Fisheries and Oceans Pêches et Océans

Newfoundland Region

DFO Science

Stock Status Report D2-01(2000)

Newfoundland & Labrador Atlantic Salmon Stock Status for 1999

Background

There are more than 200 rivers in Newfoundland and Labrador with anadromous Atlantic salmon populations. Each river is assumed to consist of at least one stock with larger rivers containing several stocks. There are 15 Atlantic salmon (Salmo salar L.) management areas known as Salmon Fishing Areas (SFAs) 1-14B in Newfoundland and Labrador (Fig. 1). Atlantic salmon exhibit a diverse life history including variations in time spent in freshwater, age at first spawning and duration and extent of ocean migrations. Spawning populations consist of varying proportions of small salmon (fork length less than 63 cm) and large salmon (fork length greater than or equal to 63 cm). The majority of rivers in insular Newfoundland primarily contain populations of small salmon or grilse which are maiden fish (never spawned before) that have spent one year at sea (1-sea-winter salmon) before returning to spawn. The majority of these fish are female. In the rivers of Labrador (SFAs 1, 2, & 14B), Bay St. George rivers (SFA 13) and Humber River (SFA 13), there are significant large salmon components which contain a mixture of maiden fish that have spent two or occasionally three winters at sea (2- or 3-sea-winter salmon) before spawning and repeat spawners which had spawned previously one or more times.The majority of the maiden large salmon spawners are female. In other Newfoundland rivers, the large salmon component mainly consists of repeat spawners, only a few of which are maiden fish.Relative proportions of the size groups varies geographically.

Since 1992, there has been a moratorium on the commercial Atlantic salmon fishery in insular Newfoundland which was extended to all of Labrador in 1998. During the five-year interval prior to the moratorium (1987-91), the commercial fishery in insular Newfoundland took an average of 398 t or about 157 thousand salmon. In Labrador in 1997, which was the last year of commercial fishing, landings were restricted by a quota of 50 t. Landings in 1997 were about 47 t or 12 thousand salmon. Also in 1992-99, there was a moratorium on the northern cod fishery, which should have eliminated salmon bycatches in cod fishing gear. The cod moratorium was extended to the south and west coasts in 1993. Cod fisheries reopened in 1997 on the south and west coasts of insular Newfoundland. It is still possible that salmon bound for Newfoundland and Labrador are caught in the small marine fisheries of Quebec, Greenland and St. Pierre-Miquelon.

The conservation requirements for Atlantic salmon rivers are considered to be threshold reference points. The consequences of egg depositions below conservation to the long-term sustainability of the stock are unknown but the likelihood of deleterious effects are greater when egg depositions are below conservation. The conservation requirements are established for individual rivers based on 2.4 eggs per m^2 of river rearing habitat and 368 or 105 eggs per hectare of lake habitat, depending on the river system. The status of stocks is assessed on the basis of the proportion of the conservation egg deposition achieved in a given year and the trends in abundance of various life stages. It is recommended that no fishing be permitted on stocks that are below 100% of conservation requirements.

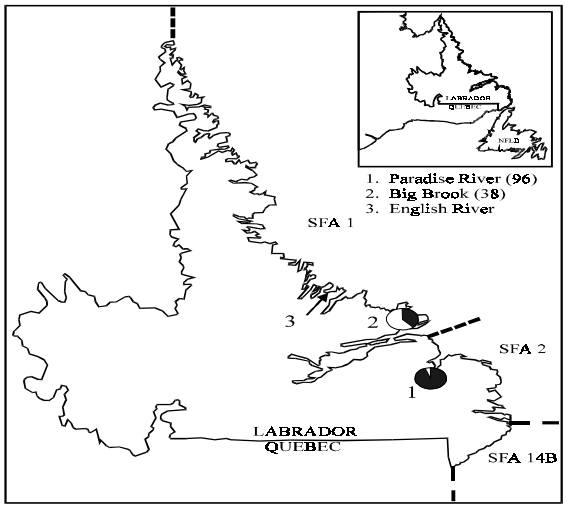

Figure 1. Map illustrating the location of the Salmon Fishing Areas of Labrador, along with salmon rivers assessed in 1999. The black portion of the circle and the numbers in parentheses indicate the percentage of the conservation reference level achieved in 1999. English River (map index 3) was not assessed relative to conservation spawning requirements.

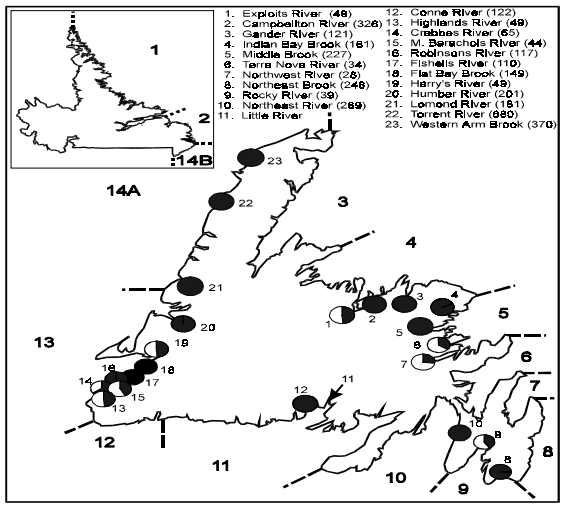

Figure 2. Map illustrating the location of the Salmon Fishing Areas of Newfoundland, along with the various salmon rivers assessed relative to their conservation requirements. The black portion of the circle and the numbers in parentheses indicate the percentage of the egg conservation requirement achieved for each river in 1999. Little River (map index 11) was not assessed relative to conservation spawning requirements.

Summary

- An integrated three year management plan introduced a river classification system whereby different recreational fishery retention levels were established based upon the status of the resource.

- Limited information from **Labrador** (SFAs 1 – 2) indicated that while salmon runs were generally low overall, numbers increased over previous years as evidenced by returns to two counting facilities.

- In **Northeast and eastern Newfoundland** (SFAs 4 – 5), total returns of small (<63 cm) and large (>63 cm) salmon in 1999 varied, with some rivers, including Exploits and Gander, having returns higher than in 1998 and the 1992-98 mean, while others had lower returns. With the exception of Exploits River, Terra Nova River and Northwest River (Port Blandford), four other rivers assessed in these SFAs met or exceeded their conservation spawning requirements in 1999. Marine survival of smolts to returns of small salmon at Campbellton River increased from 5.3% in 1998 to 6.1% in 1999, but survival was still less than the average survival of 8.1% from 1994 to 1996.

- In **Southern Newfoundland** (SFAs 9 – 11), total returns of small salmon in 1999 declined relative to 1998 at all monitored rivers with the exception of Little River. The greatest decline was observed at Northeast River (Placentia), where returns of small salmon fell about 60% from the previous year and the 1992-98 mean, and were the lowest recorded since 1987. Returns of large salmon fell at three rivers, declining 42% at Northeast River (Placentia), but were similar to or higher at Little River and North-

east Brook (Trepassey). However, at all monitored rivers returns of large salmon in 1999 were higher than the 1992-98 mean values. With the exception of Rocky River, four other monitored rivers met or exceed their conservation spawning requirements although the management target at Conne River was not attained. Some south coast rivers had average returns of small salmon during 1992 – 99 that were lower than returns prior to the closure of the commercial salmon fishery. Marine survival is monitored at three south coast rivers (Northeast Brook (Trepassey), Rocky River, and Conne River). While showing small increases over the previous year, survival remains low at or less than 5% for all rivers and below the 1992-98 means.

