

# Status of Maritime Atlantic Salmon Stocks

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## Introduction

Of the more than 550 rivers with Atlantic salmon populations in eastern Canada more than one-third are located in the Maritimes. The two largest Atlantic salmon rivers in eastern North America are located in New Brunswick. The Saint John River is the largest river, draining an estimated 55,000 km<sup>2</sup> of watershed area (in Canada and the U.S.A.). The Miramichi River, draining approximately 14,000 km<sup>2</sup> into the southern Gulf of St. Lawrence, contains the largest Atlantic salmon population with an average of 111,000 fish returned annually between 1984 and 1994 (Chaput *et al.* MS1995).

The Atlantic salmon possesses a highly refined homing ability and each river is considered to possess a unique spawning population. Atlantic salmon returns to its natal river to spawn after feeding at sea for one year (1SW = one sea-winter) or two years (2SW). Feeding occurs as far afield as the Labrador Sea, off Greenland and even the North Sea (Europe). In contrast to the Pacific salmon species, Atlantic salmon does not immediately die after spawning. Repeat spawning events are always accompanied by return migrations to sea for reconditioning and additional growth although kelts (post-spawning salmon) have been artificially reconditioned in captivity, exclusively in freshwater.

Atlantic salmon is further defined by geographic differences in biological char-

acteristics. Salmon stocks from the inner Bay of Fundy mature predominantly as 1SW fish, have a high incidence of repeat spawning and are not known to migrate to the Labrador Sea. In contrast, stocks from the outer Bay of Fundy, Atlantic coast of Nova Scotia and the southern Gulf of St. Lawrence have both 1SW (which tend to be mostly male fish) and 2SW (which tend to be mostly females) components, a lower incidence of repeat spawning and undertake extensive marine feeding migrations. Because of significant variations in the life history characteristics of the salmon stocks in the Maritimes Region, assessments are undertaken on finer spatial scales, often to the level of individual river. Over the past decade there has been a steady increase in our knowledge. In 1983, assessments were done for only the three main rivers in the Maritimes (Saint John, Miramichi, and Restigouche rivers). Assessments were produced for 26 rivers in 1994 (Science Branch 1995).

The assessment of Atlantic salmon consists of 6 parts:

- accounting of harvests,
- definition of the target spawning requirement,
- estimation of returns
- estimation of escapement and egg depositions,
- conclusions on status of the stock and prospects, and
- provision of advice for fisheries management.

The following summarizes the status of the salmon stocks in the Maritimes for 1994. I also show how divergent trends in abundance have occurred within the stocks and that the prospects are stock dependent. In one geographic area, the abundance of the freshwater stages is sufficient to sustain the spawning recruitment. In another area, the salmon stocks are in a depressed state and the potential for recovery is limited by reduced recruitment in both the freshwater and marine environments.

## Harvests

The commercial fisheries in the Maritimes were permanently closed in 1984. The Maritime commercial landings peaked in 1967 at more than 800 tons but averaged only 6% of the total Canadian landings between 1970 and 1985 (Marshall 1988). Recreational catches prior to 1984 averaged just over 20,000 fish, of which 85% originated in the rivers of the southern Gulf of St. Lawrence. Beginning in 1984, all salmon of fork length greater than or equal to 63 cm had to be released alive back to the river. The objective of this management measure, in concert with the closure of the commercial fisheries, was to augment the spawning escapement of the large salmon spawners which in recent years had been below the escapement targets. Currently, First Nations food fisheries account for 100% of the directed large salmon harvests but only 15% of the small salmon harvests, recreational fisheries accounting for the remaining 85% (Anon. 1995a).

