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Perfunctory estimates of allowable harvests of Atlantic
salmon in 18 rivers of Scotia-Fundy Region

by

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Abstract

Perfunctory estimates suggest that as many as 800 MSW and 14,000 1SW Atlantic salmon have, on average, been surplus to spawning requirements in 18 selected rivers of Scotia-Fundy Region. Estimation was hampered by i) the absence of estimates of spawner requirements for 9 acid-impacted rivers and ii) the utilization of assumed exploitation rates in the estimation of river returns from recreational harvest data. Discussion focuses on the estimation of surpluses from 5-year mean recreational harvest values, on managing to the estimates of surplus without in-season checks and adjustments and on the importance of hatchery production in maintaining surpluses.

Résumé

Des estimations superficielles au sujet du saumon de l'Atlantique indiquent que les besoins en géniteurs ont été dépassés de quelque 800 pluribermarins (PBM) et 14 000 unibermarins (UBM) en moyenne dans les 18 rivières sélectionnées de la région de Scotia-Fundy. Toutefois, ces estimations ont été entravées par les facteurs suivants : i) l'absence d'estimation sur les besoins en reproducteurs dans neuf rivières affectées par les pluies acides; ii) l'utilisation de taux d'exploitation hypothétiques dans l'estimation des montaisons à partir des prises sportives. Il est essentiellement question ici de l'estimation des surplus par rapport à la moyenne quinquennale des prises sportives, de la gestion de ces surplus estimés sans vérification et rectification en cours de saison, ainsi que de l'importance de la production des écloséries dans le maintien des surplus.

Introduction

The ability to define target spawning requirements and to accurately forecast returns of Atlantic salmon to rivers is a desirable goal of Atlantic salmon management. Knowledge of both parameters permits the pre-season setting of harvest levels knowing, with a measure of certainty, that conservation will be met. In the Scotia-Fundy Region, forecasts of salmon stocks have previously been available only for 1SW and MSW stocks originating at/above Mactaquac on the Saint John River and MSW stocks on the LaHave and Liscomb rivers. Advice of such a specific nature for the following year has not previously been provided prior to completion of returns in the current year.

This document addresses fisheries management's request for estimates in September of the future numbers of salmon that could be surplus to spawning requirements in 18 rivers of Scotia-Fundy Region - 15 of which had not been previously assessed. Rivers for which forecast surpluses were requested include:

<u>SFA 19;</u>	Middle, Baddeck, North and Grand,
<u>SFA 20;</u>	St. Mary's, Liscomb, East and West Sheet Harbour and Musquodoboit,
<u>SFA 21;</u>	Gold, LaHave, Medway, Mersey and Tusket,
<u>SFA 22;</u>	all rivers, but most importantly, Shubenacadie and Stewiacke,
<u>SFA 23;</u>	Saint John above Mactaquac and Nashwaak.

No data were available to provide forecasts specific to 1992. Hence advice was provided largely in terms of the average surplus to conservation during the period 1986-90.

Methods

Separate approaches were used to identify potential surpluses for acid-impacted and non-acid-impacted rivers.

1. Acid-impacted rivers include most rivers of the eastern and south shores of Nova Scotia (SFAs 20,21) for which total substrate areas $>0.12\%$ have been estimated by remote surveys but for which no assumption has been made about the utility of a standard 2.4 eggs/m² requirement. Egg requirements, and subsequently spawner requirements, are unknown because egg and juvenile survivals are limited by highly variable pH conditions [both temporal and spatial] within each drainage. Surpluses for these rivers were, by default, generally identified as the recreational fishery harvest for the years 1986-90 (inc. O'Neil et al. 1987, 1989, 1991). This implies that escapement of 1SW and MSW salmon meets conservation requirements and that recreational harvests and an assumed mortality of 5% of hook-and-released MSW fish represent, on average, a safe surplus to spawning requirements. Five-year sport

catch values rather than 10-, 15-, or 20-year means are used because they best reflect returns affected by the Salmon Management Plan since 1984. Also, pre-1983 recreational harvest data for SFAs of Nova Scotia were collected differently than the current licence stub return system.

Where pH precluded natural recruitment, surpluses are the adult returns of stocked hatchery smolts. All acid-impacted rivers considered herein are stocked and, in most, the escapement of hatchery fish contributes to either the preservation of depleted stock components or the maintenance of harvests. Future surpluses in these rivers are dependent on levels of stocking.

The nine acid-impacted rivers include: East River Sheet Harbour, West River Sheet Harbour, Liscomb, St. Mary's, Gold, LaHave, Medway, Mersey and Tusket.

2. Non-acid-impacted rivers include the remaining rivers for which spawners substrate area has been quantified and target eggs and spawners have been estimated. Hatchery broodstock requirements are not included in the target. Substrate was quantified in Nova Scotia on the basis of remote surveys ($> 0.12\%$ orthogradient) and in New Brunswick by field surveys without gradient qualification. With one exception (Nashwaak), surpluses were the difference between estimates of total river returns and spawner requirement.

Total returns were estimated for seven Nova Scotia rivers (Grand, Middle, Baddeck, North, Musquodoboit, Shubenacadie and Stewiacke) by expanding recreational catches (1SW retained and MSW released) by an assumed exploitation rate.

Total returns for the Saint John (at/above Mactaquac) and Big Salmon rivers of New Brunswick were derived from counts at a fishway and counts in-river (salmon pools), respectively. No returns were estimated for the Nashwaak River, N.B., because of the absence of counts, of the uncertainty in choosing between two quite different estimates of recreational harvest, and of the absence of an appropriate exploitation rate.