- In **Southwest Newfoundland** (SFAs 12 - 13), total returns of small salmon showed marked improvements at Highlands, Crabbes, Robinsons, Fischells, Flat Bay and Humber rivers and were similar to the previous year at Pinchgut Brook, a tributary of Harrys River. Salmon returns to Middle Barachois Brook seem to have declined. With the exception of Highlands River, total returns of large salmon were also generally higher. Except for Highlands, Harrys, Crabbes, and Middle Barachois brooks, all other monitored rivers met or exceeded their conservation spawning requirements. Marine survival of smolts to small salmon returns at Highlands River increased from 1.4% in 1998 to 2.5% in 1999. Survival to 2SW salmon fell to the lowest value recorded during the 1990s (0.5%).

- In **Northwest Newfoundland** (SFA 14A), total returns of small salmon were also variable, with returns at Lomond River increasing over 1998, but with substantive declines at Torrent River and Western Arm Brook. Large salmon returns were the lowest in five years at Torrent River and Western Arm Brook, but also declined at Lomond River relative to 1998. Despite the declines experienced in 1999, conservation spawning requirements at all of these rivers were greatly exceeded in each of these rivers, continuing the trend that began with the commercial salmon fishery moratorium. Marine survival of smolts to small salmon returns at Western Arm Brook fell from 7.2% in 1998 to 6.1% in 1999, and was about 12% less than the average survival during the past five years (1994 – 98).

- Overall, of 22 rivers in insular Newfoundland assessed relative to conservation requirements, 14 stocks met or exceeded their requirements, 1 river was at 65% of conservation, while 7 rivers were at 50% or less than their spawning requirements. Of the latter rivers, three were located in Bay St. George (SFA 13), while three others were enhanced stocks that have been, or are undergoing colonization programs.

- With the exception of Highlands River, **smolt production** in 1999 decreased from 5% to 29% at five of six monitored rivers when compared with 1998, and was the lowest observed during the past four or five years. In contrast, smolt numbers were 60% higher at Highlands River, but still lower than the 1993 – 96 mean. For those rivers that have experienced overall declines in smolt production, returns of small salmon are expected to decline from 1999 levels unless there are corresponding increases in marine survival to compensate for the reduction in smolt numbers.

- Rainbow trout, presumably escapees from aquaculture marine cages, have been documented in a number of rivers along the south and west coasts of Newfoundland in 1998 and 1999.

Environmental Conditions

Studies have shown that variability in ocean conditions can influence both the survival and growth of salmon as well as the timing and location of their migration. Similarly, conditions in freshwater influence growth, survival, length of residence in freshwater, and timing of exit to the sea. On return as adult salmon, migration and speed of upstream ascent are also influenced by water levels and temperatures. Freshwater environmental conditions can affect exploitation rates on returning adult salmon, and determine whether or not rivers are closed throughout the angling season as an additional conservation measure when low water levels and warm water temperatures prevail.

Freshwater

Water conditions are summarized from monthly averages recorded at gauging stations at Eagle, Gander, Isle aux Morts, Rocky and Humber rivers. In Labrador, from about Eagle River northwards, water levels in May to September were higher than normal, and similar to 1997. South of Eagle River, water conditions in Labrador rivers were similar to those on the Island portion of the Province. For insular Newfoundland, water levels on the above referenced monitored rivers were average in May; except for Isle aux Morts which was above average. All were average in June to September except for Rocky which was well below average. In many other rivers, however, low water levels prevailed for varying periods resulting in 103 of the 158 scheduled rivers on the island being closed some time during the summer. Also, for the first time one Labrador river (Shinney's River – SFA 2) was closed because of low water levels.

Marine

Annual mean air temperatures throughout most of the northwest Atlantic in 1999 warmed relative to 1998 and were above their long-term means setting record high values in the southern Labrador and eastern Newfoundland Regions. The North Atlantic Oscillation (NAO) index for 1999 was well above normal, reversing the trend of below normal and near normal values of the previous three years. The index in 1999 was similar to levels obtained during the cold early 1990s. The sea ice on the southern Labrador and Newfoundland shelves generally appeared on schedule but left early, resulting in a shorter duration of ice than usual. The ice coverage in these areas during 1999 was lower than average but similar to 1998. The number of icebergs reaching the Grand Banks in 1999 was only 22, well down from the 1384 icebergs observed in 1998. The small number of bergs in 1999 is consistent with the reduced ice cover later in the season and the generally warmer-than-normal air temperatures.

Temperatures at Station 27 ranged from 0.25^{o} to 1^{o}C above normal during the winter months over most of the water column. The spring warming of the water column in the inshore Newfoundland Region began about 2 weeks earlier than normal and maximum summer surface temperatures reached a near record high of 15^{o}C. As a result temperatures were over 2^{o}C above normal at the surface during June

and July. Bottom temperatures throughout the year ranged from 0.25° to 0.5 °C above normal. Salinities at Station 27 were above normal during the winter months and below normal during the rest of the year. During the summer and fall of 1999 the cross-sectional area of sub-zero °C (CIL) water off Bonavista, Hamilton Bank and on the Grand Bank decreased over 1998 values continuing the below normal trend established in 1995. Bottom temperatures on the Northern Grand Bank during the spring of 1999 were up to 1°C above average and over the central and Southern Grand Bank they were up to 1-3°C above the long-term average. During the fall bottom temperatures from Hamilton Bank to the southern Grand Bank were significantly above normal. The area of sub-zero °C water covering the bottom on all major banks in the Newfoundland Region during the fall, and on the Grand Banks during spring, had decreased to near 0%.

In southern areas of Newfoundland, temperatures during 1999 continued to warm and were above normal over most of the water column and near bottom. The areal extent of subzero °C bottom water covering St. Pierre Bank showed a dramatic increase during the mid-1980s, very low values in 1998 and a complete disappearance in 1999. The areal extent of bottom water with temperatures above 1°C on the banks of southern Newfoundland was about 50% of the total area during 1998 the first significant amount since 1984 and it increased further to about 70% during 1999. In general, during 1999 ocean temperatures were above normal over most areas continuing the trend established in 1996.

The Fishery

Atlantic salmon were harvested by two user groups in 1999: Aboriginal peoples, and recreational fishers including commercial outfitters. While there was no Aboriginal food fishery at Conne River in 1999, Aboriginal salmon fisheries occurred in Labrador (Fig. 1) under communal licence to the Labrador Inuit Association, and by an agreed quota with the Innu Nation for the Lake Melville area. The moratorium on commercial Atlantic salmon fishing, which began in 1992 in Newfoundland (Fig. 2), the Straits area of Labrador in 1997 (SFA 14B) and extended to all of Labrador (SFAs 1 – 2) in 1998, continued in 1999.

A three-year integrated salmon management program was introduced in 1999. This management strategy was designed to be responsive to rivers with healthy salmon populations while addressing conservation concerns on other rivers. The 1999 management program introduced a river classification system to insular Newfoundland and the straits area of Labrador that provided for different retention levels based upon the actual or perceived status of individual stocks. Retention levels associated with the river classification system were assigned either according to the degree to which conservation spawning requirements were met on average during the 1992 – 1996 moratorium years, or, in the absence of specific information, based upon historical angling data. Qualitative factors such as the degree of remoteness, level of angling effort, proximity to highly populated areas, size of river, and overall perception of stock status based upon observations from local anglers and DFO field staff contributed to the categorization process. Retention levels ranged from a seasonal limit of 6 fish on Class I rivers, to no retention and catch-and-release only on Class IV rivers. Some rivers

were closed to all angling and were not assigned a class number. Further details of the management plan can be found in Anon. (1999).

