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**Status of Atlantic Salmon (Salmo salar L.) in Selected Rivers
With Counting Facilities in the Newfoundland Region**

by

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Abstract

The status of Atlantic salmon was determined for the period 1984-91 in selected rivers with counting facilities, located in three Salmon Fishing Areas (SFAs) in the Newfoundland Region. In Middle Brook and Terra Nova River (SFA 5), spawning escapements were below target requirement, being most pronounced for the latter river. Spawning escapements in Biscay Bay River (SFA 9) were above target requirement in six out of the eight years; in 1991 the escapement was well below target. In Northeast River, Placentia (SFA 10), target requirement was exceeded in all years.

Résumé

On a déterminé l'état des stocks de saumon de l'Atlantique de 1984 à 1991 dans des rivières munies d'installations de dénombrement au sein de trois ZPS de la région de Terre-Neuve. Dans le ruisseau Middle et dans la rivière Terra Nova (ZPS 5) les échappées de géniteurs ont été inférieures aux besoins cibles, l'écart étant plus particulièrement marqué dans la rivière Terra Nova. Dans la rivière Biscay Bay (ZPS 9), les échappées de géniteurs ont été supérieures aux besoins au cours de six des huit années considérées; en 1991, elles étaient toutefois bien en dessous de la cible. Enfin, dans la rivière Northeast, à Placentia (ZPS 10), les besoins ont été largement comblés chaque année.

Introduction

In 1984, major changes were introduced in the management of Atlantic salmon in the Newfoundland Region, the details of which can be found in O'Connell et al. (1990). In 1990 and 1991, an additional change was added when quotas or allowances were implemented in the commercial fishery in all Salmon Fishing Areas (SFAs) of the region (for details see O'Connell et al. 1991a, 1992). In this paper we examine the status of Atlantic salmon in Middle Brook and Terra Nova River, Bonavista Bay (SFA 5), Biscay Bay River, St. Mary's Bay (SFA 9), and Northeast River, Placentia Bay (SFA 10), since 1984. The location of the SFA in which each river is found is shown in Fig. 1. Counts of grilse are used in conjunction with recreational fishery data and biological characteristic data to calculate spawning escapements. Stock status is evaluated relative to target spawning requirements developed for all rivers by O'Connell and Dempson (1991a,b).

Methods

RECREATIONAL FISHERY DATA

Catch and effort data for each river (Appendix 1-4) were collected by Department of Fisheries and Oceans (DFO) Officers and processed by DFO Science Branch staff. For Terra Nova River, data for Maccles Brook are included in the totals.

BIOLOGICAL CHARACTERISTIC DATA

Biological characteristic information (obtained by sampling recreational catches) used to calculate egg depositions for adult Atlantic salmon < 63 cm in length (grilse) are presented in Tables 1 (Middle Brook and Terra Nova River) and 2 (Biscay Bay River and Northeast River, Placentia). For fish ≥ 63 cm in length (large salmon), mean values of all available data for Gander River (SFA 4) and Terra Nova River combined were used for Middle Brook and Terra Nova River (Table 1). For Biscay Bay River and Northeast River, data for Biscay Bay River, Colinet River, and Little Salmonier River combined (the latter two rivers are located in SFA 9) were used (mean weight = 2.94 kg; proportion female = 0.74; N = 17).

Fecundity was determined from ovaries collected in the recreational fishery. Ovaries were stored in Gilson's fluid until ovarian tissue had broken down after which time eggs were transferred to 10% formalin. Eggs, which for the most part were in early stages of development, were counted directly. Relative fecundity values used to calculate egg depositions for both grilse and large salmon for each river are shown in Table 3. For Terra Nova River, the average for that river was used in 1985 and 1986.

ESCAPEMENT AND EGG DEPOSITION

Escapement and egg deposition were calculated in terms of grilse and large salmon separately. Total egg deposition was obtained by summing depositions for grilse and large salmon.

Total River Escapement

Total river escapement (TRE) was calculated as follows:

$$(1) \quad \text{TRE} = \text{RC}_b + C$$

where,

RC_b = recreational catch below counting facility
 C = count of fish at counting facility

For Terra Nova River, recreational catch below the fishway did not include that of Maccles Brook.

Spawning Escapement

Spawning escapement (SE) was calculated according to the formula:

$$(2) \quad \text{SE} = \text{FR} - \text{RC}_a - \text{BR}$$

where,

FR = fish released at counting facility
 RC_a = recreational catch above counting facility
 BR^a = broodstock removal (Biscay Bay River only)

Egg Deposition

Egg deposition (ED) was calculated as follows:

$$(3) \quad \text{ED} = \text{SE} \times \text{PF} \times \text{RF} \times \text{MW}$$

where,

SE = number of spawners
 PF = proportion of females
 RF = relative fecundity (no. of eggs/kg)
 MW = mean weight of females

For Terra Nova River, spawning escapement and egg deposition were calculated for the area above the lower fishway, including the area above Mollyguajeck Falls.

The phenomenon of atresia has been reported to occur in Atlantic salmon in the Soviet Union (Melnikova 1964) and in France (Prouzet et al. 1984). Recently there is evidence to show that it can occur to varying degrees in insular Newfoundland (O'Connell and Dempson, unpublished data). Since egg deposition calculations above were based on eggs in early stages of development, they should be regarded as potential egg depositions.

TARGET SPAWNING REQUIREMENTS

The target spawning requirement for each river (Table 4) was developed by O'Connell and Dempson (1991a,b). The egg deposition requirement for classical fluvial parr rearing habitat (Elson 1957) was 240 eggs/unit (a unit = 100 m²) (Elson 1975); the requirement for lacustrine habitat was 368 eggs/ha (O'Connell et al. 1991). Spawning requirements were calculated in terms of grilse only. Egg deposition from large salmon was considered as a buffer to the estimate of spawning requirement.

Results

Counts at Counting Facilities

Counts of grilse and large salmon at the Middle Brook and lower Terra Nova River fishways for the period 1979-91 are shown in Table 5. In Middle Brook, counts of both grilse and large salmon in 1990 and 1991 (quota years) were below the mean for the years subsequent to the introduction of the major management measures in 1984 (1984-89). For Terra Nova River, counts of grilse in 1990 and 1991 were below the 1984-89 mean. In 1990, the count of large salmon in Terra Nova River was higher than the 1984-89 mean while in 1991 it was lower.