Sport landings for SFAs 19-22 are based on Nova Scotia licence stub returns; those of SFA 23 were obtained from DFO and New Brunswick Dept. of Natural Resources and Energy field personnel and through creel surveys conducted by the Central Branch, Saint John River Salmon Anglers Association.

Results

Estimates of average surpluses-to-requirements for the specified 18 stocks in Scotia-Fundy Region are 841 1SW and up to 13,974 MSW Atlantic salmon (Table 1). The background for each assessment is provided in Tables 2-20.

Discussion

The concerns relevant to the estimation of potential surpluses of Atlantic salmon in rivers for which little quantitative information is available can be summarized as follows:

1. Recreational catch data as a basis for future surpluses

Many problems associated with using recreational harvest data as a pre-season "forecast" of surpluses are significantly worse than those for pre-season forecasts based on stock-recruit models. Problems are particularly acute on small streams with little or no harvest or reporting thereof. Lack of harvest can indicate that surpluses are small, or, with assumed exploitation rates, are non-existent and that run-size is insufficient to meet conservation requirements. During low and/or warm water conditions, fish may have been denied access to the river and to exposure to the traditional recreational fishery. Objective treatment of this type of harvest data suggests that returns were low rather than just unavailable to the fishery. Conversely, high surpluses may be mistakenly interpreted in stocks that yield abnormally high proportions of their numbers under ideal angling conditions.

2. Mean values, 1986-1990 as future surpluses

Five-year arithmetic means of recreational catch data can obscure the potential impact of events in the most recent year(s). Indeed, a 5-year mean that precludes use of the nearly complete knowledge of the current year is particularly troublesome, e.g., events in 1990 and 1991 that contributed to lower than expected 1SW returns and catches in 1991 (to date) are likely to impact on MSW returns in 1992. Thus, it could well be folly to extrapolate averages for 1986-1990 into and beyond 1992. This problem is most acute in MSW data which, in their raw format, may be inflated by multiple-hooked fish. Conversely, estimates of MSW catches which are projected to total returns with historical exploitation rates (derived using "landings" and therefore lower than those based on "releases") would tend to underestimate run-size and surpluses.

3. In-season adjustments

In-season estimates or indices of run-size can be derived from information at fishways that are, or can be, manned, or that can be automated to count salmon. Some smaller rivers, particularly those which have clear water, and no fish counting facilities could be assessed by teams of divers. Snorkelling of some/all holding pools in indicator rivers could generate either complete river counts or indicator-pool counts of small and large salmon that could be applied on a seasonal basis. Trapping facilities (e.g., partial fences or trap nets or an electrofishing boat) offer opportunities to develop indices of run-size or estimates of run-size based, for example, on mark-recapture methods.

4. Impact of 1991 returns on future surpluses

1SW returns in 1991 were low throughout the region. This downturn is expected to be reflected in 1992 in stocks in which some portion of the fish return as MSW salmon. Small numbers of returns will result in reduced egg depositions by 1SW fish in 1991 and the same can be expected in 1992 by MSW salmon unless exploitation of MSW salmon is reduced.

5. Mixed stock harvests

Reduced egg depositions of particular stock components are likely to occur in wild stocks if managers do not confine net fisheries to locations where stock components are "mixed". For example, early-season netting in headwater refugia could decimate unique early-run components. Fisheries managers will therefore require advice on unique stock components, their stream of origin and run-timing so that fishing plans can be developed to ensure escapement of the broadest possible genetic base.

6. Broodstock as spawning requirements

Hatchery broodstock are not included in target spawning requirements even though continued hatchery releases are essential to sustain the identified surpluses. Given the heavy dependence of some rivers on hatchery stocking, variable release numbers and quality of the hatchery product can affect hatchery returns and determine surpluses. Variable marine survival can be expected to affect equally the return rates for hatchery and wild smolts. There are no broodstock requirements for rivers which do not have some natural recruitment capacity, e.g., rivers which are, acidified and obstructed, other than those cases where stocking is done to create put-and-take fisheries, e.g., Mersey River.

7. Utility of hatchery production

Hatchery stocking is used to mitigate the loss of salmon habitat (e.g., impoundment or acidification of rivers) and rebuild (enhance) stocks and stock components which, for reasons such as past over-exploitation, have been depressed (e.g., early-run, virgin 3SW and Serrentine). Unfortunately many of the rivers for which surpluses are declared include stock components which are currently being enhanced. To continue these efforts in certain rivers (Saint John, St. Mary's and Middle rivers, to name a few), fisheries managers will require more specific information on season and fishing locations which should be closed to fishing. Surpluses and hatchery stocking can also be used to develop salmon runs in new habitat, e.g., Saint John River upriver of Grand Falls. Fisheries managers and users must be made aware of the costs of the alternatives in allocating all surpluses to fisheries.

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Table 1. Atlantic salmon spawning requirements and average surplus to requirements for 18 rivers in Scotia-Fundy Region with current or potential for native food fisheries. (Big Salmon River, N.B. inc. only because it is used as an indicator for stock status in the Shubenacdie and Stewiacke rivers)