In 1999, approximately 16,000 salmon angling licences were sold (preliminary figure). Although twelve (12) rivers were closed to angling for conservation reasons in 1999, the potential number of fishing days available in insular Newfoundland was the highest its been since 1977. Environmental reasons, such as warm water temperatures and low water levels, resulted in 103 of 158 rivers in insular Newfoundland being closed for some period of time during 1999. Overall, 15.8% of the potential number of fishing days available were lost due to environmental closures; the fourth highest value recorded for the period 1975 to 1999. Individually, SFAs 4, 12, and 13 were affected the greatest with 26.5, 39.4, and 28.0% of the available fishing days closed, respectively. Also, for the first time one Labrador river was closed for environmental reasons in 1999.

Labrador

The salmon angling fishery in Labrador mainly occurs on rivers in coastal areas draining into the Labrador Sea and is pursued by guests at outfitting camps, both private and commercial, as well as by non-camp recreational fishers. Angling catch data for SFAs 1 and 2 are derived, as in previous years, from records kept by DFO River Guardians and log books from outfitting camps. For SFA 14B rivers, catch statistics for 1996 - 1999 were derived from the License Stub Return System (the 1999 data are preliminary). The 1999 salmon angling fishery for all Labrador rivers opened on 15 June and closed on 15 September. Although retention of one large salmon was allowed in SFAs 1 and 2, there was no retention of large salmon allowed for the entire season in SFA 14B. In SFAs 1 and 2, anglers could retain four salmon for the season, one of which could be large, while rivers in SFA 14B were included in the river classification system with a seasonal retention limit of two small salmon.

In 1999, the total Labrador angling catch was 7,843, about the same as in 1998 and considerably higher than levels experienced in most other years. The catch of small salmon was 6,520 (2,265 retained and 4,255 released) and large salmon was 1,323 (338 retained and 985 released) (Fig. 3). In SFA 1, the total catch (small and large salmon combined) of 909 increased slightly over 1998. In SFA 2, the total catch of 5,016 was 18% higher than in 1998. The total catch of 1,918 salmon in SFA 14B was 21% lower than the previous year. The proportion of salmon released by anglers in Labrador, which has been increasing over time, was 67% of the total catch, and was the highest value reported to date. In total, there were 5,240 small and large salmon reported to have been hooked and released in 1999.

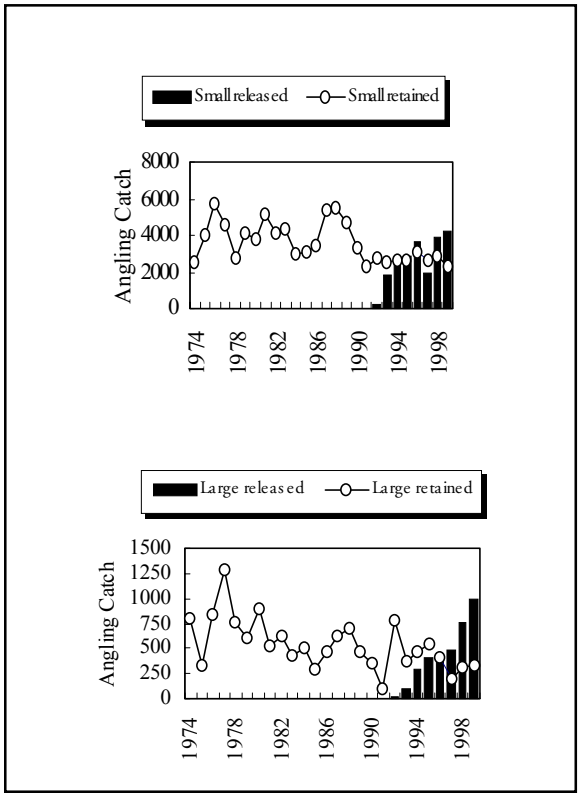

Figure 3. Angling catches of small and large salmon in Labrador SFAs 1, 2 and 14B, 1974-1999. Data for 1996-1999 are from the License Stub Return System for SFA 14B (data for 1999 are preliminary) and DFO statistics for SFAs 1 & 2, 1974-1999.

Newfoundland

A preliminary estimate of 24,075 small salmon (14,937 retained and 9,138 released) were angled in insular Newfoundland SFAs 3 - 14A in 1999, a decline of 41% from 1998 and 40% from the 1992 – 1996 mean, the lowest in recent years (Fig. 4). An estimated 2,831 large salmon were released 21% less than in 1998 but 43% higher than the mean for 1992 – 1996. The proportion of hooked-and-released small salmon increased steadily during the period 1994 – 1998 (0.22 – 0.52) but decreased markedly (0.38) in 1999. The number of small salmon retained decreased by 24% from 1998 and by 48% from the mean for 1992 – 1996, by far the lowest in recent years.

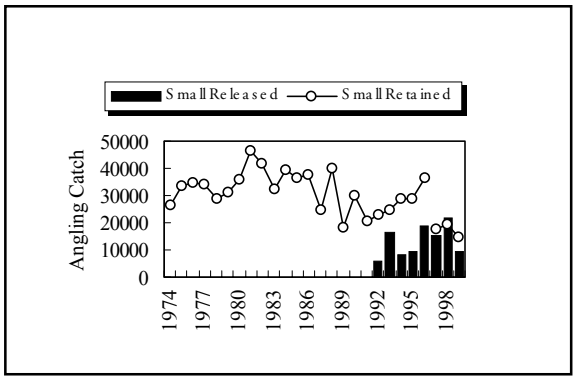

Figure 4. Angling catches of small salmon in Newfoundland SFAs 3 – 14A, 1974 – 1999. Data for 1997 – 1999 are from the Licence Stub Return System and information for 1999 is preliminary.

Resource Description

The status of Atlantic salmon stocks is determined from the annual returns to rivers and spawning escapements relative to conservation requirements, abundance of smolts, and trends in marine survival. During the commercial salmon fishery moratorium (1992-99), the numbers of small and large salmon returning to rivers in insular Newfoundland are considered to be the total numbers of salmon produced. Spawning escapements are determined by accounting for known removals of salmon, including recreational harvests, broodstock collections, in-river mortalities, or scientific samples. The status of stocks is assessed on the basis of the proportion of the conservation egg deposition achieved in a given year. For Atlantic salmon rivers, conservation requirements are customized for each river depending on the amount of parr-rearing habitat available for salmon, which is developed from a physical survey of the river. The conservation requirements are based on 2.4 eggs per m^2 of river rearing habitat and 368 or 105 eggs per hectare of lake habitat depending on the river system (105 eggs per hectare is used for

some northwest coast and some Labrador rivers). The conservation requirements are considered to be threshold reference points, but may not be appropriate for Labrador salmon stocks. In 1999, 26 rivers were assessed (Table 1).

Counts of smolts and small salmon enable estimates of marine survival to be derived. Examination of survival trends over time can provide insight into the effects of management measures designed to reduce marine exploitation, or, alternatively in the absence of fisheries, allow estimates of natural survival to be calculated. Counts of smolts also provide a direct measure of freshwater production, and in some cases, allow estimates of egg-to-smolt survival to be derived and evaluated in relation to current conservation requirements. In Newfoundland, information on smolts and adult salmon counts is available from six rivers: Campbellton River (SFA 4); Northeast Brook (Trepassey) (SFA 9); Rocky River (SFA 9); Conne River (SFA 11); Highlands River (SFA 13); Western Arm Brook (SFA 14A) (Figs. 5 and 6). While the time series of available data varies among rivers, each of the above has information that allows direct comparisons back to the 1993 smolt class. Often, biological characteristic data are used to remove repeat spawning fish from the population estimates for small salmon to derive values of survival to 1SW salmon. However, in the following discussions information on marine survival pertains to returns of small salmon only.