Counts of grilse and large salmon for the Biscay Bay River counting fence and the Northeast River fishway are presented in Table 6. In Biscay Bay River, counts of grilse and large salmon in both quota years were below the 1984-89 mean, being most pronounced in 1991. For Northeast River, the count of grilse in 1990 was similar to the 1984-89 mean while that of 1991 was below the mean; the count of large salmon exceeded the 1984-89 mean in 1990 but decreased in 1991.

Total Escapement, Spawning Escapement, and Percentage of Target Achieved

Total escapements and spawning escapements of grilse and large salmon, potential egg depositions, and percentages of target spawning requirement achieved for Middle Brook and Terra Nova River for 1984-91 are shown in Table 7. For Middle Brook, the percentage of target met ranged from 50% (1989) to 134% (1984). For Terra Nova River the range was 15% (1987) - 30% (1988).

In Biscay Bay River (Table 8), the target spawning requirement was exceeded in all years except 1989 and 1991. Since a partial count of grilse and large salmon was obtained in 1989, the percentage of target achieved was higher than the 87% depicted. Egg deposition in 1991 was by far the lowest recorded for Biscay Bay River. The percentage of target achieved in Northeast River was in excess of requirement in all years, ranging from 152% (1985) to 346% (1986).

Discussion

The area above Mollyguajeck Falls in Terra Nova River was stocked with adults from the upper fishway in 1985-89 and the first grilse returns from these stockings with a smolt age of 3+ years were expected in 1990. For this

reason, the area above Mollyguaieck Falls was included in the target spawning requirement. Since counts were not conducted in the fish passage at Mollyguaieck Falls, the numbers of adults destined to return to the area above the falls in 1990 and 1991 is not known.

Cautions associated with the parameter values used to calculate target spawning requirements have been discussed previously by O'Connell et al. (1991b) and O'Connell and Dempson (1991a,b) and will not be dealt with here in detail. Recent research findings pertaining to the egg-to-smolt survival parameter however warrant mention. This parameter is very sensitive to change in terms of impact on calculations of egg deposition requirements using the model presented in O'Connell and Dempson (1991a,b). There is reason to believe that egg-to-smolt survival could be substantially lower than used in the model. However, further substantiation could be required. The use of a lower value would increase target spawning requirements accordingly.

References

- Elson, P. F. 1957. Using hatchery reared Atlantic salmon to best advantage. *Can. Fish. Cult.* 21: 7-17.
- Elson, P. F. 1975. Atlantic salmon rivers smolt production and optimal spawning. An overview of natural production. *Int. Atl. Salmon Found. Spec. Publ. Ser. 6*: 96-119.
- Melnikova, M. N. 1964. The fecundity of Atlantic salmon (Salmo salar L.) from the Varguza River. *Vopr. Ikhtiolog.* 4: 469-476.
- O'Connell, M. F., and J. B. Dempson. 1991a. Atlantic salmon (Salmo salar L.) target spawning requirements for selected rivers in salmon fishing area 5 (Bonavista Bay), Newfoundland. *CAFSAC Res. Doc.* 91/17. 10 p.
- O'Connell, M. F., and J. B. Dempson. 1991b. Atlantic salmon (Salmo salar L.) target spawning requirements for rivers in Notre Dame Bay (SFA 4), St. Mary's Bay (SFA 9), and Placentia Bay (SFA 10), Newfoundland. *CAFSAC Res. Doc.* 91/18. 14 p.
- O'Connell, M. F., J. B. Dempson, E.G.M. Ash, and N. M. Cochrane. 1991a. Status of Atlantic salmon (Salmo salar L.) stocks of the Newfoundland Region, 1990. *CAFSAC Res. Doc.* 91/16. 52 p.
- O'Connell, M. F., J. B. Dempson, and R. J. Gibson. 1991b. Atlantic salmon (Salmo salar L.) smolt production parameter values for fluvial and lacustrine habitats in insular Newfoundland. *CAFSAC Res. Doc.* 91/19. 11p.
- O'Connell, M. F., J. B. Dempson, T. R. Porter, D. G. Reddin, E.G.M. Ash, and N. M. Cochrane. 1992. Status of Atlantic salmon (Salmo salar L.) stocks of the Newfoundland Region, 1991. *CAFSAC Res. Doc.* 92/22. 56 p.
- O'Connell, M. F., J. B. Dempson, and D. G. Reddin. 1990. Evaluation of the impacts of the Atlantic salmon management plan (1984-88) in the Newfoundland Region. *CAFSAC Res. Doc.* 90/35. 46 p.

Prouzet, P., P. Y. LeBail, and M. Heydorff. 1984. Sex ratio and potential fecundity of Atlantic salmon (Salmo salar L.) caught by anglers on the Elorn River (Northern Brittany, France) during 1979 and 1980. Fish. Mgmt. 15: 123-130.

Table 1. Biological characteristic data for Atlantic salmon < 63 cm in length for Middle Brook and Terra Nova River, Bonavista Bay (SFA 5) and for salmon ≥ 63 cm in length for Gander River (SFA 4) and Terra Nova River, Newfoundland.