SFA	River	Spawning Requirements		Average Surplus to Conservation		Comments
		MSW	1SW	MSW	1SW	
19	Middle	470	80	0	165	Native Food Fishery quota of 130 salmon exploits fish returning to the Middle and Baddeck rivers.
19	Baddeck	450	80	0	35	Average of 10 MSW lost in hook-and-release mortality.
19	North	200	30	574	370	Apparent high returns of salmon requires verification before surpluses are allocated.
19	Grand	100	440	74	487	Unknown removals may exceed the 20% poaching and disease factor included in the 2.4 eggs m ⁻² target.
20	St. Mary's	unk	unk	27	1007	Acid-impacted, surplus assumed to equal the 5 yr mean harvest of 1SW salmon in the angling fishery.
20	Liscomb	unk	unk	0	157	Acid-impacted, surplus assumed to equal the 5 yr mean harvest of 1SW salmon in the angling fishery.
20	East, Sheet Hbr.	unk	unk	0	>50	Acid-impacted, surplus of 50 1SW salmon projected for 1992. Surplus expected to be >50 beyond 1992 as a result of increased stocking.
20	West, Sheet Hbr.	unk	unk	0	161	Acid-impacted, surplus assumed to equal 5 yr mean harvest of 1SW salmon in the angling fishery.
20	Musquodoboit	400	400	0	385	Surplus based on the 5 yr mean harvest of 1SW salmon in the angling fishery.
21	Gold	unk	unk	5	313	Acid-impacted, surplus assumed to equal the 5 yr mean harvest of 1SW salmon in the angling fishery.
21	LaHave	unk	unk	28	2069	Acid-impacted, surplus assumed to equal the 5 yr mean harvest of 1SW salmon in the angling fishery.
21	Medway	unk	unk	10	631	Acid-impacted, surplus assumed to equal the 5 yr mean harvest of 1SW salmon in the angling fishery.
21	Mersey	0	0	100	600	Acid-impacted, surplus is total returns from hatchery stocking; surplus projected for 1992 is 50 MSW and 600 1SW salmon.
21	Tusket	unk	unk	0	500	Acid-impacted, surplus derived mainly from hatchery stocking.
22	Shubenacdie	130	350	0	0	Management closure in effect during 1991 dependant on counts of adequate spawners in the Big Salmon River, N.B.; also subject to in-season review.
22	Stewiacke	310	800	0	0	Management closure in effect during 1991 dependant on counts of adequate spawners in the Big Salmon River, N.B.; also subject to in-season review.
23	Big Salmon	420	280	0	0	As per Stewiacke and Shubenacdie above.
23	Saint John (above Mact.)	4,400	3,200	0	<6370	Mean surplus (1986-90); preliminary estimate of 1992 surplus of 0 MSW and 4800 1SW may be more realistic; subject to in-season review.
23	Nashwaak	1,800	1,700	23	674	Highly unlikely that MSW spawning requirement has been met in recent years (see Saint John).

* Excludes hatchery broodstock.

TABLE 2. Middle River (SFA 19).

Target: 2.07×10^6 eggs (470 MSW, 80 1SW salmon) calculated as area \times 2.4 eggs/m².

Year	1986	1987	1988	1989	1990	Mean
<u>Angling Harvest</u>						
MSW ¹	5	6	7	14	10	8
1SW	36	53	36	11	80	49
<u>Native Harvest</u>						
MSW	-	-	-	-	-	-
1SW	-	-	-	-	-	-
<u>Total Returns</u>						
MSW	-	-	-	-	-	-
1SW	-	-	-	-	-	-
<u>Spawning Escapement</u>						
MSW	-	-	-	470	325	-
1SW	-	-	-	80	60	-
<u>% of egg target met</u>	-	-	-	100	66	-

¹Assumed hook-and-release mortality.

Background: The spawning escapement target was not balanced for an equal number of males and females. Stocking for research purposes was conducted in 1985-89. Late October counts of salmon conducted by divers in 1989 and 1990 indicated 7-14% of the escapement was of hatchery origin. Diver counts also suggested that spawning escapement would have been 100% of target in 1989 (O'Neil et al. 1989) and 66% (380 salmon) of the target in 1990 (Amiro et al. 1991). A negotiated native food fishery of 100 salmon was increased to 130 salmon in 1990 and was taken in approximately 10 nets at a headland between the Middle and Baddeck rivers.

Broodstock Requirements: None.

Forecast: None available.

Surplus: Assuming an angling exploitation rate of 0.20 and a 2.0 inflation factor for reported releases of MSW salmon, average angling 1986-90 could indicate returns of 245 1SW and 420 MSW salmon and surpluses of 165 grilse and 0 MSW salmon.

TABLE 3. Baddeck River (SFA 19).

Target: 2.0×10^6 eggs (450 MSW, 80 1SW salmon) calculated as area \times 2.4 eggs/m².

Year	1986	1987	1988	1989	1990	Mean
<u>Angling Harvest</u>						
MSW ¹	7	6	9	12	10	9
1SW	20	26	19	10	40	23
<u>Native Harvest</u>						
MSW	-	-	-	-	-	-
1SW	-	-	-	-	-	-
<u>Total Returns</u>						
MSW	-	-	-	-	-	-
1SW	-	-	-	-	-	-
<u>Spawning Escapement</u>						
MSW	-	-	-	-	-	-
1SW	-	-	-	-	-	-
<u>% of egg target met</u>	-	-	-	-	-	-

¹Assumed hook-and-release mortality.

Background: The spawning escapement target was not balanced for an equal number of males and females. A limited stocking of parr took place 1986-89. A native food fishery for 130 "salmon" at a headland between Middle and Baddeck rivers likely intercepts Baddeck River stock. Electrofishing conducted in the mid-1970s indicated that juvenile population densities were less than those of the near-by Margaree, Middle and North rivers. Salmon management plans instituted since 1984 have increased the incidence of hook-and-released salmon which may have resulted in increased spawning escapements.

Broodstock Requirements: None.

Forecast: None available.

Surplus: Assuming an angling exploitation rate of 0.20 and a 2.0 inflation factor for reported releases of MSW salmon, average angling 1986-90, could indicate returns of 115 1SW and 432 MSW salmon and surpluses of 35 grilse and 0 MSW salmon. In-season adjustments to allowable harvests would be difficult due to the lateness of the run and the short, pre-spawning holding time in the river.