## Targets

The formal definition of conservation for Atlantic salmon, adopted in 1991, is based on the World Conservation Strategy. It intends to ensure that the "fullest sustainable advantage" is derived from the resource (CAFSAC 1991). The practical application of that definition is based on the potential production of salmon stocks. An interim level of 2.4 eggs per m<sup>2</sup> of fluvial rearing habitat is being used. It is an interim value because river-specific refined values can be used in its place as they become available. As an example, there are about 55 million m<sup>2</sup> of habitat area in the Miramichi River which translates to an egg deposition target of 132 million eggs. Generally, these egg targets are converted to number of spawners required using average fecundity values for the stock, which, for the Miramichi River translates to 23,600 large salmon.

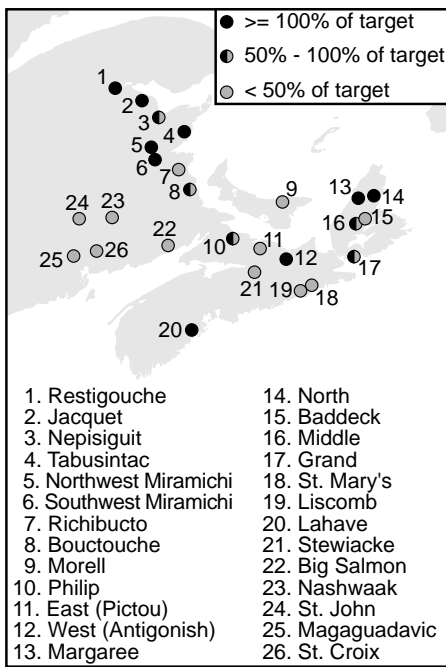


Figure 1. Egg depositions in 1994 relative to targets for 26 rivers in the Maritime provinces. Figure and data are extracted from Anon. (1995a).

### Estimation of Returns and Escapements

Estimates of total returns are obtained using various techniques. In 1994, 26 rivers were assessed using counts at fishways and counting fences (11 rivers), mark and recapture experiments (7 rivers), visual count surveys such as snorkeling (4 rivers) and angling catches (4 rivers). The returns represent the size of the population before any in-river removals. Spawning escapement is simply the returns minus all known in-river removals.

### Status of Stocks in 1994

There are geographical differences in the health of the wild salmon stocks in the Maritimes. Returns and spawning escapement of salmon to the rivers of the Bay of Fundy and to most rivers of the Atlantic coast of Nova Scotia were deficient (less than 50% of target) (Fig. 1). This contrasts with the higher escapement levels observed in the rivers of the Gulf of St. Lawrence where half of the assessed rivers received egg depositions which equaled or exceeded the targets.

Severe deficiencies in egg depositions in the Bay of Fundy and Atlantic coast rivers occurred in spite of intensive smolt

stocking programs. To give an idea of how extensive these stocking programs are, the 681,000 smolts were stocked to the following areas: 250,000 smolts for the Saint John River, 232,000 smolts to ten rivers of southwestern Nova Scotia (Salmon Fishing Area 21), 112,000 smolts to six rivers of the Eastern Shore (SFA 20) and 87,000 smolts to six rivers of eastern Cape Breton (SFA 19) (Fig. 2). The objectives of the stocking program are to mitigate losses to acid rain (SFA 20 and 21) and hydroelectric development, as well as for enhancement of wild stocks. Salmon returning to rivers affected by acidification or obstructions are comprised of high proportions of hatchery-reared fish. Hatchery-reared fish comprise negligible proportions of the salmon returns to the rivers of the southern Gulf of St. Lawrence, with the exception of the Morell River in P.E.I. (Fig. 2).

Aquaculture escapees are a potential threat to the survival of the wild salmon stocks of the Bay of Fundy. Escapees of salmon from the Passamaquoddy Bay industry were sampled from several New Brunswick rivers of the Bay of Fundy and these escapees dominated the returns to the St. Croix and Magaguadavic rivers (Fig. 2). Escapees from the aquaculture cages in a single storm in 1994 were estimated to have been in the order of 20,000 to 40,000 fish, greater than the entire run of wild and hatchery-reared Atlantic salmon returning to all the rivers of the Bay of Fundy in 1994.