Resource Status

Labrador (SFAs 1-2, 14B)

There are 19 scheduled salmon rivers in SFAs 1 – 2 and 14B, although there are many more rivers that contain populations of Atlantic salmon. Prior to the closure of the Labrador commercial salmon fishery in 1998, landings (small and large salmon combined) averaged 369 t annually during the period from 1984 to 1989, and 111 t per year from 1990 to 1997, the period in which quotas and allowances were in effect. Commercial salmon landings during the last year of the commercial fishery (1997) were about 47 t. Specific rivers assessed in Labrador in 1999 include English River and Big Brook (Michaels River) (SFA 1), and Paradise River (SFA 2) (Fig. 1). The former two rivers were assessed using fish counting facilities while mark-recapture was used at Paradise River.

Status

Salmon returns to English River in 1999 were low, totalling 107 small and large salmon combined. Salmon returns at Big Brook (N = 917), however, were 45% higher than in 1997, the only previous year that the river had been assessed. Conservation spawning requirements for Labrador rivers have not been defined and the use of 2.4 eggs per m² of fluvial habitat and 105 eggs per hectare of pond habitat may not be appropriate. However, using the fluvial egg deposition rate as a reference level only, then Big Brook would have achieved 38% of the reference value. The habitat area of English River is not currently defined to allow for a similar comparison; however, the number of spawners seems very low considering the river has a drainage area of about 300 square kilometres.

In contrast with SFA 1 rivers, 5,172 salmon were estimated to have returned to Paradise River in SFA 2, of which about 9.5% were large salmon. Using 2.4 eggs per m² of fluvial habitat as a reference, then 96% of the reference value would have been met at Paradise River (Fig. 1).

For the first time, one river in Labrador was closed for environmental reasons during 1999 (Shinney's River, SFA 2).

Management concerns

Despite the potential production of salmon from the vast amount of habitat available in Labrador, relatively little information is available on the status of individual stocks. Information on salmon abundance obtained from two rivers in SFA 1 in 1999 suggests stocks are low, English River in particular, by comparison with other rivers assessed in SFA 2 and in Newfoundland. In the absence of suitable conservation requirements, an alternate means by which comparisons of salmon abundance can be made is to scale numbers of salmon returning to the river relative to the watershed drainage area. In doing this, Big Brook has a value of 1.2 salmon per km², compared with 1.0 for Paradise River, but only 0.33 for English River. Sand Hill River, SFA 2, was assessed from 1994 to 1996 and would have a value of 2.6 salmon per km² . If numbers of Arctic charr and brook trout are factored into this, then the value for English River increases to 1.5. In contrast, two rivers on the northern peninsula of Newfoundland in SFA 14A (Torrent River, Western Arm Brook) have corresponding conservation requirement values in the range of 1.1 to 2.0 salmon per km² of drainage but with actual returns that are far in excess of conservation, now ranging between 8 to 10 salmon per km². There is no information available to assess salmon stocks in SFA 14B.

The Trans Labrador Highway has the potential to increase exploitation substantially on southern Labrador salmonid stocks by providing anglers easier access to these rivers. Mechanisms should be put in place to control angling effort.

Northeast and eastern Newfoundland (SFAs 3 – 8)

There are 60 scheduled rivers in SFAs 3 – 8. Prior to the closure of the Newfoundland commercial salmon fishery, landings (small and large salmon combined) averaged 422 t annually during the period from 1984 to 1991. The largest (Exploits) and third largest (Gander) rivers in Newfoundland occur in the area. Specific rivers assessed in this area include Exploits, Campbellton, and Gander rivers in SFA 4, and Middle Brook, Terra Nova River, Northwest River (Port Blandford), and Indian Bay Brook in SFA 5 (Fig. 2). All of the above stocks are assessed using fish counting facilities.

Status

Total returns of small and large salmon in 1999 were variable, with some rivers, including Exploits and Gander, having returns similar to or higher than in 1998 and the 1992 to 1998 mean, while others had lower returns. Returns of small salmon at Exploits River were the second highest since the moratorium began. Returns of large salmon in 1999 were the highest recorded at both Exploits and Gander rivers. With the exception of Exploits River, Terra Nova River and Northwest River (Port Blandford), other rivers assessed in these SFAs met or exceeded their conservation spawning requirements in 1999 (Fig. 2, Table 1). The opening up of additional habitat in 1985, as part of ongoing enhancement initiatives since the late 1980's, has more than doubled the amount of accessible rearing area on Terra Nova River and the river is essentially still in a colonization phase. Returns to

this river were somewhat higher during the moratorium years compared to the pre-moratorium years, but it is not possible to determine the relative contribution of enhancement measures versus the closure of the commercial fishery in this regard. Most of the habitat in Northwest River (Port Blandford) was opened up to anadromous salmon in the late 1940s and enhancement programs (colonization) have been carried out on the Exploits River since the late 1950s.

Campbellton River, Middle Brook, and Indian Bay Brook have exceeded their conservation spawning requirements in each of the years that the rivers have been assessed during the moratorium (Table 1). Gander River has met or exceed conservation in 5 of 8 years, while Terra Nova River, Exploits River and Northwest River (Port Blandford) have yet to reach their conservation spawning requirements.

Forty-one (41) of the rivers in SFAs 3 - 8 were closed to recreational salmon angling for some part of the 1999 season because of environmental conditions.

Marine survival

At Campbellton River (SFA 4), estimates of marine survival are available since the 1993 smolt class. During the 1993 - 1995 period, survival to subsequent small salmon returns averaged 8.1%. This fell to 3.4% with adult returns in 1997. Since then, survival has remained relatively low at 5.3% and 6.1%
for small salmon returns in 1998 and 1999, respectively (Fig. 5).

Smolt production

Smolts produced at Campbellton River have ranged from a high of 62050 in 1997 to a low of 31577 in 1993. Smolt production in 1999 fell 6% from 1998, and was 24% lower than the peak run in 1997 (Fig. 6). Despite the decline in smolt production over the past two years, the 1999 run was similar to the mean production for 1993 – 1998 ($\bar{x}$ = 47303). Returns of adult small salmon in 2000 will be below that of 1999 unless there is an increase in marine survival to compensate for the decrease in smolt production.

Management concerns

Salmon returns to Northwest River (Port Blandford) have declined each year since 1996. In 1999, only 28% of the conservation spawning requirement was achieved. As in the past, it is recommended that no fishing mortality be permitted on stocks that are below 100% of their conservation requirements. Special management measures were in effect on Terra Nova River during 1998 and 1999. In the absence of these measures, spawning escapements would have been lower. Marine survival is monitored at only one river (Campbellton), and rates remain then salmon returns to some rivers in 2000 could be less than in 1999 unless smolt survival increases.