TABLE 4. North River (SFA 19).

Target: 0.85×10^6 eggs (200 MSW, 30 1SW salmon) calculated as area \times 2.4 eggs/m².

Year	1986	1987	1988	1989	1990	Mean
<u>Angling Harvest</u>						
MSW ¹	50	27	27	20	31	31
1SW	185	177	118	120	202	160
<u>Native Harvest</u>						
MSW	-	-	-	-	-	-
1SW	-	-	-	-	-	-
<u>Total Returns</u>						
MSW	-	-	-	-	-	-
1SW	-	-	-	-	-	-
<u>Spawning Escapement</u>						
MSW	-	-	-	-	-	-
1SW	-	-	-	-	-	-
<u>% of egg target met</u>	-	-	-	-	-	-

¹Assumed hook-and-release mortality.

Background: The spawning escapement target was not balanced for an equal number of males and females. In-river exploitation rates by recreational fishermen of as high as 0.84 (Amiro and Marshall 1990) in the 1970s are not believed to be applicable to the present-day fishery. Counts of salmon by divers were unsuccessful in 1990 and will be attempted again in 1991.

Broodstock Requirements: 16 wild 2SW salmon.

Forecast: None available.

Surplus: Assuming an angler exploitation rate of 0.40 and a 2.0 inflation factor for reported releases of MSW salmon, average angling 1986-90 could indicate returns of 400 1SW and 774 MSW salmon and surpluses of 370 grilse and 574 MSW salmon.

TABLE 5. Grand River (SFA 19).

Target: 1.1×10^6 eggs (100 MSW, 440 1SW salmon) calculated as area \times 2.4 eggs/m².

Year	1986	1987	1988	1989	1990	Mean
<u>Angling Harvest</u>						
MSW ¹	10	5	5	4	5	6
1SW	298	308	303	286	335	306
<u>Native Harvest</u>						
MSW	-	-	-	-	-	-
1SW	-	-	-	-	-	-
<u>Total Returns</u>						
MSW	-	-	-	-	-	-
1SW	-	-	1065 ³	-	-	-
<u>Spawning Escapement</u>						
MSW	-	-	-	-	-	-
1SW	-	-	716 ³	540 ³	500 ³	585 ³
<u>% of egg target met</u>	-	-	133 ²	100 ²	92 ²	108 ²

¹Assumed hook-and-release mortality.

²Estimates of spawning escapement above the fishway compared to total river requirements.

³Includes MSW salmon.

Background: Counts were conducted at a fishway during 1988-90. Returns in 1990 and 1991 were 50 and 40% hatchery-origin. MSW fish are repeat-spawning grilse with only a small portion of 2SW salmon. Because of unknown removals above the fishway (approx. 40% of the rearing area), location and by-pass rate of the fishway, total river escapements could not be estimated in all years. However, escapement above the fishway was nearly adequate for the entire drainage in 1989 and 1990 (Amiro and Longard 1990; Amiro et al. 1991; O'Neil et al. 1989).

Broodstock Requirements: 26 wild fish inc. repeat 1SW and maiden 2SW salmon.

Forecast: None available.

Surplus: At an assumed exploitation rate of 0.33 and a 2.0 inflation factor for reported releases of MSW salmon, average angling, 1986-90, could indicate returns of 927 1SW and 174 MSW salmon and average surpluses of 487 1SW and 74 MSW salmon. However, grilse have been less than required in 1990 and 1991. Native food fisheries occurred in 1990 and 1991.

TABLE 6. St. Mary's River (SFA 20).

Target: 4.0×10^6 m² of habitat (> 0.12% gradient) some of which is acid-impacted; spawning escapement requirement unknown.

Year	1986	1987	1988	1989	1990	Mean
<u>Angling Harvest</u>						
MSW ¹	47	16	35	23	14	27
1SW	1126	524	1209	567	1612	1007
<u>Native Harvest</u>						
MSW	-	-	-	-	-	-
1SW	-	-	-	-	-	-
<u>Total Returns</u>						
MSW	-	-	-	-	-	-
1SW	-	-	-	-	-	-
<u>Spawning Escapement</u>						
MSW	-	-	-	-	-	-
1SW	-	-	-	-	-	-
<u>% of egg target met</u>						
	-	-	-	-	-	-

¹Assumed hook-and-release mortality.

Background: Previous estimates of spawning requirements (Marshall 1986) require revision because the river is partially acid-impacted. The population appears stable under current exploitation by the angling fishery but is in part maintained by hatchery stocking.

Broodstock Requirements: 17 3SW salmon.

Forecast: None available.

Surplus: Surplus to requirements is assumed to equal the mean angling harvest of 1007 1SW salmon and the estimated hook-and-release mortality of 27 MSW salmon.

TABLE 7. Liscomb River (SFA 20).

Target: 2.2×10^6 m² of habitat (> 0.12% gradient) much of which is acid-impacted; spawning escapement requirement unknown.

Year	1986	1987	1988	1989	1990	Mean
<u>Angling Harvest</u>						
MSW ¹	1	1	1	0	0	1
1SW	184	253	136	48	165	157
<u>Native Harvest</u>						
MSW	-	-	-	-	-	-
1SW	-	-	-	-	-	-
<u>Total Returns²</u>						
MSW	226	143	121	146	66	140
1SW	1686	2390	1044	858	1558	1507
<u>Spawning Escapement</u>						
MSW	225	142	120	146	66	140
1SW	1502	2137	908	802	1393	1352
<u>% of egg target met</u>	-	-	-	-	-	-

¹Assumed hook-and-release mortality.

²Counts at Liscomb Falls Fishway; most angling below fishway.