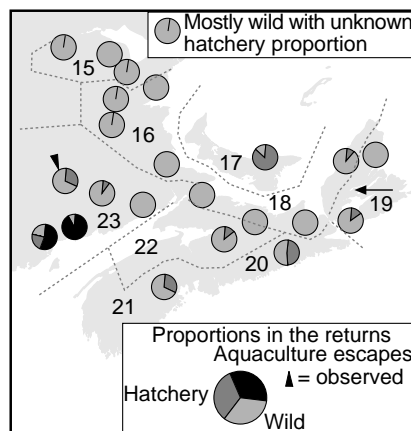


Figure 2. Wild, hatchery-origin, and aquaculture escapee proportions in the total returns of salmon in 1994 to selected rivers of the Maritime provinces. Numbers in text refer to Salmon Fishing Areas (SFA) 15 to 23. Figure and data are extracted from (Anon. 1995a).

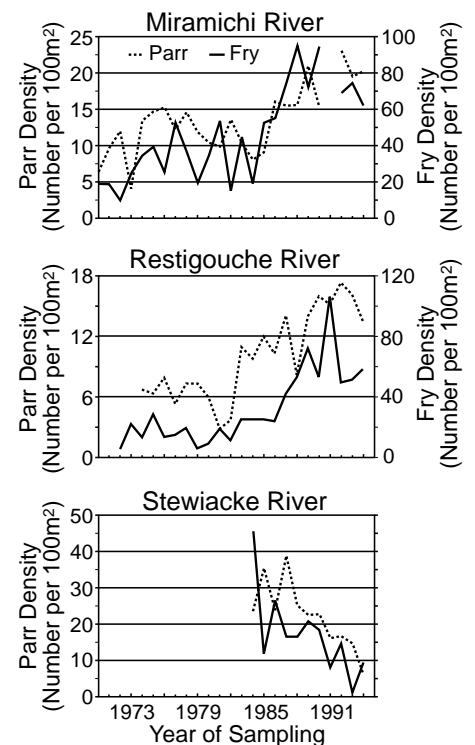


Figure 3. Trends in juvenile densities from three rivers in the Maritimes Region. Data sources are: Restigouche River (Locke et al. MS1995) Miramichi River (Chaput et al. MS1995) and Stewiacke River for 1984 to 1991 (Amiro MS1992) and for 1992 to 1994 (Anon. 1995a).

### Status Over the Last Two Decades

The commercial fisheries were closed and recreational fisheries for large salmon were converted to hook-and-release in 1984 in response to the declining escapement of Atlantic salmon throughout the Maritime Provinces. The expectation of this management action was that escapement would increase with increased recruitment in future generations. The expectations have been borne out in the southern Gulf of St. Lawrence stocks but not in the Bay of Fundy and Atlantic coast rivers.

Juvenile surveys have been conducted annually since 1970 at index sites in both the Miramichi and Restigouche rivers. The increased escapement of adult salmon in these rivers was followed by the increased abundance of fry (hatch of the current year) and parr (juveniles of one year old or more) (Figure 3). Juvenile salmon densities have remained high since 1985 at about twice the levels observed in the 1970's. A shorter

time series of juvenile data from the Stewiacke River (inner Bay of Fundy) shows the opposite trend with both fry and parr densities declining since 1984 and being at the lowest level ever in 1994 (Fig. 3).

Spawning escapement and total returns of 2SW salmon also show opposite trends in the two geographic areas. Where returns and escapements to the southern Gulf of St. Lawrence rivers generally improved since the 1970's, escapements to the Bay of Fundy and Atlantic coast rivers peaked in 1985 and returns as well as spawner abundance have continued their downward trend to the lowest level ever in 1994 (Fig. 4). The escapement of 2SW salmon to Canadian rivers in 1994 was estimated to have been fewer than 82,000 fish, 50% of which

spawned in the southern Gulf of St. Lawrence rivers (Anon. 1995b). With healthy salmon stocks throughout Canada, the southern Gulf stocks would be expected to contribute about 28% of the total Canadian 2SW spawning escapement.