| River | Fork length of Females (cm) | | | | Weight of Females (kg) | | | | River Age (y) | | | | Sex Ratio % | |
|--|-----------------------------|-------------|------------|------------------|------------------------|-------------|-------------|------------------|---------------|-------------|-------------|------------|----------------|-----------|
| | N | \bar{X} | SD | Range | N | \bar{X} | SD | Range | N | \bar{X} | SD | Range | N | Female |
| Grilse | | | | | | | | | | | | | | |
| Middle Brook | | | | | | | | | | | | | | |
| 1983 | 19 | 50.8 | 4.5 | 35.0-56.0 | 17 | 1.66 | 0.32 | 1.00-2.27 | 19 | 3.58 | 0.51 | 3-4 | 24 | 79 |
| 1984 | 121 | 49.8 | 4.4 | 38.5-62.0 | 121 | 1.48 | 0.40 | 0.60-2.80 | 121 | 3.51 | 0.59 | 3-6 | 154 | 79 |
| 1985 | 88 | 50.1 | 4.2 | 33.9-57.1 | 88 | 1.51 | 0.34 | 0.70-2.30 | 88 | 3.43 | 0.56 | 2-5 | 107 | 82 |
| 1986 | 42 | 52.0 | 4.8 | 45.0-61.4 | 41 | 1.58 | 0.47 | 0.90-2.70 | 42 | 3.74 | 0.59 | 3-5 | 49 | 86 |
| 1987 | 7 | 49.5 | 3.4 | 44.0-55.0 | 7 | 1.30 | 0.33 | 1.00-2.00 | 7 | 3.71 | 0.49 | 3-4 | 17 | 41 |
| Total | 277 | 50.3 | 4.4 | 33.9-62.0 | 274 | 1.51 | 0.39 | 0.60-2.80 | 277 | 3.53 | 0.58 | 2-6 | 351 | 79 |
| Terra Nova River | | | | | | | | | | | | | | |
| 1983 | 81 | 51.8 | 3.8 | 38.5-61.5 | 83 | 1.66 | 0.35 | 0.91-2.70 | 83 | 3.64 | 0.67 | 3-5 | 105 | 79 |
| 1984 | 73 | 50.2 | 3.7 | 43.0-61.0 | 73 | 1.57 | 0.36 | 0.96-2.70 | 73 | 3.55 | 0.62 | 3-5 | 99 | 74 |
| 1985 | 29 | 51.8 | 4.4 | 44.0-60.5 | 18 | 1.45 | 0.49 | 0.80-2.60 | 29 | 3.62 | 0.72 | 3-6 | 41 | 71 |
| 1986 | 35 | 52.6 | 3.7 | 46.0-59.0 | 35 | 1.61 | 0.36 | 0.90-2.40 | 35 | 3.45 | 0.66 | 3-6 | 53 | 66 |
| 1987 | 35 | 51.5 | 3.5 | 42.0-61.0 | 36 | 1.52 | 0.32 | 0.80-2.40 | 36 | 3.50 | 0.70 | 2-5 | 50 | 72 |
| Total | 253 | 51.4 | 3.9 | 38.5-61.5 | 245 | 1.59 | 0.36 | 0.80-2.70 | 256 | 3.57 | 0.66 | 2-6 | 348 | 74 |
| Large Salmon | | | | | | | | | | | | | | |
| Gander River | | | | | | | | | | | | | | |
| | 8 | 69.2 | 80.6 | 63.0-82.6 | 8 | 3.66 | 1.81 | 2.38-7.71 | 8 | 3.50 | 0.53 | 3.00-4.00 | 10 | 80 |
| Terra Nova River | | | | | | | | | | | | | | |
| | 6 | 68.3 | 38.4 | 63.0-73.5 | 6 | 3.08 | 0.60 | 2.27-3.70 | 6 | 4.00 | 0.63 | 3.00-5.00 | 6 | 100 |
| Gander and Terra Nova rivers combined | | | | | | | | | | | | | | |
| | 14 | 68.8 | 63.9 | 63.0-82.6 | 14 | 3.41 | 1.41 | 2.27-7.71 | 14 | 3.71 | 0.61 | 3.00-5.00 | 16 | 88 |

Table 2. Biological characteristic data for Atlantic salmon < 63 cm in length for Biscay Bay River, St. Mary's Bay (SFA 9) and Northeast River, Placentia Bay (SFA 10), Newfoundland.

| River | Fork length of Females (cm) | | | | Weight of Females (kg) | | | | River Age (y) | | | | Sex Ratio % Female | |
|------------------------|-----------------------------|-------------|------------|------------------|------------------------|-------------|-------------|------------------|---------------|-------------|-------------|------------|-----------------------|-----------|
| | N | \bar{X} | SD | Range | N | \bar{X} | SD | Range | N | \bar{X} | SD | Range | N | Female |
| SFA 9 | | | | | | | | | | | | | | |
| Biscay Bay River | 505 | 52.6 | 3.5 | 41.5-62.4 | 326 | 1.68 | 0.36 | 0.81-3.50 | 519 | 3.10 | 0.59 | 2-5 | 698 | 75 |
| SFA 10 | | | | | | | | | | | | | | |
| Northeast River | | | | | | | | | | | | | | |
| 1974 | 1 | 55.9 | - | - | 1 | 1.81 | - | - | 1 | 3.00 | - | - | 1 | 100 |
| 1975 | - | - | - | - | 1 | 1.59 | - | - | 1 | 3.00 | - | - | 1 | 100 |
| 1978 | 59 | 53.7 | 2.7 | 45.7-59.0 | 59 | 1.52 | 0.19 | 1.10-2.00 | 59 | 2.93 | 0.36 | 2-4 | 63 | 94 |
| 1979 | - | - | - | - | 12 | 1.43 | 0.24 | 0.91-1.82 | 12 | 2.58 | 0.51 | 2-3 | 14 | 86 |
| 1980 | 38 | 53.4 | 2.2 | 46.0-57.2 | 38 | 1.58 | 0.23 | 1.10-2.10 | 38 | 2.68 | 0.47 | 2-3 | 42 | 90 |
| 1981 | 91 | 52.6 | 2.6 | 43.0-58.0 | 86 | 1.54 | 0.24 | 0.91-2.04 | 93 | 2.91 | 0.43 | 2-4 | 103 | 90 |
| 1982 | 16 | 54.3 | 2.5 | 51.0-58.5 | 22 | 1.55 | 0.28 | 1.00-2.00 | 22 | 2.77 | 0.53 | 2-4 | 24 | 92 |
| 1983 | 19 | 51.9 | 1.9 | 49.0-56.0 | 26 | 1.50 | 0.20 | 1.15-1.90 | 26 | 2.46 | 0.51 | 2-3 | 29 | 90 |
| 1984 | 24 | 52.2 | 2.3 | 46.0-58.0 | 22 | 1.51 | 0.19 | 1.10-1.90 | 24 | 2.92 | 0.50 | 2-4 | 27 | 89 |
| 1985 | 47 | 51.8 | 3.2 | 41.7-57.8 | 47 | 1.56 | 0.24 | 1.00-2.16 | 47 | 2.91 | 0.35 | 2-4 | 51 | 92 |
| 1986 | 63 | 53.2 | 2.3 | 46.8-60.0 | 63 | 1.69 | 0.25 | 0.90-2.40 | 63 | 3.14 | 0.43 | 2-4 | 68 | 93 |
| 1987 | 1 | 49.0 | - | - | 1 | 1.40 | - | - | 1 | 3.00 | - | - | 1 | 100 |
| TOTAL | 359 | 52.9 | 2.7 | 41.7-60.0 | 378 | 1.56 | 0.24 | 0.90-2.40 | 387 | 2.88 | 0.47 | 2-4 | 424 | 91 |

Table 3. Relative fecundity values used to calculate egg deposition for each river.