Background: Estimates of spawning requirements (Semple and Cameron 1990) require revision because the river is acid-impacted and because escapements which approached the previous target, did not appear to contribute to increased recruits. Future returns are dependent upon level of hatchery stocking which has accounted for between 25 and 51% of 1986-90 returns (Amiro et al. 1991) and the annual severity of acid impact upon all juvenile stages.

Broodstock Requirements: 39 2SW salmon.

Forecast Reduced returns of 1SW fish in 1991 (to about 52% of the 5-year mean) imply reduced returns of MSW salmon in 1992 (forecast method; Amiro et al. 1991). Although no quantitative forecast of 1SW returns is available, future returns are not expected to change, provided hatchery stocking is continued at current level.

Surplus: Surplus to requirements is assumed to equal the mean angling harvest of 157 1SW salmon. No surplus of MSW salmon is expected in view of their low abundance.

TABLE 8. East River, Sheet Harbour (SFA 20).

Target: 2.9×10^6 m² of habitat (> 0.12% gradient) of which most is acid-impacted or obstructed to upstream migration.

Year	1986	1987	1988	1989	1990	Mean
<u>Angling Harvest</u>						
MSW ¹	0	1	1	1	0	1
1SW	2	87	131	69	21	62
<u>Native Harvest</u>						
MSW	-	-	-	-	unknown ²	-
1SW	-	-	-	-	unknown ²	-
<u>Total Returns</u>						
MSW	-	-	-	-	-	-
1SW	-	-	-	-	-	-
<u>Spawning Escapement</u>						
MSW	-	-	-	-	-	-
1SW	-	-	-	-	-	-
<u>% of egg target met</u>						
	-	-	-	-	-	-

¹Assumed hook-and-release mortality.

²Native fishery of about 200 fish of which one quarter were thought destined for East River and the remainder for West River, Sheet Harbour.

Background: Spawning requirements are unknown because of acid impact. Returns are 75% hatchery origin. Returns from hatchery smolt releases will comprise the majority of the releases in the future; hatchery smolts are expected to return at an average rate of 0.6%.

Broodstock Requirements: 55 1SW fish, including repeat spawners.

Forecast 17,000 smolts released in 1991 are expected to yield a return of 100 1SW fish in 1992 and represent about 75% of the total return.

Surplus: The surplus in 1992 will equal at least 50 1SW salmon. The surplus beyond 1992 is expected to increase in accordance with increasing stocking of both smolts in the lower river and parr upstream of the hydro obstructions.

TABLE 9. West River, Sheet Harbour (SFA 20).

Target: 2.4×10^6 m² of habitat (> 0.12% gradient), of which most is acid-impacted.

Year	1986	1987	1988	1989	1990	Mean
<u>Angling Harvest</u>						
MSW ¹	2	1	1	1	0	1
1SW	132	166	94	262	150	161
<u>Native Harvest</u>						
MSW	-	-	-	-	unknown ²	-
1SW	-	-	-	-	unknown ²	-
<u>Total Returns</u>						
MSW	-	-	-	-	-	-
1SW	-	-	-	-	-	-
<u>Spawning Escapement</u>						
MSW	-	-	-	-	-	-
1SW	-	-	-	-	-	-
<u>% of egg target met</u>						
	-	-	-	-	-	-

¹Assumed hook-and-release mortality.

²Native fishery of about 200 salmon, mostly 1SW fish, three quarters of which were thought to be destined for West River and the remainder for East River.

Background: Population seems stable under current exploitation by the angling fishery (mean recreational harvest of 175 1SW fish, 1974-90) but because of severity of acid impact is not likely to be capable of withstanding a higher exploitation rate. Hatchery releases are being used to partly mitigate for acid impact.

Broodstock Requirements: None.

Forecast No quantitative forecast of returns available.

Surplus: Surplus to requirements is assumed to equal the mean angling harvest of 161 1SW salmon.

TABLE 10. Musquodoboit River (SFA 20).

Target: 1.9×10^6 eggs (400 MSW, 400 1SW salmon) calculated as area \times 2.4 eggs/m².

Year	1986	1987	1988	1989	1990	Mean
<u>Angling Harvest</u>						
MSW ¹	19	9	14	8	6	11
1SW	356	184	264	237	255	259
<u>Native Harvest</u>						
MSW	-	-	-	-	-	-
1SW	-	-	-	-	-	-
<u>Total Returns</u>						
MSW	-	-	-	-	-	-
1SW	-	-	-	-	-	-
<u>Spawning Escapement</u>						
MSW	-	-	-	-	-	-
1SW	-	-	-	-	-	-
<u>% of egg target met</u>	-	-	-	-	-	-

¹Assumed hook-and-release mortality.

Background: Spawning requirement based on MSW salmon and a 1:1 male:female sex ratio. Because the run, based on recent broodstock collections, is 30% or more hatchery origin, surpluses identified are dependent upon continuation of the current level of hatchery support.

Broodstock Requirements: 27 2SW salmon.

Forecast No quantitative forecast of returns available.

Surplus: Assuming an exploitation rate of 0.33 and a 2.0 inflation factor for reported releases of MSW salmon, average angling 1986-90 could indicate returns of 785 1SW and 341 MSW salmon and average surpluses of 385 1SW and 0 MSW fish.

TABLE 11. Gold River (SFA 21).

Target: 1.8×10^6 m² of habitat (> 0.12% gradient), much of which is acid-impacted.