### Why are There Differences Between Areas?

In terms of habitat perturbations, the southern Gulf of St. Lawrence rivers are comparatively pristine. Many of the Atlantic coast rivers have been impacted by acid rain depositions. Five Bay of Fundy rivers have been developed for hydro-electric generation, the most notable being the Saint John River. More recently a tidal power generating station was constructed at the

mouth of the Annapolis River, Nova Scotia. Several of the Bay of Fundy rivers are also impacted by causeways situated at or near their mouths, the most significant being on the Annapolis River (Nova Scotia) and the Petitcodiac River (New Brunswick). Provision for salmon passage on the latter is known to be ineffective.

Marine conditions have also changed. The winter marine habitat in the Northwest Atlantic, based on sea surface temperatures and corresponding probability functions of salmon abundance at temperature (Reddin *et al.* 1993), has decreased since 1983 and has remained low compared to the 1970's (Fig. 5). The marine habitat area during January to March is highly correlated with the abundance of 2SW salmon in North America (Anon. 1995b). There is also a strong correlation between the marine habitat area and the sea survivals of hatchery reared smolts to the Saint John River (Fig. 5), suggesting that a marine environmental factor may be contributing to the depressed stock levels. Although the correlation with the southern Gulf of St. Lawrence 2SW returns is not evident, higher returns of salmon were observed in the 1970's when the Greenland high seas fishery was harvesting as many as 200,000 salmon of North American origin annually (Anon. 1990). This occurred at a time when juvenile densities in the Miramichi and Restigouche were about half the current levels. The returns in recent years of 2SW salmon to the southern Gulf of St. Lawrence rivers are stable in spite of the depressed marine survival observed in other stocks. Stable returns could be the result of high smolt production from these rivers as inferred from the increased juvenile densities.

### Long-term Prospects

For the southern Gulf of St. Lawrence stocks, the returns are expected to remain the same or increase, especially if marine survival remains the same or improves. For the stocks of the Bay of Fundy and Atlantic Coast of Nova Scotia, there is very little basis for optimism. Freshwater production, even when not impacted by habitat perturbations as in the case of the Stewiacke River, is depressed. Even if sea survival were to improve substantially, less smolt production is expected from these rivers