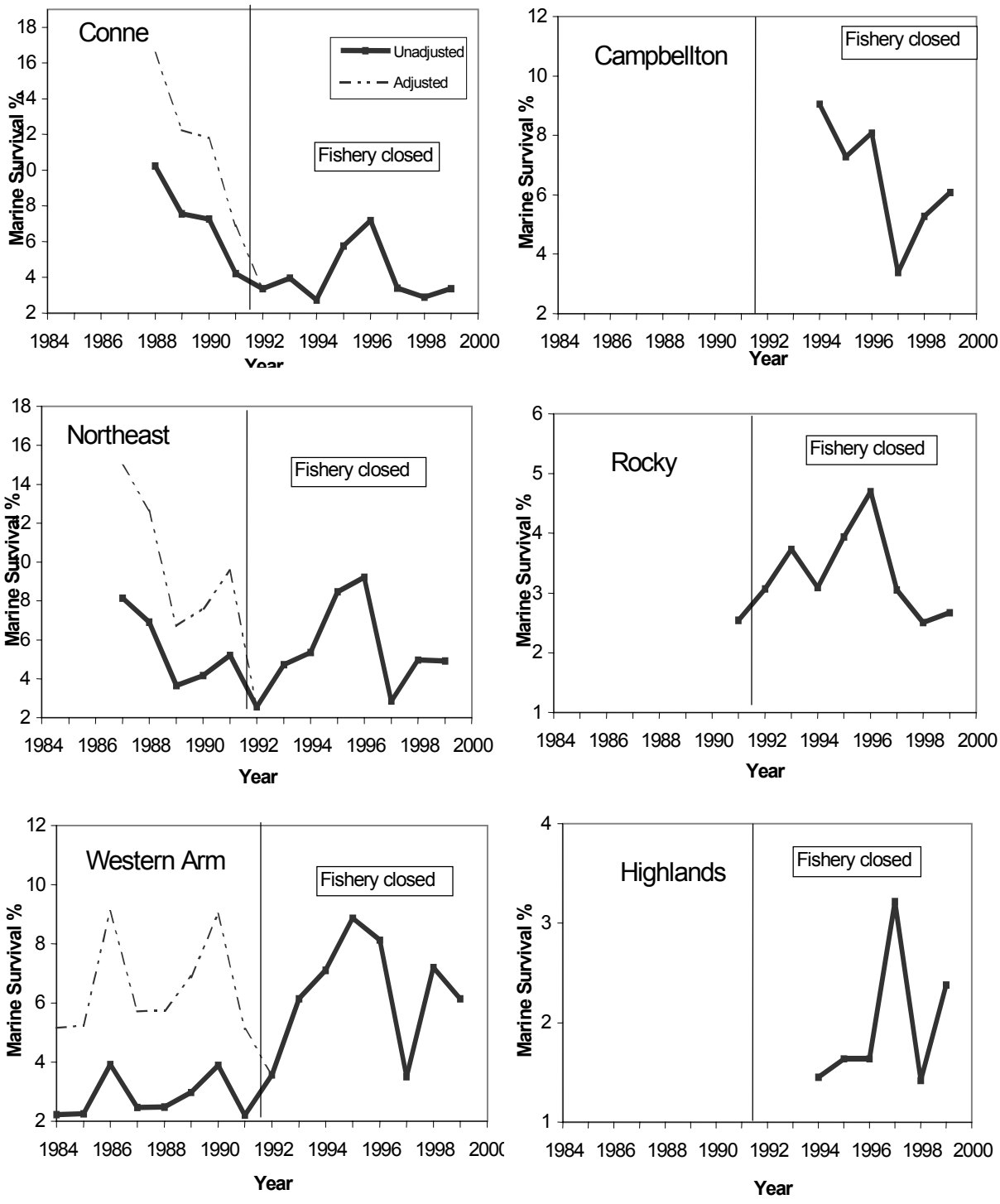

Figure 5. Marine survival rates for small salmon at Conne River, Campbellton River, Northeast Brook (Trepassey), Rocky River, Western Arm Brook, and Highlands River, Newfoundland. Dashed lines illustrate survival rates adjusted for marine exploitation.

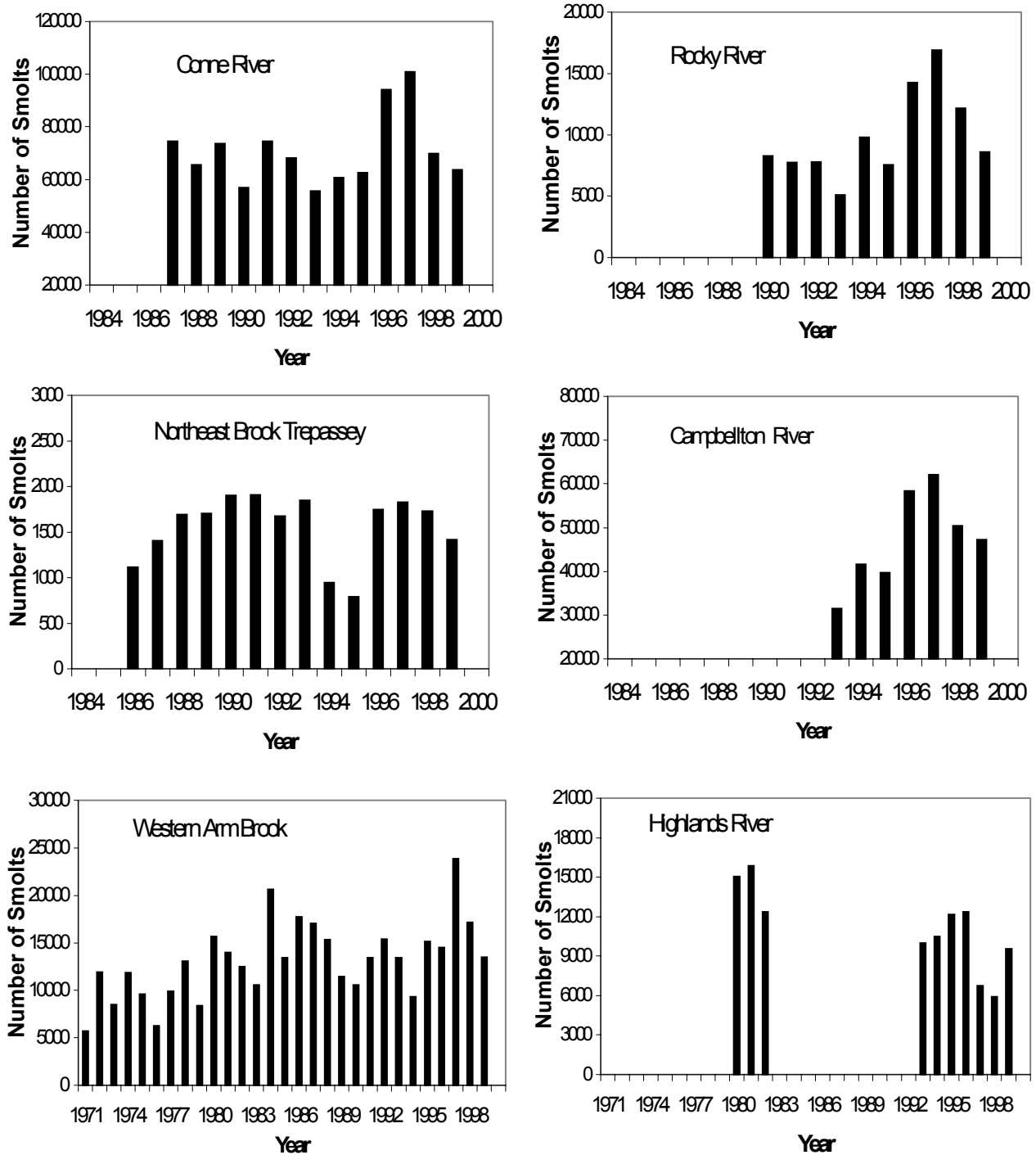

Figure 6. Smolt counts at Conne River, Rocky River, Northeast Brook (Trepassey), Campbellton River, Western Arm Brook, and Highlands River, Newfoundland.