Year	1986	1987	1988	1989	1990	Mean
<u>Angling Harvest</u>						
MSW ¹	9	4	2	6	5	5
1SW	293	284	198	472	318	313
<u>Native Harvest</u>						
MSW	-	-	-	-	-	-
1SW	-	-	-	-	-	-
<u>Total Returns</u>						
MSW	-	-	-	-	-	-
1SW	-	-	-	-	-	-
<u>Spawning Escapement</u>						
MSW	-	-	-	-	-	-
1SW	-	-	-	-	-	-
<u>% of egg target met</u>	-	-	-	-	-	-

¹Assumed hook-and-release mortality.

Background: The river suffers from chronic low summer discharges and is stocked with native smolts at a rate of about 1 fish per 100 m² of substrate, to mitigate acid impact. MSW salmon returns are believed to be inadequate to seed area at 2.4 eggs/m². The population seems stable under current exploitation by the angling fishery and current levels of smolt stocking.

Broodstock Requirements: 18 2SW salmon.

Forecast No quantitative forecast of returns available.

Surplus: Surplus to requirements is assumed to equal the mean angling harvest of 313 1SW salmon and an assumed hook-and-release mortality of 5 MSW salmon.

TABLE 12. LaHave River (SFA 21).

Target: 5.1×10^6 m² of habitat (> 0.12% gradient), much of which is acid-impacted.

Year	1986	1987	1988	1989	1990	Mean
<u>Angling Harvest</u>						
MSW ¹	48	23	16	33	19	28
1SW	1844	2562	1518	2411	2008	2069
<u>Native Harvest</u>						
MSW	-	-	-	-	-	-
1SW	-	-	-	-	-	-
<u>Total Returns</u>						
MSW	-	-	-	-	-	-
1SW	-	-	-	-	-	-
<u>Spawning Escapement</u>						
MSW	-	-	-	-	-	-
1SW	-	-	-	-	-	-
<u>% of egg target met</u>	-	-	-	-	-	-

¹Assumed hook-and-release mortality.

Background: Specific spawning requirements (Cutting et al. 1987) require revision because of variable acid impact in the drainage. Based on two decades of fish counts at Morgan Falls (Amiro et al. 1991) eggs depositions for the 40% of the drainage above Morgan Falls have exceeded the 2.4 eggs/m² target level. MSW salmon returns are inadequate to fully seed the entire drainage at 2.4 eggs/m². 1SW and MSW salmon escaping the fisheries are probably adequate to meet spawning requirements at 2.4 eggs per/m² but distribution of spawners and higher seeding rates required in acid-impacted areas may be hampering attainment of conservation requirements throughout the drainage. Spawning requirements must include 110 MSW salmon and 25 1SW salmon for hatchery broodstock needed to sustain food and recreational fisheries in other rivers in Queens, Shelburne and Lunenburg counties. With the exception of 1991 when season-end counts at Morgan Falls will be 20% of 1SW and 50% of MSW counts in 1989-90 and lowest in a decade, the population appears stable under current exploitation by the existing angling fishery.

Broodstock Requirements: 110 2SW and 25 1SW salmon.

Forecast No quantitative forecast of returns available.

Surplus: Surplus to requirements is assumed to equal the mean angling harvest of 2069 1SW salmon and the mean estimated mortality from hook-and-release of 28 MSW salmon.

TABLE 13. Medway River (SFA 21).

Target: 6.8×10^6 m² of habitat (> 0.12% gradient), much of which is acid-impacted.

Year	1986	1987	1988	1989	1990	Mean
<u>Angling Harvest</u>						
MSW ¹	16	7	10	10	7	10
1SW	603	826	570	564	590	631
<u>Native Harvest</u>						
MSW	-	-	-	-	-	-
1SW	-	-	-	-	-	-
<u>Total Returns</u>						
MSW	-	-	-	-	-	-
1SW	-	-	-	-	-	-
<u>Spawning Escapement</u>						
MSW	-	-	-	-	-	-
1SW	-	-	-	-	-	-
<u>% of eqg target met</u>	-	-	-	-	-	-

¹Assumed hook-and-release mortality.

Background: No estimate of spawning requirements exists because river is acid-impacted. Acid impact is partly mitigated by hatchery stocking which contributes to a significant part of the return and annual harvest.

Broodstock Requirements: 50 2SW salmon.

Forecast No quantitative forecast of returns available.

Surplus: Surplus to requirements is assumed to equal the mean angling harvest of 631 1SW salmon and the mean estimated hook-and-release mortality of 10 MSW salmon.

TABLE 14. Mersey River (SFA 21).

Target: No estimate of area; acid-impacted and obstructed by hydro-development.

Year	1986	1987	1988	1989	1990	Mean
<u>Angling Harvest</u>						
MSW ¹	1	0	1	3	0	1
1SW	46	64	106	118	143	95
<u>Native Harvest</u>						
MSW	-	-	-	-	-	-
1SW	-	-	-	-	600 ²	-
<u>Total Returns</u>						
MSW	-	-	-	-	-	-
1SW	-	-	-	-	-	-
<u>Spawning Escapement</u>						
MSW	-	-	-	-	-	-
1SW	-	-	-	-	-	-
<u>% of egg target met</u>	-	-	-	-	-	-

¹Assumed hook-and-release mortality.

²DFO Fishery Officer's estimate of harvest; comprised of both 1SW and MSW salmon.

Background: Natural production in the lower unobstructed portion of the drainage appears to be negligible. Returns are largely the result of annual hatchery-smolt releases of LaHave stock. Forecast of returns is by assumption of a mean smolt-adult return rate. Annual releases are expected to range from 15-20,000 smolts annually and mean return rate of 4% is reasonable based on past performance.

Broodstock Requirements: None from Mersey R.

Forecast Annual returns are forecast at 700 fish (600 1SW and 100 MSW salmon). In 1992, adult return is expected to be 600 1SW and 50 MSW salmon; the lower MSW return in 1992 would be consistent with the lower return of 1SW salmon in 1991.