| River | Year | Relative fecundity (No. eggs/kg) | N |
|----------------------------|-------|-------------------------------------|-----|
| SFA 5 | | | |
| Middle Brook | 1984 | 1896 | 102 |
| | 1985 | 1988 | 83 |
| | 1986 | 1955 | 36 |
| | Total | 1941 | 211 |
| Terra Nova River | 1984 | 1709 | 46 |
| | 1985 | 2372 | 6 |
| | 1986 | 1364 | 14 |
| | Total | 1713 | 66 |
| SFA 9 | | | |
| Biscay Bay River | | 2066 | 290 |
| SFA 10 | | | |
| Northeast River, Placentia | | 2267 | 106 |

Table 4. Atlantic salmon target spawning requirement for each river in terms of eggs and grilse.

| River | Target spawning requirement | |
|-------------------------------|-------------------------------|--------------|
| | Eggs (No. x 10 ⁶) | Grilse (No.) |
| SFA 5 | | |
| Middle Brook | 2.342 | 1012 |
| Terra Nova River ¹ | 14.303 | 7094 |
| SFA 9 | | |
| Biscay Bay River | 2.951 | 1134 |
| SFA 10 | | |
| Northeast River, Placentia | 0.719 | 224 |

¹Calculations are for the area above the lower fishway, including the area above Mollyguajack Falls.

Table 5. Counts of Atlantic salmon at Middle Brook and lower Terra Nova River fishways, Bonavista Bay (SFA 5), 1979-91.

| Year | Middle Brook | | Terra Nova River | |
|------|-------------------|-----------------|------------------|--------------|
| | Grilse | Large salmon | Grilse | Large salmon |
| 1979 | 1283 ¹ | 54 ¹ | 569 | 170 |
| 1980 | 1703 | 91 | 842 | 40 |
| 1981 | 2415 | 38 | 1115 | 90 |
| 1982 | 1281 | 20 | 963 | 19 |
| 1983 | 1195 | 75 | 1210 | 57 |
| 1984 | 1379 | 57 | 1233 | 107 |
| 1985 | 904 | 27 | 1557 | 112 |
| 1986 | 1036 | 15 | 1051 | 140 |
| 1987 | 914 | 19 | 974 | 56 |
| 1988 | 772 | 14 | 1737 | 206 |
| 1989 | 496 | 19 | 1138 | 142 |
| 1990 | 745 | 13 | 1149 | 144 |
| 1991 | 562 | 14 | 873 | 114 |

¹Partial count: not included in mean

| | | | | |
|---------|--------|------|--------|-------|
| 1979-83 | | | | |
| Mean | 1648.5 | 56.0 | 939.8 | 75.2 |
| SD | 557.1 | 32.7 | 250.7 | 59.0 |
| N | 4 | 4 | 5 | 5 |
| 1984-89 | | | | |
| Mean | 916.8 | 25.2 | 1281.7 | 127.2 |
| SD | 291.9 | 16.3 | 301.3 | 49.6 |
| N | 6 | 6 | 6 | 6 |

Table 6. Counts of Atlantic salmon at the Biscay Bay River counting fence, St. Mary's Bay (SFA 9), 1983-91, and the Northeast River fishway, Placentia Bay (SFA 10), 1979-91.

| Year | Biscay Bay River | | Northeast River | |
|------|-------------------|------------------|------------------|-----------------|
| | Grilse | Large salmon | Grilse | Large salmon |
| 1979 | | | 454 | 37 |
| 1980 | | | 433 | 34 |
| 1981 | | | 334 ¹ | 62 ¹ |
| 1982 | | | 86 ¹ | 36 ¹ |
| 1983 | 2330 | 88 | 233 | 22 |
| 1984 | 2430 | 83 | 419 | 44 |
| 1985 | 1377 ¹ | 21 ¹ | 384 | 0 |
| 1986 | 2516 | 101 | 725 | 39 |
| 1987 | 1302 ¹ | 106 ¹ | 325 ¹ | 16 ¹ |
| 1988 | 1695 | 58 | 543 | 11 |
| 1989 | 889 ¹ | 104 ¹ | 706 | 15 |
| 1990 | 1657 | 73 | 551 | 25 |
| 1991 | 394 | 35 | 353 | 8 |

¹Partial count: not included in mean

| | | | | |
|---------|--------|------|-------|------|
| 1979-83 | | | | |
| Mean | | | 373.3 | 31.0 |
| SD | | | 122.0 | 7.9 |
| N | | | 3 | 3 |
| 1984-89 | | | | |
| Mean | 2213.7 | 81.7 | 555.4 | 21.8 |
| SD | 451.2 | 20.0 | 157.8 | 18.9 |
| N | 3 | 3 | 5 | 5 |

Table 7. Total escapement, spawning escapement, estimated egg deposition, and percentage of target spawning requirement achieved in Middle Brook and Terra Nova River, Bonavista Bay (SFA 5), 1984-1991. G = grilse; LS = large salmon.

| Year | Total escapement | | Spawning escapement | | Egg deposition (No. x 10 ⁶) | | % Target achieved |
|-------------------------|------------------|-----|---------------------|-----|--|-------|-------------------|
| | G | LS | G | LS | G | LS | |
| Middle Brook | | | | | | | |
| 1984 | 1675 | 57 | 1265 | 57 | 2.804 | 0.332 | 134 |
| 1985 | 1283 | 27 | 745 | 27 | 1.834 | 0.157 | 85 |
| 1986 | 1547 | 15 | 758 | 15 | 2.014 | 0.087 | 90 |
| 1987 | 1053 | 19 | 866 | 19 | 2.005 | 1.107 | 90 |
| 1988 | 1337 | 14 | 629 | 14 | 1.456 | 0.081 | 66 |
| 1989 | 626 | 19 | 461 | 19 | 1.067 | 1.107 | 50 |
| 1990 | 1070 | 13 | 721 | 13 | 1.669 | 0.076 | 75 |
| 1991 | 763 | 14 | 485 | 14 | 1.123 | 0.081 | 51 |
| Terra Nova River | | | | | | | |
| 1984 | 1534 | 107 | 1100 | 107 | 2.185 | 0.550 | 19 |
| 1985 | 2012 | 112 | 1431 | 112 | 2.885 | 0.576 | 24 |
| 1986 | 1459 | 140 | 974 | 140 | 1.964 | 0.720 | 19 |
| 1987 | 1404 | 56 | 940 | 56 | 1.895 | 0.288 | 15 |
| 1988 | 2114 | 206 | 1617 | 206 | 3.260 | 1.059 | 30 |
| 1989 | 1377 | 142 | 1085 | 142 | 2.187 | 0.730 | 20 |
| 1990 | 1518 | 144 | 1052 | 144 | 2.121 | 0.740 | 20 |
| 1991 | 1127 | 114 | 815 | 114 | 1.643 | 0.586 | 16 |