South Newfoundland (SFAs 9 – 11)

There are 50 scheduled rivers in SFAs 9–11. Prior to the closure of the Newfoundland commercial salmon fishery, landings (small and large salmon combined) averaged 87 t annually during the period from 1984 to 1991. Owing to the proximity of the populated St. John's and Mount Pearl areas, some rivers in SFA 9 are often subject to substantial angling pressure. Bay d'Espoir (SFA 11) is the site of an aquaculture industry utilizing rainbow (steelhead) trout, Atlantic salmon, and at times brook trout. Numbers of each of these species have escaped sea cages and entered Conne River. In recent years, rainbow trout have also been confirmed in other south coast Newfoundland rivers including Biscay Bay River (SFA 9), Long Harbour River, Grand Bank Brook and Little River (SFA 11).

Specific rivers assessed in this area include Northeast Brook (Trepassey) and Rocky River in SFA 9, Northeast River (Placentia) in SFA 10, Little River and Conne River in SFA 11 (Fig. 2). Conne River has both a conservation spawning requirement and a management target. Spawning escapements of the above stocks are assessed using fish counting facilities while mark-recapture methods are used to survey smolt production at Conne River.

Status

Total returns of small salmon in 1999 declined relative to 1998 at all monitored rivers with the exception of Little River. The greatest decline was observed at Northeast River (Placentia), where small salmon returns fell about 60% from the previous year and the 1992-98 mean, and were the lowest recorded since 1987. Large salmon returns fell at three rivers, dropping 42% at Northeast River (Placentia), but were similar to or higher at Little River and Northeast Brook (Trepassey). However, at all monitored rivers returns of large salmon in 1999 were higher than the 1992-98 mean values. With the exception of Rocky River, all other monitored rivers met or exceed their conservation spawning requirements in 1999 (Fig. 2), while Conne River achieved 68% of its management target. Northeast Brook (Trepassey) and Northeast River (Placentia) have exceeded their conservation spawning requirements in each year during the moratorium (Table 1). Conne River has met its conservation requirement in 6 of 8 years, while Rocky River has yet to reach its conservation requirement. Enhancement initiatives (colonization) have been in progress on Rocky River and Little River since the 1980's, with Little River currently undergoing a fry stocking programs. Consequently, Little River was not evaluated relative to a specific conservation requirement. Note that some south coast rivers had average returns of small salmon during 1992 – 99 that were lower than returns prior to the closure of the commercial salmon fishery.

Forty (40) of the rivers in SFAs 9 - 11 were closed to recreational salmon angling for some part of the 1999 season because of environmental conditions.

Marine survival

For Northeast Brook (Trepassey) (SFA 9), a late run river, marine survival has varied among years (Fig. 5). Peak survivals from the 1994 and 1995 smolt classes were in excess of 8 and 9%, respectively. Marine survival declined to 3% in 1997, and has remained at about 5% for adult small salmon returns in 1998 and 1999.

Rocky River (SFA 9) is an enhanced stock. Fry stocking occurred from 1984 to 1987, and again in 1995 and 1996. In 1987, 140 adult salmon were also stocked. Marine survival

averaged 3.5% from the 1990 to 1995 smolt classes, about 23% lower than that reported for Conne River. Marine survival has remained low with values no higher than 3% during the past three years (Fig. 5).

For Conne River (SFA 11), estimates of marine survival have varied widely among years (Fig. 5). The highest survivals occurred with the 1987 - 1989 smolt classes (7-10%), and again with returns in 1996 from the 1995 smolt class (7.2%). Survival from the 1996 smolt class fell to 3.4% and declined to 2.9% with adult small salmon returns in 1998. Marine survival for adults returning in 1999 was 3.4%, similar to that observed from the 1996 smolt class.

Smolt production

In each of the rivers where smolts were monitored, production in 1999 fell from 9% (Conne River) to 29% (Rocky River) relative to 1998, and was lower than the mean production during the 1992 – 1998 moratorium years (Fig. 6). The number of smolts leaving these rivers has declined in each of the past two years. Corresponding increases in marine survival will be required in order for adult small salmon returns in 2000 to meet or exceed 1999 values.

Management concerns

Some south coast rivers had average returns of small salmon during 1992 – 1999 that were lower than returns prior to the closure on the commercial salmon fishery. Marine survival rates remained low on three monitored rivers. Unless survival increases, salmon returns to some rivers in 2000 will be less than in 1999 owing to the decline in smolt production. Consideration could be given to opening Conne River as a Class III or IV river as it has achieved its conservation spawning requirement in six of eight years since the moratorium began. Total returns, however, are still low by comparison with the 1986 to 1989 period. There is evidence from two rivers that increased egg depositions do not necessarily result in increased smolt production.

Southwest Newfoundland (SFAs 12 - 13)

There are 26 scheduled rivers in SFAs 12 and 13. SFA 12 was closed to commercial fishing in 1984. Prior to the closure of the Newfoundland commercial salmon fishery, landings (small and large salmon combined) in SFA 13 averaged 52 t annually, during the period from 1984 to 1991. Humber River, the second largest river in Newfoundland, and several rivers in Bay St. George, produce significant numbers of large salmon, many of which are maiden multi-sea-winter fish. Historically, rivers in Bay St. George produced among the highest recreational catches of salmon in insular Newfoundland, although in recent years, a number of these stocks remain at low levels of abundance. Highlands River, Fischells Brook, and Cooks Brook were closed to recreational fishing in 1999. Rainbow trout, presumably aquaculture escapees, have been observed or angled in La Poile River and Garia Brook (SFA 12), and Flat Bay Brook, Robinsons River, and Humber River (SFA 13).

Specific rivers assessed in this area include Highlands River, Harry's (Pinchgut) River, Crabbes River, Middle Barachois Brook, Fischells Brook, Robinsons River, Flat Bay Brook, and Humber River (Fig. 2). Crabbes, Fischells, Robinsons, Middle Barachois and Flat Bay rivers were assessed by snorkelling surveys, Highlands and Pinchgut using fish counting facilities, and Humber River by mark-recapture.

Status

Total returns of small salmon showed marked improvements for all rivers except Middle Barachois Brook relative to recent years, and were similar to the previous year at Pinchgut Brook, a tributary of Harrys River. Total returns of large salmon were also generally higher, with the exception of Highlands River. All monitored rivers met or exceeded their conservation spawning requirements except for Highlands, Harrys, Crabbes, and Middle Barachois Brook (Fig. 2, Table 1). Highlands, Fischells, Middle Barachois, Robinsons and Flat Bay rivers have reached their conservation requirements only once since the moratorium began. Humber River has met or exceeded its conservation requirement in 5 of 8 years, while Crabbes and Harrys rivers have yet to reach their conservation spawning requirements.

Twenty (20) of the rivers in SFAs 12 and 13 were closed to recreational salmon angling for some part of the 1999 season because of environmental conditions.

Marine survival

For Highlands River, counts of smolts and adult salmon are available from two time periods: 1980 - 1982 and 1993 - 1999. Highlands River is characterized by a run of two-sea-winter (2SW) salmon as well as a few 3SW fish. Marine survival from smolts to small salmon was less than 1% in the early 1980's, but increased to 1.6% from the 1993 - 1995 smolt classes reaching a high of 3.2% for 1997 small salmon returns (Fig. 5). Returns of small salmon in 1998 coincided with the lowest marine survival rate obtained (1.42%) during the 1990's, but survival increased to 2.5% with salmon that returned in 1999. Survival to 2SW salmon returns in 1999 was the lowest in recent years which corresponds to the low survival rate of small salmon in 1998.