Surplus: All returns, i.e., 600 1SW and 100 MSW salmon (alternately for 1992, 600 1SW and 50 MSW salmon).

TABLE 15 Tusket River (SFA 21).

Target: 6.6×10^6 m² of habitat (> 0.12% gradient), most of which is acid-impacted.

Year	1986	1987	1988	1989	1990	Mean
<u>Angling Harvest</u>						
MSW ¹	3	3	7	2	2	3
1SW	114	358	167	113	128	176
<u>Native Harvest</u>						
MSW	-	-	-	-	-	-
1SW	-	-	-	-	-	-
<u>Total Returns</u>						
MSW	-	-	-	-	-	-
1SW	-	-	-	-	-	-
<u>Spawning Escapement</u>						
MSW	-	-	-	-	-	-
1SW	-	-	-	-	-	-
<u>% of egg target met</u>	-	-	-	-	-	-

¹Assumed hook-and-release mortality.

Background: Wild production limited to a part of a tributary, the Carleton River. Partial counts of 496 1SW and 64 MSW were recorded after the angling fishery in 1990. Over 60% of the returns are of hatchery origin. Annual wild production appears to be limited to about 200 fish annually. Annual stocking with 30,000 smolts will be continued. Based on past performance, smolt-to-adult return rate of 1.5% may be possible (Amiro et al. 1991).

Broodstock Requirements: 31 hatchery and wild 2SW salmon.

Forecast: Returns forecasted are:

Hatchery - 360 1SW and 90 MSW salmon
Wild - 160 1SW and 40 MSW salmon.

Surplus: Surplus derived mainly from hatchery returns is about 500 1SW salmon.

TABLE 16. Shubenacadie River (SFA 22).

Target: 1.4×10^6 eggs (130 MSW, 350 1SW salmon) calculated as area x 2.4 eggs/m².

Year	1986	1987	1988	1989	1990	Mean
<u>Angling Harvest</u>						
MSW ¹	4	2	1	1	1	2
1SW	92	49	32	61	21	51
<u>Native Harvest</u>						
MSW	-	-	-	-	80 ²	-
1SW	-	-	-	-	-	-
<u>Total Returns</u>						
MSW	-	-	-	-	-	-
1SW	-	-	-	-	-	-
<u>Spawning Escapement</u>						
MSW	-	-	-	-	-	-
1SW	-	-	-	-	-	-
<u>% of egg target met</u>	-	-	-	-	-	-

¹Assumed hook-and-release mortality.

²DFO Officer's estimate (both sea ages).

Background: Stock status assumed to be similar to that of the Big Salmon River (Amiro 1987). This has resulted in a management closure of all fisheries in 1991 pending an in-season count of 700 salmon in the Big Salmon River

Broodstock Requirements: None.

Forecast: No quantitative forecast available.

Surplus: Angling harvests and presumably returns to all rivers of the inner Bay of Fundy have been extremely low in four of the past five years. (Scarcities have been confirmed where in-river counts have been made.) Counts to the end of September on the Big Salmon River, do not indicate that conservation requirements will be met in 1991. It appears prudent to extend the same management plan for the Shubenacadie River into 1992.

TABLE 17. Stewiacke River (SFA 22).

Target: 3.1×10^6 eggs (310 MSW, 800 1SW salmon) calculated as area \times 2.4 eggs/m².

Year	1986	1987	1988	1989	1990	Mean
<u>Angling Harvest</u>						
MSW ¹	29	11	4	10	2	11
1SW	428	114	212	1073	143	394
<u>Native Harvest</u>						
MSW	-	-	-	-	-	-
1SW	-	-	-	-	-	-
<u>Total Returns</u>						
MSW	-	-	-	-	-	-
1SW	-	-	-	-	-	-
<u>Spawning Escapement</u>						
MSW	-	-	-	-	-	-
1SW	-	-	-	-	-	-
<u>% of egg target met</u>	-	-	-	-	-	-

¹Assumed hook-and-release mortality.

Background: Indices of stock status correlate with those of the Big Salmon River (Amiro 1987 and Amiro et al. 1991). This has resulted in a management closure of all fisheries in 1991 pending an in-season count of 700 salmon in the Big Salmon River.

Broodstock Requirements: 33 wild 1SW (inc. repeat spawning) salmon.

Forecast: No quantitative forecast available.

Surplus: Angling harvests and presumably returns to all rivers of the inner Bay of Fundy have been extremely low in four of the past five years. (Scarcities have been confirmed where in-river counts have been made.) Counts to the end of September on the Big Salmon River, do not indicate that conservation requirements will be met in 1991. It appears prudent to extend the same management plan for the Stewiacke River into 1992.

TABLE 18. Big Salmon River^a (SFA 23).

Target: 2.2×10^6 eggs (420 MSW, 280 1SW salmon) calculated as area \times 2.4 eggs/m².

Year	1986	1987	1988	1989	1990	Mean
<u>Angling Harvest</u> ¹						
MSW	-	-	-	-	-	-
1SW	124	31	30	150	45	76
<u>Native Harvest</u>						
MSW	-	-	-	-	-	-
1SW	-	-	-	-	-	-
<u>Total Returns</u>						
MSW	-	-	-	-	-	-
1SW	-	-	-	-	-	-
<u>Spawning Escapement</u>						
MSW	-	-	-	-	-	-
1SW	-	-	-	975 ²	235 ²	-
<u>% of egg target met</u>	-	-	-	140	34	-

¹NBDNRE field personnel.

²Includes MSW salmon.

