5) eggs. The "effective" total deposition from the 100 spawned eggs would be 78.1 + 11= 89.1. The "effective" egg deposition rate from MSW salmon on the NW Miramichi in an average year is 87.7% (78.1 ÷ 89.1), with the "effective rate for grilse being the remainder – i.e., 12.3%. Using the same calculations for the SW Miramichi, the egg deposition from MSW salmon would increase from 92.5% (actual) to 96.1% (effective). Effective egg deposition rate calculations from MSW salmon for the NW and SW Miramichi systems is depicted in the red text in Table 3.

This exercise illustrates the importance of protecting MSW spawners in the greater Miramichi River system. It also strongly suggests that even at low-to-moderate recruitment levels, a grilse harvest will not have a major impact on egg deposition.

Table 3. Calculation of Effective Egg Deposition from Multi-Sea Winter Salmon, Northwest, and Southwest Miramichi Rivers

Basic Data

River	Prop. Large	Prop. Small	Prop. Female Lg.	Prop. Female Sm.	Fecundity Lg.	Fecundity Sm.	Eggs/ Fish Lg.	Eggs/ Fish Sm.	Total Eggs
Northwest Miramichi	0.34	0.66	0.81	0.24	7427	3612	2045	572	2618
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From: DFO Can. Sci. Advis. Sec.Sci. Resp. 2018/015

Calculations

River	Prop. from MSWs	Prop. From Grilse	Value Grilse Egg vs. MSW Egg	Discounted Grilse Ratio	Value Eggs with Grilse component Discunted	Effective MSW % Egg Dep.
Northwest Miramichi	78.1%	21.9%	50.0%	10.9%	89.1%	87.7%
Southwest Miramichi	92.5%	7.5%	50.0%	3.7%	96.3%	96.1%

(*): As interpreted from: Part II - Developing limit reference points for salmon populations of Gulf Region. 75% Confidence SLRP (see below)

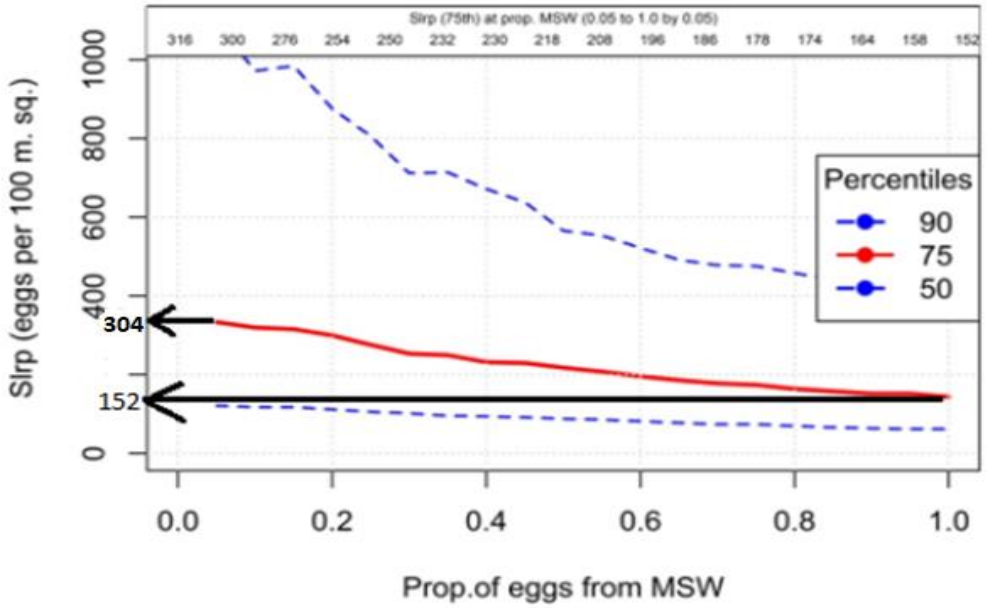

Figure 3. Relationship Between Proportion of MSW Salmon Contributing Egg Deposition and the 75% Confidence LRP for Various Atlantic Canadian Rivers
(*): Copied from: Chaput (2018). Part II - Developing limit reference points for salmon populations of Gulf Region. 75% Confidence SLRP

References:

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Chaput. 2018. Part II - Developing limit reference points for salmon populations of Gulf Region. 75% Confidence SLRP. Hand-out to Precautionary Approach Consultation Meeting in Miramichi.

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