Table 8. Total escapement, spawning escapement, estimated egg deposition, and percentage of target spawning requirement achieved in Biscay Bay River, St. Mary's Bay (SFA 9) and Northeast River, Placentia Bay (SFA 10), 1984-1991. G = grilse; LS = large salmon.

| Year | Total escapement | | Spawning escapement | | Egg deposition (No. x 10 ⁶) | | % Target achieved |
|-----------------------------------|------------------|-----|---------------------|-----|--|-------|-------------------|
| | G | LS | G | LS | G | LS | |
| SFA 9 | | | | | | | |
| Biscay Bay River | | | | | | | |
| 1984 | 2430 | 83 | 2108 | 83 | 5.487 | 0.373 | 199 |
| 1985 ¹ | 1638 | 21 | 1109 | 21 | 2.887 | 0.094 | 101 |
| 1986 | 2688 | 101 | 2184 | 101 | 5.685 | 0.454 | 208 |
| 1987 ¹ | 1393 | 106 | 1171 | 106 | 3.048 | 0.476 | 119 |
| 1988 | 1802 | 61 | 1333 | 61 | 3.470 | 0.274 | 127 |
| 1989 ¹ | 981 | 104 | 805 | 104 | 2.095 | 0.467 | 87 |
| 1990 | 1670 | 73 | 1328 | 73 | 3.457 | 0.328 | 128 |
| 1991 | 394 | 35 | 384 | 35 | 0.999 | 0.157 | 39 |
| SFA 10 | | | | | | | |
| Northeast River, Placentia | | | | | | | |
| 1984 | 459 | 44 | 389 | 44 | 1.219 | 0.198 | 197 |
| 1985 | 519 | 0 | 346 | 0 | 1.095 | 0.000 | 152 |
| 1986 | 879 | 39 | 645 | 39 | 2.314 | 0.175 | 346 |
| 1987 ¹ | 350 | 16 | 317 | 16 | 1.020 | 0.072 | 152 |
| 1988 | 637 | 11 | 451 | 11 | 1.451 | 0.049 | 209 |
| 1989 | 809 | 15 | 599 | 15 | 1.928 | 0.067 | 277 |
| 1990 | 699 | 25 | 526 | 25 | 1.693 | 0.112 | 251 |
| 1991 | 368 | 8 | 349 | 8 | 1.123 | 0.036 | 161 |

¹Based on incomplete count

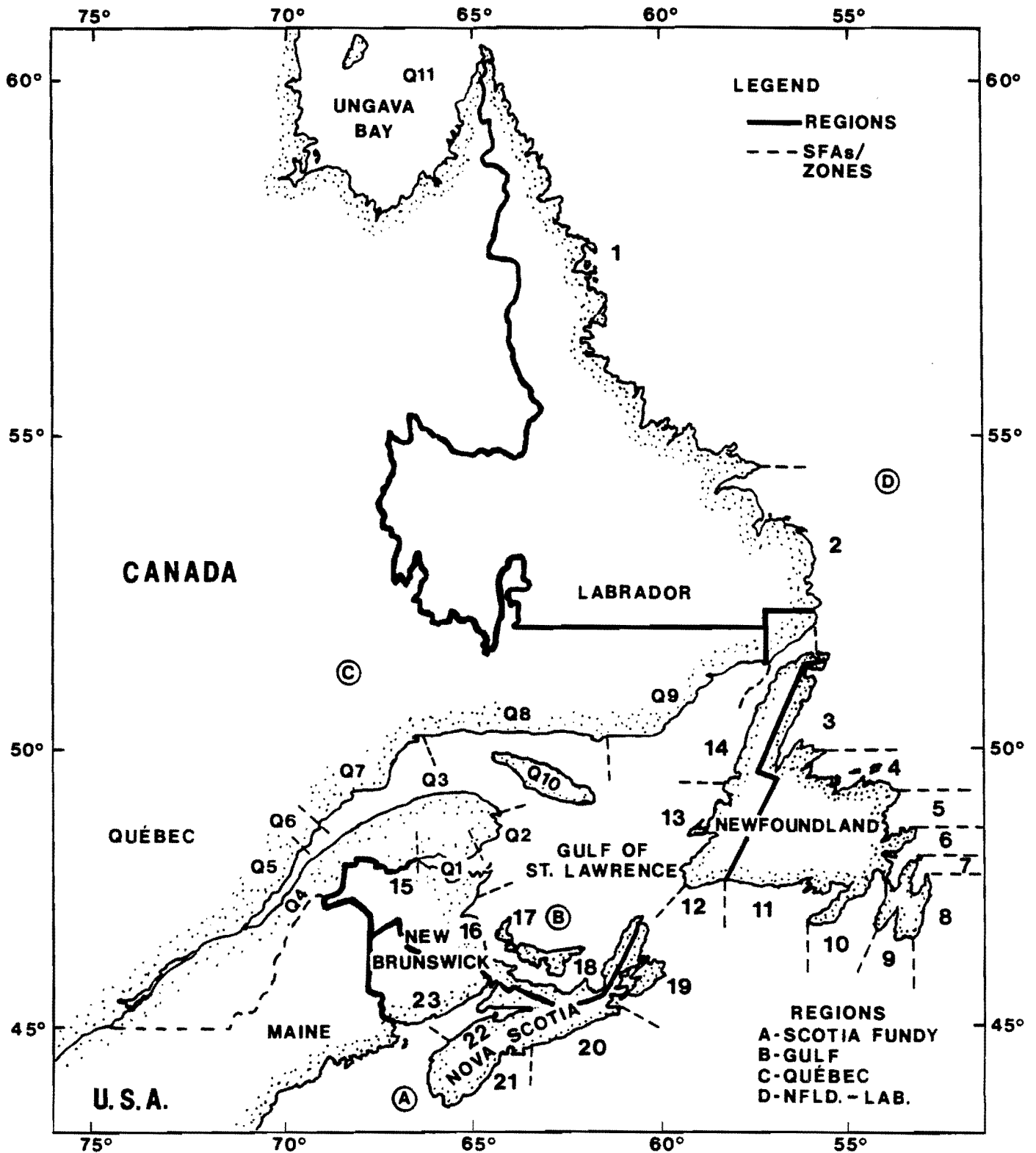


Fig. 1. Map of Atlantic Provinces of Canada showing Salmon Fishing Areas (SFAs) 1-23, Salmon Management Zones of Quebec (Qs) 1-11, and regional boundaries. The Newfoundland Region is comprised of SFAs 1-11.