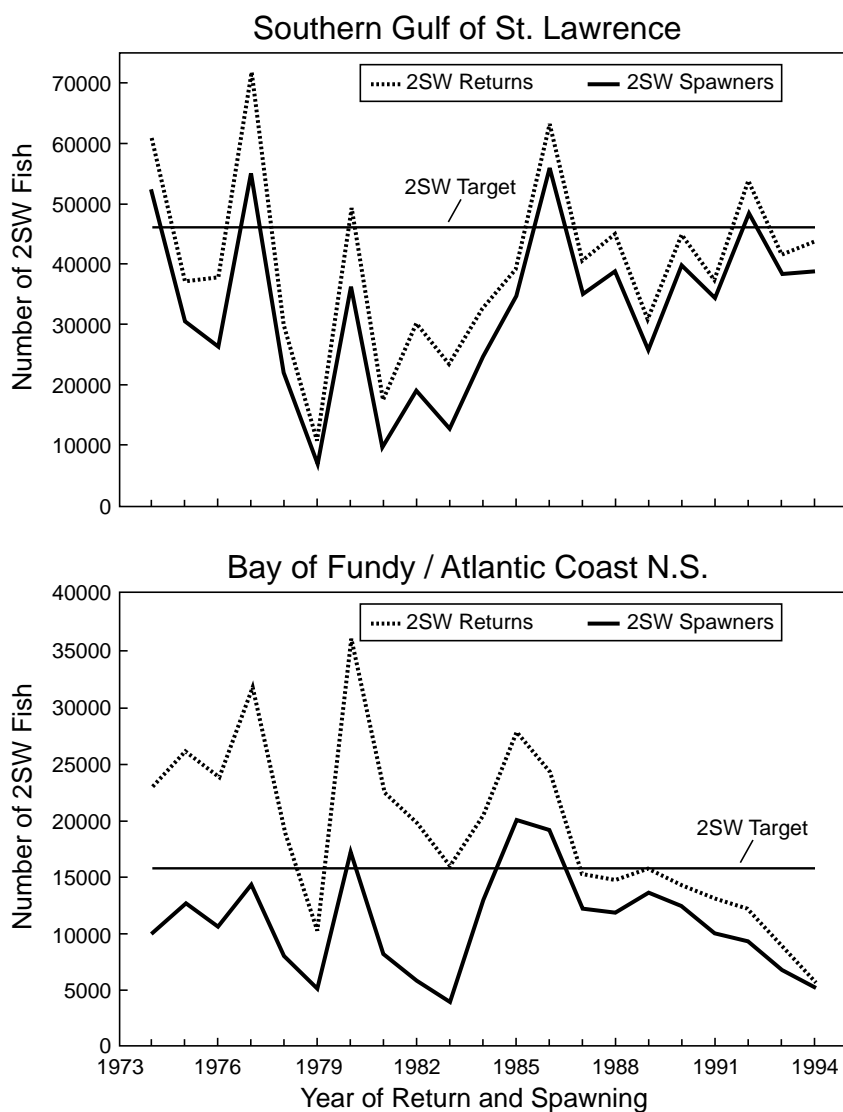


Figure 4. Trends in returns and escapements of 2SW salmon to two areas of the Maritimes, 1974 to 1994. Data are from Anon. (1995b).

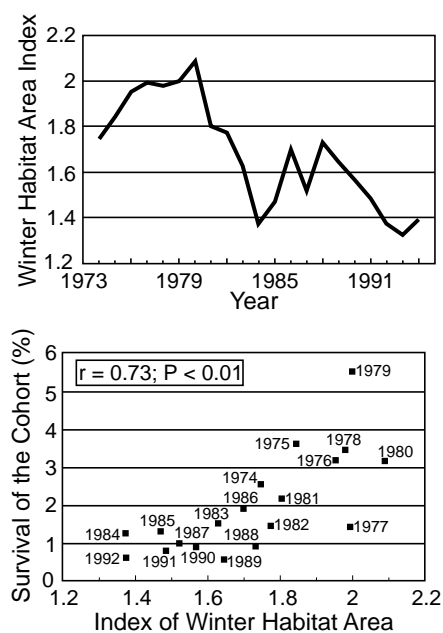


Figure 5. Trends in the winter marine habitat index of the Northwest Atlantic (upper) and relationship between the marine habitat index and sea survival of the cohort of the hatchery-reared smolts from the Saint John River (lower). Habitat index data are from Anon. (1995b) and smolt survival data are from Marshall and Cameron (MS1995).

and recovery to the levels of the 1970's will be further delayed.

There is little opportunity to improve sea survival by regulating fisheries because fisheries-induced mortality has been essentially eliminated. The only large salmon harvests are in First Nations food fisheries and these represent a negligible proportion (<1%) of the total returns. Remnants of marine commercial fisheries exist off the Labrador coast and the Quebec north shore. The Greenland fishery is greatly reduced from its peak harvest of almost 2,700 t in 1971 (Jensen 1988).

Chadwick (1995) proposed index rivers as the most useful way to manage anadromous fish stocks. It is not possible to pick a single river in the Maritimes which would be representative of the status of the Atlantic salmon stocks but stock status is more similar within two main geographic areas: the southern Gulf of St. Lawrence rivers and the Bay of Fundy/Atlantic coast rivers. The Atlantic salmon species in the Maritimes is defined by its stock complexity. Reliable indicators of stock abundance

are required to properly manage the resource. The key to ensuring its sound management lies in recognizing this diversity and in monitoring the largest number of stocks possible.

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