Smolt production

Smolt production at Highlands River increased by about 60% over the previous year, but was still lower than the mean production from 1993 to 1996 (Fig. 6). During 1997 and 1998, smolt numbers at Highlands River fell dramatically as a result of an extreme winter flood in February 1996. Higher numbers of smolts are expected in 2000.

Management concerns

Particular consideration should be given to the conservation needs of salmon populations in SFA 13. The spawning populations in some Bay St. George rivers appear to be very low, particularly, the escapements to Middle Barachois Brook. Restrictive measures should continue on some stocks. Poaching on some rivers such as Harrys River, Flat Bay Brook, and Fischells Brook are believed to be long-standing problems hampering stock recovery. The improved numbers of spawners in Robinsons, Flat Bay and Fishcells brooks are encouraging. Returns to Robinsons River and Flat Bay Brook follow an increasing trend that began in 1994. The salmon population in the lower Humber River should be managed as a unique stock, because of the apparent later timing of the run to this section of the river, and the contribution of a small number of 3SW salmon to the population.

Northwest Newfoundland (SFA 14A)

There are 22 scheduled rivers in SFA 14A. Prior to the closure of the Newfoundland commercial salmon fishery, landings (small and large salmon combined) averaged 37 t annually during this period 1984 - 1991. Compared with rivers in other SFAs in Newfound-

land, salmon returns and spawning escapements in SFA 14A have improved the greatest since 1992. Rainbow trout, presumably from aquaculture escapees, have been angled in Trout River, Parsons Pond, Portland Creek, and River of Ponds (SFA 14A) in recent years. Specific rivers assessed in this area include Lomond River, Torrent River, and Western Arm Brook (Fig. 2). All of these stocks are assessed using fish counting facilities.

Status

Total returns of small salmon were variable, with returns at Lomond River increasing over 1998, but with substantive declines at Torrent River and Western Arm Brook. Returns of large salmon declined at Lomond River and were the lowest in five years at Torrent River and Western Arm Brook. Despite the declines experienced in 1999, conservation spawning requirements at each of these rivers were greatly exceeded as in all years since the closure of the commercial salmon fishery (Fig. 2, Table 1). Lomond and Torrent rivers are enhanced (colonized) stocks.

Only two (2) rivers in SFA 14A were closed due to environmental reasons in 1999.

Marine survival

For Western Arm Brook (SFA 14A), estimates of marine survival are available for 27 years. Survival ranged from a low of 2.2% for small salmon returns in 1991, to a high of 12.1% in 1979. In general, higher marine survivals occurred subsequent to the closure of the commercial fishery in 1992, but similar or even higher values were obtained prior to the closure of fisheries. Marine survival was 6.1% for small salmon returns in 1999, which is about 12% lower than the average survival during the previous five years (1994 - 1998) (Fig. 5). It must be kept in mind that the above-referenced estimates of marine survival shown for years prior to 1992 have not been corrected for commercial exploitation. When corrected, the difference between marine survival rates in pre- and post-1992 periods are even greater (Fig. 5).

Smolt production

Since the moratorium began in 1992, numbers of smolts produced at Western Arm Brook ranged from a high of 23,845 in 1997 to a low of 9,283 in 1994 (Fig. 6). Smolt production in 1999 fell 21% from 1998, and was 43% lower than the peak run in 1997. The decline in smolt production occurred despite the high spawning escapements observed during the moratorium. Returns of adult small salmon in 2000 will be below that of 1999 unless there is an increase in marine survival, to compensate for the decrease in smolt production.

Management concerns

Some rivers in SFA 14A have returns that greatly exceed their conservation spawning requirements, thus there is opportunity for increased harvest. A controlled fishery could be permitted on Western Arm Brook, whereby about 100 salmon could be angled for scientific purposes under an Experimental Permit. Consideration could be given to changing the classification of some additional rivers. There is evidence from one river that increased egg depositions do not necessarily result in increased smolt production.

Sources of Uncertainty

Unlike the situation for many marine species, the status of Atlantic salmon stocks is for the most part based on near-to-absolute counts, which reduces uncertainty as to the abundance of the resource. In a few cases, abundance of

smolts and adults is estimated using mark-recapture techniques. Marine survival of smolts to adult salmon is highly variable making predictions of subsequent abundance difficult. There is also a lack of current data on sex ratios, sizes and fecundity of large salmon in spawning escapements in Newfoundland and Labrador. Although the majority of spawners are small salmon, for which good data are available, updating and improving biological characteristic data for large salmon would reduce uncertainty with respect to egg deposition contributions from this component.

In recent years, the License Stub Return System has become the main source of angling data for stock assessment purposes. This system is still evolving and relies heavily on the co-operation of anglers to maximize the precision of estimates of catch and effort. Currently, the return rate of angling logs is around 50%, far short of the desired 90%. Even though angling catch rates are often used as indices of salmon abundance, analyses for certain rivers with counting facilities have shown no meaningful relationships between catch rate and abundance. Uncertainty exists between the comparability of the current Licence Stub Return System information and the historic data collected through the River Guardian System. It is important that efforts continue to improve the return rate of licence stubs and to validate the information from the stubs through creel surveys. Estimates of total returns of salmon to monitored rivers require the annual collection of angling data below fish counting facilities.

Research Recommendations

Accurate estimates of salmon abundance are fundamental and essential to determine the status of salmon stocks and for the provision of advice to support current management strategies. A network of geographically distributed rivers annually monitored for smolt and adult salmon production is necessary to derive estimates of marine and freshwater survival, develop stock-recruitment relationships, and understand how fish populations respond to exploitation. While the reasons for the varying marine survival may be difficult to explain in the absence of an intensive marine program, marine survival rates when viewed for trends are valuable especially for management purposes and to the general public.

Specific recommendations are as follows:

1. At a minimum, all fish monitoring facilities and mark-recapture projects carried out in 1999 should be continued in 2000 and maintained in subsequent years. These projects form the long-term core data for providing stock assessment advice.

2. Further investigations on smolt and adult salmon production should be conducted on south coast salmon populations to determine why these stocks did not improve with the closure of the commercial salmon fishery in 1992.

3. Investigations should be initiated to substantiate and quantify the importance of the fall run of large multi-sea winter (MSW) salmon that spawns in the lower part of Humber River.

4. Studies to better understand the impact of predation by cod, seals, and sea birds on migrating smolts and adult salmon should be expanded. Near shore or in-river predation may be one of the causes of the current low survival of salmon.

5. Research is required on the effect of hook-and-release fishing on salmon survival and

spawning success. Given the limitations of past experiments and their absence in Newfoundland and Labrador, appropriate experiments should be designed and projects carried out to determine if the hook-and-release mortality rates currently used in the regional stock assessments are valid.

6. Investigations are required to assess the potential impacts on wild salmonid stocks of the apparent large numbers of escaped-farmed salmonids in Bay d'Espoir. A series of index stations needs to be established and annually surveyed to document the distribution and relative abundance of escaped farmed fish in Bay d'Espoir and in Conne River and adjacent watersheds. This would provide a means by which the new containment practices in the aquaculture industry can be monitored. The index stations would also furnish baseline information necessary to examine potential impacts on wild fish populations.

7. The wide geographic distribution of rivers on the west and south coasts on Newfoundland where rainbow trout were observed in 1999 is of concern. A study is required to determine the origin of these fish and if they are successfully spawning.

8. The salmon angling Licence Stub Return System implemented in 1994 has the potential to be a consistent and reliable method of data collection. Additional improvements to the system, such as verification with other methods and by increasing angler response rates, are required. Harvest and effort statistics provide a means for evaluating the effectiveness of management measures and for assessing the status of stocks, which is vital to the management of Atlantic salmon.