Appendix 1. Atlantic salmon recreational fishery catch and effort data for Middle Brook, Bonavista Bay (SFA 5), Newfoundland, 1953-91.

RIVER: MIDDLE BROOK (GAMBO)

CODE: 11097600

| YEAR | EFFORT ROD DAYS | GRILSE <63 CM | SALMON >63 CM | TOTAL CATCH | CPUE | PERCENT GRILSE |
|------|--------------------|------------------|------------------|----------------|------|-------------------|
| 1953 | 710 | 116 | 0 | 116 | 0.16 | . |
| 1954 | 360 | 57 | 0 | 57 | 0.16 | 100 |
| 1955 | 134 | 29 | 1 | 30 | 0.22 | 98 |
| 1956 | 923 | 95 | 7 | 102 | 0.11 | 81 |
| 1957 | 289 | 144 | 0 | 144 | 0.50 | 100 |
| 1958 | 459 | 172 | 2 | 174 | 0.38 | 99 |
| 1959 | 427 | 160 | 4 | 164 | 0.38 | 98 |
| 1960 | 334 | 58 | 0 | 58 | 0.17 | 100 |
| 1961 | 208 | 30 | 2 | 32 | 0.15 | 97 |
| 1962 | 459 | 174 | 0 | 174 | 0.38 | 100 |
| 1963 | 638 | 350 | 0 | 350 | 0.55 | 100 |
| 1964 | 1266 | 570 | 0 | 570 | 0.45 | 100 |
| 1965 | 1568 | 454 | 2 | 456 | 0.29 | 100 |
| 1966 | 1627 | 272 | 0 | 272 | 0.17 | 100 |
| 1967 | 965 | 217 | 0 | 217 | 0.22 | 100 |
| 1968 | 2014 | 374 | 0 | 374 | 0.19 | 100 |
| 1969 | 1704 | 389 | 2 | 391 | 0.23 | 99 |
| 1970 | 1111 | 323 | 2 | 325 | 0.29 | 99 |
| 1971 | 662 | 185 | 0 | 185 | 0.28 | 100 |
| 1972 | 287 | 224 | 0 | 224 | 0.78 | 100 |
| 1973 | 213 | 283 | 0 | 283 | 1.33 | 100 |
| 1974 | 1823 | 277 | 11 | 288 | 0.16 | 96 |
| 1975 | 1635 | 415 | 8 | 423 | 0.26 | 97 |
| 1976 | 1339 | 280 | 2 | 282 | 0.21 | 100 |
| 1977 | 1511 | 767 | 3 | 770 | 0.51 | 99 |
| 1978 | 1322 | 391 | 1 | 392 | 0.30 | 100 |
| 1979 | 211 | 28 | 0 | 28 | 0.13 | 100 |
| 1980 | 1358 | 542 | 2 | 544 | 0.40 | 93 |
| 1981 | 1574 | 587 | 0 | 587 | 0.37 | 100 |
| 1982 | 2481 | 504 | 8 | 512 | 0.21 | 99 |
| 1983 | 1505 | 372 | 20 | 392 | 0.26 | 96 |
| 1984 | 2712 | 410 | 0 | 410 | 0.15 | 100 |
| 1985 | 2319 | 538 | * | 538 | 0.23 | 100 |
| 1986 | 2307 | 789 | * | 789 | 0.34 | 100 |
| 1987 | 840 | 187 | * | 187 | 0.22 | 100 |
| 1988 | 1545 | 708 | * | 708 | 0.46 | 100 |
| 1989 | 712 | 165 | * | 165 | 0.23 | 100 |
| 1990 | 949 | 349 | * | 349 | 0.37 | 100 |
| 1991 | 903 | 278 | * | 278 | 0.31 | 100 |

MEANS, 95% CONFIDENCE LIMITS, N'S:

| | | | | | | |
|------------------|--------|--------|------|--------|-------|-------|
| 74-83 | 1475.9 | 416.3 | 5.5 | 421.8 | 0.29 | 99 |
| $\bar{X}+95\%CL$ | +400.7 | +144.5 | +4.6 | +144.2 | +0.08 | +1.18 |
| N | 10 | 10 | 10 | 10 | 10 | 10 |

| | | | | | | |
|------------------|--------|--------|-----|--------|-------|-------|
| 84-89 | 1919.0 | 522.0 | 0.0 | 522.0 | 0.27 | 100 |
| $\bar{X}+95\%CL$ | +988.7 | +308.0 | . | +308.0 | +0.15 | +0.00 |
| N | 5 | 5 | 1 | 5 | 5 | 5 |

1987 DATA NOT INCLUDED IN MEAN.

PERCENT GRILSE IS CALCULATED BY SMOLT CLASS.
 IN THE ABOVE TABLE A PERIOD INDICATES NO DATA FOR THAT YEAR.
 * NOT ALLOWED TO RETAIN LARGE SALMON IN INSULAR NEWFOUNDLAND.

Appendix 2. Atlantic salmon recreational fishery catch and effort data for Terra Nova River (Maccles Brook included), Bonavista Bay (SFA 5), Newfoundland, 1953-91.