Background: Spawning escapements are expressed as a proportion of required numbers of adults, not eggs or by age-class of spawners. Estimates of escapement are conducted by divers in late autumn. In-season abundance has been assessed by NBDNRE personnel making shore and in-stream counts of salmon in pools. Similarity in recruitment pattern has been demonstrated for all stocks of the inner Bay of Fundy (Amiro 1987).

Broodstock Requirements: 24 1SW (inc. repeat spawning) salmon.

Forecast: No quantitative forecast available.

Surplus: Returns to Big Salmon River, like all rivers of the inner Bay of Fundy, have been extremely low in four of the past five years and resulted in a management closure of all fisheries pending an in-season count of 700 salmon in the Big Salmon River. Counts to the end of September were less than 50% of the target number of spawners.

^aIncluded due to the reliance of this river for management of Stewiacke and Shubenacadie rivers.

TABLE 19. Saint John River at/above Mactaquac (SFA 23).

Target: 29.4×10^6 eggs (4,400 MSW, 3,200 1SW salmon) calculated as area \times 2.4 eggs/m².

Year	1986	1987	1988	1989	1990	Mean
<u>Anqing Catch</u> ¹						
MSW ¹	-	-	-	-	-	-
1SW	1,692	1,650	1,755	2,304	1,610	1,802
<u>Native Harvest</u> ²						
MSW	2,400	1,120	760	240	247	953
1SW	600	280	190	560	273	381
<u>Total Returns</u> ³						
MSW	6,925	4,832	3,537	4,541	4,125	4,792
1SW	8,766	9,237	10,180	10,861	8,804	9,570
<u>Spawning Escapement</u> ⁴						
MSW	3,519	2,758	1,704	3,491	3,202	2,935
1SW	5,887	7,020	7,810	7,533	6,057	6,861
<u>% of egg target met</u>	80	63	39	79	73	67
<u>% of 1SW target met</u>	184	219	244	235	189	214

¹DFO and NBDNRE field personnel; inc. Kingsclear sport retentions.

²Incomplete.

³Estimated to the river and destined for Mactaquac.

⁴Poaching and disease included.

Background: Annual total returns based on complete counts at Mactaquac raised by estimated removals down river. (Marshall 1991). Spawner requirements based on eggs of MSW fish and a 1:1 male:female ratio (Marshall and Penney 1983). An escapement of 6900 1SW fish (1986-90) would contribute to about 4% of the target eggs. Hatchery fish, 1986-90, averaged 18% of 1SW returns, 15% of MSW returns. Forecasts performed annually, wild 1SW fish based on previous egg depositions; wild MSW fish based on 1SW returns and their fork length (Marshall 1991). Hatchery returns based on release numbers. Total returns destined for Mactaquac in 1991 are expected to number about 5,000 MSW and 8,000 1SW fish, i.e., about 105% of MSW and 84% of 1SW mean returns, 1986-90.

Broodstock Requirements: About 475 MSW salmon, mostly early-run.

Forecast: No forecast of returns in 1992 and beyond available. Mean estimates 1986-90 will exceed near future returns because egg depositions contributing to near-future returns are less than for those contributing to returns, 1986-90. MSW fish will therefore be less than 1986-90.

Surplus: Calculated on average, as total returns less spawning requirement (inc. 400 MSW broodstock) i.e., 0 MSW and 6,370 1SW fish. However, per above, future returns are expected to decline. Maximum 1SW surplus in 1992 will be more like the 4,800 fish in 1991. Removal of MSW fish foregoes i) filling of habitat which has been under-escaped since 1986, and ii) development initiatives elsewhere on the system. The early-run Serpentine component (pre-mid June) should be protected.

TABLE 20. Nashwaak River (SFA 23)

Target: 11.9×10^6 eggs (1800 MSW, 1700 1SW salmon) calculated as area \times 2.4 eggs/m².

Year	1986	1987	1988	1989	1990	Mean
<u>Angling Catch</u> ¹						
MSW ²	-	-	9	11	7	9
1SW	751	750	201	448	196	469
<u>Native Harvest</u> ³						
MSW	-	-	-	-	-	-
1SW	-	-	-	-	-	-
<u>Total Returns</u>						
MSW	-	-	-	-	-	-
1SW	-	-	-	-	-	-
<u>Spawning Escapement</u>						
MSW	-	-	-	-	-	-
1SW	-	-	-	-	-	-
<u>% of egg target met</u>						
	-	-	-	-	-	-

¹New Brunswick DNRE field personnel.

²Assumed hook-and-release mortality.

³First significant effort noted in 1991.

Background: Target egg depositions based on 1SW:MSW ratios (sport catch) and biological characteristics for Nashwaak (1974-83); Penney and Marshall 1984 and eggs/female at Mactaquac. Egg requirement based on MSW fish; 1SW fish provide males to give 1:1 male to female ratio in MSW fish. Angling catches of 743 MSW (released) and 879 1SW fish; (mean of 1986-90), also available from NBDNRE Fishsys (37 MSW fish lost to hook-and-release mortality). Mean exploitation rate of 0.34 derived prior to hook-and-release regulations in 1984 from Fishsys is not known to be applicable to either set of angler catch data since 1984.

Broodstock Requirements: 20 2SW salmon.

Forecast: No estimate of returns; surplus based on mean sport catches 1986-90 (NBDNRE field personnel and Fishsys).

Surplus: 1986-90 of $(469+879)/2 = 674$ 1SW fish and $(37+9)/2 = 23$ MSW fish. Egg depositions contributing to 1SW returns 1992 presumed, per above Mactaquac, to be fewer than those contributing to 1SW returns 1986-90. Hatchery contribution is minor relative to that of the main river destined for Mactaquac.