9. Studies that examine the influence of both freshwater and marine environmental conditions on the survival and production of Atlantic salmon should be continued and expanded. Investigations of this nature could have increasing importance in the context of various climate change scenarios and impacts on fisheries resources.

Outlook

Short-term

Stock-specific forecasts for salmon returns in the year 2000 were not made. With the exception of Highlands River in Bay St. George, smolt output from all other monitored rivers has declined in each of the past two years. Thus, in the absence of any improvement in marine survival rates, returns of small salmon in 2000 could be lower. With respect to Labrador, salmon returns in the year 2000 will be from higher numbers of spawners than in recent years.

Long-term

In insular Newfoundland, the number of spawners has been relatively high in recent years due to the closure of the commercial fishery. Natural mortality rates in freshwater and marine environments will continue to play a major role in determining population sizes. Without an increase in marine survival rates, adult salmon populations will not increase.

Owing to a lack of long-term salmon monitoring facilities in Labrador, there is no information from which to project beyond the year 2000.

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Contact:

R. Porter
Department of Fisheries and Oceans
P O Box 5667
St. John's, NF A1C 5X1
Tel: (709)772-4409
Fax: (709)772-3578
Email: PorterR@DFO-MPO.GC.CA

This report is available from the:

Science, Oceans and Environment Branch
Department of Fisheries and Oceans
P O Box 5667
St. John's, NF A1C 5X1

Phone Number: 709-772-4355
Fax Number: 709-772-6100
e-mail address: tillmanj@dfo-mpo.gc.ca
Internet address: www.dfo-mpo.gc.ca/csas

ISSN 1480-4913 (for English series)
ISSN 1480-4921 (for French series)

Table 1. Summary of Atlantic salmon stock status in the Newfoundland Region. Conservation met refers to the actual percentage of the conservation spawning requirement achieved, but is intended as a reference level only for Labrador stocks. Refer to footnotes for definition of characters and abbreviations.

Region / River	SFA	Map Index	Method	Total Returns in 1999 Small	Total Returns in 1999 Large	Conservation met (%) 1995	1996	1997	1998	1999	1992 - 1999	Status in 1999: Smolts Relative to 1998	Smolts Relative to 1992 - 98	Marine Survival Relative to 1998	Marine Survival Relative to 1992 - 98	Egg Deposition Relative to 1998	Egg Deposition Relative to 1992 - 98
Labrador																	
English *	1	3	Fe	59	48												
Big Brook *	1	2	Fe	737	180			24		38	0 of 2 yrs					-	⇧
Paradise *	2	1	MR	4681	491					96	0 of 1 yrs						
Newfoundland																	
Northeast Coast																	
Exploits	4	1	Fw	28303	2239	39	69	24	48	50	0 of 8 yrs					⇔	⇧
Lower	4		Fw			121	210	72	146	146	7 of 8 yrs					⇔	⇧
Middle	4		Fw			24	43	15	35	35	0 of 8 yrs					⇔	⇧
Upper	4		Fw			12	26	10	6	7	0 of 8 yrs					⇔	⬇
Campbellton	4	2	Fe	3076	493	279	304	200	311	326	7 of 7 yrs	⬇	⇔	⇧	⬇	⇔	⇧
Gander	4	3	Fe	18491	482	95	124	62	110	121	5 of 8 yrs					⇔	⇧
Indian Bay Brook	5	4	Fe	2248	365			113	183	161	3 of 3 yrs					⬇	⇔
Middle Brook	5	5	Fw	1950	130	114	250	196	306	227	8 of 8 yrs					⬇	⇧
Terra Nova River	5	6	Fw	1952	343	45	36	32	32	34	0 of 8 yrs					⇔	⇔
Northwest Brook (Port Blandford)	5	7	Fe	314	93	37	55	46	42	28	0 of 5 yrs					⬇	⬇

Assessment methods: Fe = counting fence; Fw = fishway count; Sc = snorkel count; MR = Mark-recapture

Trend symbols: ⬇ > 10% decrease; ⇧ > 10% increase; ⇔ no change = ± 10%

Map index numbers refer to text figure and legend

Marine survival is from smolts in year i to small salmon in year i + 1

* Use of 240 eggs/100 m2 as a conservation requirement for Labrador rivers may not be appropriate, and is used here only as a reference level

Table 1. Continued. Summary of Atlantic salmon stock status in the Newfoundland Region. Conservation met refers to the actual percentage of the conservation spawning requirement achieved, but is intended as a reference level only for Labrador stocks. Refer to footnotes for definition of characters and abbreviations.

Region / River	SFA	Map Index	Method	Total Returns in 1999 Small	Total Returns in 1999 Large	Conservation met (%) 1995	1996	1997	1998	1999	1992 - 1999	Status in 1999: Smolts Relative to 1998	Smolts Relative to 1992 - 98	Marine Survival Relative to 1998	Marine Survival Relative to 1992 - 98	Egg Deposition Relative to 1998	Egg Deposition Relative to 1992 - 98
Newfoundland																	
South Coast																	
Northeast Brook (Trepassey)	9	8	Fe	95	18	194	196	135	256	248	8 of 8 yrs	↓	↓	⇔	↓	⇔	⇧
Rocky River	9	9	Fe	377	77	56	34	56	54	39	0 of 8 yrs	↓	↓	⇧	↓	↓	⇔
Northeast River (Placentia)	10	10	Fw	363	167	422	736	486	484	269	8 of 8 yrs					↓	↓
Little River	11	11	Fe	307	49												
Conne	11	12	Fe	2357	241	147	204	125	150	122	6 of 8 yrs	⇔	↓	⇧	↓	↓	⇔
Southwest Coast																	
Highlands	13	13	Fe	141	72	67	79	105	59	49	1 of 7 yrs	⇧	⇔	⇧	⇧	↓	↓
Crabbes	13	14	Sc	686	264		68	95	44	65	0 of 7 yrs					⇧	⇧
Middle Barachois	13	15	Sc	565	67		52	97		44	0 of 6 yrs					-	↓
Robinsons	13	16	Sc	1431	203		67	91		117	1 of 6 yrs					-	⇧
Fischells	13	17	Sc	1264	246			44	23	110	1 of 6 yrs					⇧	⇧
Flat Bay	13	18	Sc	2261	235	45	85	89		149	1 of 7 yrs					-	⇧
Harrys	13	19	Fe	1643	171	48	52	50	49	49	0 of 8 yrs					⇔	⇧
Humber	13	20	MR	27585	4433	128	186	115	120	201	6 of 8 yrs					⇧	⇧
Northwest Coast																	
Lomond	14A	21	Fw	1091	121	187	143	161	151	181	8 of 8 yrs					⇧	⇧
Torrent	14A	22	Fw	4330	411	1033	1279	797	924	680	8 of 8 yrs					↓	↓
Western Arm B rook	14A	23	Fe	1046	22	286	415	200	625	370	8 of 8 yrs	↓	↓	↓	⇔	↓	⇧

Assessment methods: Fe = counting fence; Fw = fishway count; Sc = snorkel count; MR = Mark-recapture

Trend symbols: ↓ > 10% decrease; ⇧ > 10% increase; ⇔ no change = ± 10%

Map index numbers refer to text figure and legend

Marine survival is from smolts in year i to small salmon in year i + 1

* Use of 240 eggs/100 m2 as a conservation requirement for Labrador rivers may not be appropriate, and is used here only as a reference level