RIVER: TERRA NOVA RIVER

CODE: 11102200

| YEAR | EFFORT ROD DAYS | GRILSE <63 CM | SALMON >63 CM | TOTAL CATCH | CPUE | PERCENT GRILSE |
|------|--------------------|------------------|------------------|----------------|------|-------------------|
| 1953 | 1706 | 151 | 13 | 164 | 0.10 | . |
| 1954 | 1003 | 72 | 13 | 85 | 0.08 | 92 |
| 1955 | 335 | 178 | 16 | 194 | 0.58 | 82 |
| 1956 | 2685 | 198 | 18 | 216 | 0.08 | 91 |
| 1957 | 569 | 73 | 3 | 76 | 0.13 | 99 |
| 1958 | 590 | 123 | 12 | 135 | 0.23 | 86 |
| 1959 | 959 | 120 | 20 | 140 | 0.15 | 86 |
| 1960 | 463 | 157 | 8 | 165 | 0.36 | 94 |
| 1961 | 623 | 117 | 14 | 131 | 0.21 | 92 |
| 1962 | 777 | 254 | 25 | 279 | 0.36 | 82 |
| 1963 | 1160 | 274 | 29 | 303 | 0.26 | 90 |
| 1964 | 699 | 334 | 5 | 339 | 0.48 | 98 |
| 1965 | 787 | 327 | 10 | 337 | 0.43 | 97 |
| 1966 | 117 | 224 | 2 | 226 | 1.93 | 99 |
| 1967 | 557 | 337 | 2 | 339 | 0.61 | 99 |
| 1968 | 143 | 319 | 12 | 331 | 2.31 | 97 |
| 1969 | 1477 | 523 | 0 | 523 | 0.35 | 100 |
| 1970 | 285 | 443 | 18 | 461 | 1.62 | 97 |
| 1971 | 1458 | 402 | 11 | 413 | 0.28 | 98 |
| 1972 | 456 | 467 | 11 | 478 | 1.05 | 97 |
| 1973 | 1044 | 334 | 1 | 335 | 0.32 | 100 |
| 1974 | 2098 | 243 | 5 | 248 | 0.12 | 99 |
| 1975 | 1723 | 506 | 2 | 508 | 0.29 | 99 |
| 1976 | 1236 | 424 | 7 | 431 | 0.35 | 99 |
| 1977 | 1956 | 850 | 13 | 863 | 0.44 | 97 |
| 1978 | 1608 | 628 | 6 | 634 | 0.39 | 99 |
| 1979 | 910 | 537 | 15 | 552 | 0.61 | 98 |
| 1980 | 872 | 512 | 22 | 534 | 0.61 | 96 |
| 1981 | 1303 | 739 | 33 | 772 | 0.59 | 94 |
| 1982 | 1174 | 465 | 24 | 489 | 0.42 | 97 |
| 1983 | 2157 | 486 | 43 | 529 | 0.25 | 92 |
| 1984 | 2042 | 636 | 0 | 636 | 0.31 | 100 |
| 1985 | 1810 | 751 | * | 751 | 0.41 | 100 |
| 1986 | 1485 | 620 | * | 620 | 0.42 | 100 |
| 1987 | 1764 | 546 | * | 546 | 0.31 | 100 |
| 1988 | 1613 | 682 | * | 682 | 0.42 | 100 |
| 1989 | 1946 | 357 | * | 357 | 0.18 | 100 |
| 1990 | 2165 | 624 | * | 624 | 0.29 | 100 |
| 1991 | 1701 | 448 | * | 448 | 0.26 | 100 |

MEANS, 95% CONFIDENCE LIMITS, N'S:

| | | | | | | |
|------------------|--------|--------|------|--------|-------|-------|
| 74-83 | 1503.7 | 539.0 | 17.0 | 556.0 | 0.37 | 97 |
| $\bar{X}+95\%CL$ | +338.5 | +120.6 | +9.6 | +122.9 | +0.12 | +1.77 |
| N | 10 | 10 | 10 | 10 | 10 | 10 |

| | | | | | | |
|------------------|--------|--------|-----|--------|-------|-------|
| 84-89 | 1779.2 | 609.2 | 0.0 | 609.2 | 0.34 | 100 |
| $\bar{X}+95\%CL$ | +285.9 | +186.1 | . | +186.1 | +0.13 | +0.00 |
| N | 5 | 5 | 1 | 5 | 5 | 5 |

1987 DATA NOT INCLUDED IN MEAN.

PERCENT GRILSE IS CALCULATED BY SMOLT CLASS.

IN THE ABOVE TABLE A PERIOD INDICATES NO DATA FOR THAT YEAR.

* NOT ALLOWED TO RETAIN LARGE SALMON IN INSULAR NEWFOUNDLAND.

Appendix 3. Atlantic salmon recreational fishery catch and effort data for Biscay Bay River, St. Mary's Bay (SFA 9), Newfoundland, 1953-91.

RIVER: BISCAY BAY RIVER

CODE: 27002300

| YEAR | EFFORT ROD DAYS | GRILSE <63 CM | SALMON >63 CM | TOTAL CATCH | CPUE | PERCENT GRILSE |
|------|--------------------|------------------|------------------|----------------|------|-------------------|
| 1953 | 124 | 82 | 3 | 85 | 0.69 | . |
| 1954 | 47 | 19 | 0 | 19 | 0.40 | 100 |
| 1955 | 113 | 36 | 2 | 38 | 0.34 | 90 |
| 1956 | 338 | 105 | 1 | 106 | 0.31 | 97 |
| 1957 | 219 | 165 | 0 | 165 | 0.75 | 100 |
| 1958 | 486 | 195 | 6 | 201 | 0.41 | 96 |
| 1959 | 551 | 415 | 6 | 421 | 0.76 | 97 |
| 1960 | 959 | 295 | 9 | 304 | 0.32 | 98 |
| 1961 | 585 | 174 | 0 | 174 | 0.30 | 100 |
| 1962 | 659 | 193 | 0 | 193 | 0.29 | 100 |
| 1963 | 663 | 320 | 20 | 340 | 0.51 | 91 |
| 1964 | 1522 | 151 | 1 | 152 | 0.10 | 100 |
| 1965 | 1272 | 346 | 25 | 371 | 0.29 | 86 |
| 1966 | 715 | 123 | 0 | 123 | 0.17 | 100 |
| 1967 | 3239 | 206 | 7 | 213 | 0.07 | 95 |
| 1968 | 798 | 141 | 0 | 141 | 0.18 | 100 |
| 1969 | 1326 | 148 | 0 | 148 | 0.11 | 100 |
| 1970 | 960 | 149 | 0 | 149 | 0.16 | 100 |
| 1971 | 743 | 217 | 4 | 221 | 0.30 | 97 |
| 1972 | 564 | 66 | 0 | 66 | 0.12 | 100 |
| 1973 | 880 | 190 | 0 | 190 | 0.22 | 100 |
| 1974 | 1043 | 71 | 1 | 72 | 0.07 | 99 |
| 1975 | 1553 | 108 | 0 | 108 | 0.07 | 100 |
| 1976 | 1074 | 168 | 0 | 168 | 0.16 | 100 |
| 1977 | 1607 | 144 | 0 | 144 | 0.09 | 100 |
| 1978 | 1790 | 121 | 5 | 126 | 0.07 | 97 |
| 1979 | 612 | 186 | 5 | 191 | 0.31 | 96 |
| 1980 | 392 | 283 | 32 | 315 | 0.80 | 85 |
| 1981 | 1181 | 424 | 31 | 455 | 0.39 | 90 |
| 1982 | 1044 | 367 | 9 | 376 | 0.36 | 98 |
| 1983 | 1064 | 414 | 10 | 424 | 0.40 | 97 |
| 1984 | 915 | 322 | 0 | 322 | 0.35 | 100 |
| 1985 | 1121 | 290 | * | 290 | 0.26 | 100 |
| 1986 | 1124 | 393 | * | 393 | 0.35 | 100 |
| 1987 | 1062 | 101 | * | 101 | 0.10 | 100 |
| 1988 | 1221 | 349 | * | 349 | 0.29 | 100 |
| 1989 | 965 | 102 | * | 102 | 0.11 | 100 |
| 1990 | 1165 | 232 | * | 232 | 0.20 | 100 |
| 1991 | 1134 | 10 | * | 10 | 0.01 | 100 |

MEANS, 95% CONFIDENCE LIMITS, N'S:

| | | | | | | |
|------------------|--------|--------|------|--------|-------|-------|
| 74-83 | 1136.0 | 228.6 | 9.3 | 237.9 | 0.21 | 96 |
| $\bar{X}+95\%CL$ | +309.0 | +94.9 | +8.8 | +101.1 | +0.12 | +3.65 |
| N | 10 | 10 | 10 | 10 | 10 | 10 |
| 84-89 | 1069.2 | 291.2 | 0.0 | 291.2 | 0.27 | 100 |
| $\bar{X}+95\%CL$ | +156.3 | +139.4 | . | +139.4 | +0.11 | +0.00 |
| N | 5 | 5 | 1 | 5 | 5 | 5 |

1987 DATA NOT INCLUDED IN MEAN.

PERCENT GRILSE IS CALCULATED BY SMOLT CLASS.

IN THE ABOVE TABLE A PERIOD INDICATES NO DATA FOR THAT YEAR.

* NOT ALLOWED TO RETAIN LARGE SALMON IN INSULAR NEWFOUNDLAND.

Appendix 4. Atlantic salmon recreational fishery catch and effort data for Northeast River, Placentia Bay (SFA 10), Newfoundland, 1953-91.

RIVER: NORTHEAST RIVER (PLACENTIA)

CODE: 29030700

| YEAR | EFFORT ROD DAYS | GRILSE <63 CM | SALMON ≥63 CM | TOTAL CATCH | CPUE | PERCENT GRILSE |
|------|--------------------|------------------|------------------|----------------|------|-------------------|
| 1953 | 219 | 24 | 3 | 27 | 0.12 | . |
| 1954 | 137 | 28 | 8 | 36 | 0.26 | 75 |
| 1955 | 153 | 61 | 5 | 66 | 0.43 | 85 |
| 1956 | 392 | 83 | 0 | 83 | 0.21 | 100 |
| 1957 | 649 | 196 | 2 | 198 | 0.31 | 98 |
| 1958 | 175 | 79 | 14 | 93 | 0.53 | 93 |
| 1959 | 292 | 118 | 0 | 118 | 0.40 | 100 |
| 1960 | 399 | 80 | 0 | 80 | 0.20 | 100 |
| 1961 | 310 | 54 | 0 | 54 | 0.17 | 100 |
| 1962 | 1135 | 46 | 0 | 46 | 0.04 | 100 |
| 1963 | 340 | 61 | 0 | 61 | 0.18 | 100 |
| 1964 | 345 | 66 | 5 | 71 | 0.21 | 92 |
| 1965 | 296 | 38 | 0 | 38 | 0.13 | 100 |
| 1966 | 282 | 163 | 0 | 163 | 0.58 | 100 |
| 1967 | 504 | 62 | 3 | 65 | 0.13 | 98 |
| 1968 | 1467 | 125 | 0 | 125 | 0.09 | 100 |
| 1969 | 130 | 66 | 2 | 68 | 0.52 | 98 |
| 1970 | 111 | 77 | 3 | 80 | 0.72 | 96 |
| 1971 | 740 | 148 | 4 | 152 | 0.21 | 95 |
| 1972 | 588 | 49 | 0 | 49 | 0.08 | 100 |
| 1973 | 1720 | 238 | 0 | 238 | 0.14 | 100 |
| 1974 | 1721 | 142 | 0 | 142 | 0.08 | 100 |
| 1975 | 877 | 121 | 4 | 125 | 0.14 | 97 |
| 1976 | 1164 | 147 | 1 | 148 | 0.13 | 99 |
| 1977 | 1465 | 180 | 1 | 181 | 0.12 | 99 |
| 1978 | 1237 | 161 | 0 | 161 | 0.13 | 100 |
| 1979 | 969 | 138 | 0 | 138 | 0.14 | 100 |
| 1980 | 1612 | 246 | 6 | 252 | 0.16 | 96 |
| 1981 | 2339 | 349 | 0 | 349 | 0.15 | 100 |
| 1982 | 1303 | 150 | 0 | 150 | 0.12 | 100 |
| 1983 | 2037 | 165 | 0 | 165 | 0.08 | 100 |
| 1984 | 988 | 70 | 0 | 70 | 0.07 | 100 |
| 1985 | 1276 | 173 | * | 173 | 0.14 | 100 |
| 1986 | 862 | 234 | * | 234 | 0.27 | 100 |
| 1987 | 349 | 36 | * | 36 | 0.10 | 100 |
| 1988 | 772 | 186 | * | 186 | 0.24 | 100 |
| 1989 | 852 | 210 | * | 210 | 0.25 | 100 |
| 1990 | 786 | 173 | * | 173 | 0.22 | 100 |
| 1991 | 153 | 19 | * | 19 | 0.12 | 100 |

MEANS, 95% CONFIDENCE LIMITS, N'S:

| | | | | | | |
|------------------|--------|-------|------|-------|-------|-------|
| 74-83 | 1472.4 | 179.9 | 1.2 | 181.1 | 0.12 | 99 |
| $\bar{X}+95\%CL$ | +332.0 | +49.0 | +1.5 | +49.1 | +0.02 | +0.88 |
| N | 10 | 10 | 10 | 10 | 10 | 10 |
| 84-89 | 950.0 | 174.6 | 0.0 | 174.6 | 0.18 | 100 |
| $\bar{X}+95\%CL$ | +245.8 | +78.2 | . | +78.2 | +0.11 | +0.00 |
| N | 5 | 5 | 1 | 5 | 5 | 5 |

1987 DATA NOT INCLUDED IN MEAN.

PERCENT GRILSE IS CALCULATED BY SMOLT CLASS.

IN THE ABOVE TABLE A PERIOD INDICATES NO DATA FOR THAT YEAR.

* NOT ALLOWED TO RETAIN LARGE SALMON IN INSULAR NEWFOUNDLAND.