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Status of Atlantic salmon in the Miramichi River, 1984

by

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ABSTRACT

Returns of large salmon (MSW) to the Miramichi River in 1984 were estimated to be very low (about 10,000 salmon). Severe restrictions on the harvest of MSW salmon in 1984 substantially reduced homewater landings (309 salmon, compared to 19,466 salmon in 1983). Despite poor returns, a greater proportion of salmon potentially survived to spawning in 1984 (85%) than in 1983 (10%) because of the reduction in harvest. However, the required egg deposition for optimum spawning was not achieved: two methods for calculating spawning escapement indicated only from 15 to 45% of target egg deposition was achieved. Grilse returns in 1984 were slightly greater than in 1983. Counts of grilse at Millbank were used to predict a return of about 18,000 MSW salmon in 1985. Spawning requirements will be met if homewater fishing mortality remains at 1984 levels. Average grilse returns in the past five years suggest there may be a surplus of about 3,500 grilse in 1985.

RESUME

Selon les estimations, les retours de saumons rédibermarins à la Rivière Miramichi en 1984 ont été très faibles, soit environ 10 000 individus. Les restrictions sévères imposées en 1984 sur la pêche au saumon rédibermarin ont diminué considérablement les prises de ces gros saumons dans leurs eaux natales (309 saumons en 1984, contre 19 466 saumons en 1983). Malgré la faiblesse des retours, le potentiel de survie jusqu'au frai fut de loin supérieur en 1984 (85%) par rapport à 1983 (10%), et cela grâce à la diminution des prises. Toutefois, le niveau optimal de déposition d'oeufs n'a pas été atteint. Selon deux méthodes de calcul pour l'échappement des géniteurs, seulement de 15% à 45% de l'objectif aurait été atteint. Les retours de madeleineaux en 1984 furent Le dénombrement de madeleineaux à quelque peu supérieurs à ceux de 1983. Millbank a servi de base pour une prévision des retours de saumons rédibermarins en 1985 qui se chiffre à environ 18 000 individus. Le nombre requis de géniteurs ne sera pas atteint si les mortalités dans les eaux natales demeurent aux mêmes niveaux qu'en 1984. Les retours moyens de madeleineaux pendant les cinq dernières années indiquent un surplus possible d'environ 3 500 madeleineaux en 1985.

INTRODUCTION

Critically low returns of Atlantic salmon to the Miramichi River in 1983 (Randall and Schofield 1983) prompted more severe controls on the harvest of this stock in 1984 than in 1983. Commercial fishermen in Miramichi Bay and estuary accepted provincial compensation in lieu of a two week season. Landing of salmon by non-salmon commercial gear was prohibited in 1984. Anglers on all tributaries were restricted to a grilse only fishery (salmon < 63 cm, age 1 sea-winter); large salmon (age 2 sea-winters and older) were released. Seasonal bag limits for anglers remained at 10 fish (all grilse). Regulations governing black salmon angling remained unchanged, whereby anglers were allowed to keep 2 fish, whether salmon or grilse. As in 1983 and earlier, Native fishermen were not restricted by quota or seasonal controls.

In addition to changes in homewater regulations, commercial salmon fishermen at Newfoundland were subjected to area closures and reduced seasons in 1984. Miramichi salmon are intercepted in many areas of Newfoundland (Pippy 1982), and these changes in regulations should have reduced exploitation of mainland salmon.

Together, 1984 regulations controlling the harvest of Miramichi salmon at Newfoundland and in homewaters were the severest in history. The objective of this paper was to evaluate spawning escapement in the Miramichi River in 1984 in view of these regulations. Salmon returns in 1984 were predicted to be low (Randall and Schofield 1983), but reduced homewater exploitation should increase the portion of returns that survive to spawning.

METHODS

a. Landings

Since there was no commercial fishery in Miramichi Bay, only Native fishermen and anglers reported salmon landings in 1984. Native landings from Burnt Church, Red Bank and Eel Ground were reported from Band Council offices on a weekly basis. Landings of grilse and salmon were reported separately.

As in previous years, angling landings were estimated from two sources: (i) field reports from DFO fishery officers, and (ii) a stub reporting system from anglers, collected and summarized by the Department of Natural Resources (DNR) and DFO. DFO officers submitted angling summaries once monthly. Unfortunately, no records were available from Carleton and York Counties (Southwest Miramichi River) in 1984. Landings of both bright and black salmon from the rest of the Miramichi system were adjusted upwards by about 19%, which was the proportion of catches from these counties in 1983. DFO angling landings have been collected annually since 1951 (Smith 1981; Swetnam and O'Neil 1984). For this assessment, these landings were used to indicate long-term trends in angling catches. For recent years, however, landings estimated from the stub report system by DNR were more accurate (Randall and Chadwick 1983); these landings were used to estimate angling harvest in the current year. DNR statistics were not available for this assessment; therefore, 1984 estimates of grilse landings were predicted from a significant correlation (P < 0.01) between Millbank and DNR catches, 1969 to 1983.

Independent counts of salmon and grilse were available from the Millbank trap (which has been monitored annually since 1954) and from fish barriers operated on the Dungarvon and S.W. Miramichi tributaries (monitored by DNR since 1981). Biological characteristics of adult salmon were determined from samples collected at Millbank. Sampling included: collecting flank scales for aging; measuring fork length (mm) and weight (0.1 kg); recording sex (sacrificing 1 in 10 grilse and external sexing of all fish after August 15) and collecting ovaries for eqg counts.

b. Stock and recruitment

During 1984, 85 sites were electrofished to estimate juvenile salmon densities. Historic juvenile densities (1969-1981) were used by Randall and Chadwick (1983) to calculate a stock-recruitment relationship for the Miramichi River, where stock was estimated from black salmon angling catches (year i) and recruitment was estimated from small parr densities (year i+ 1). This relationship was updated using current data for this assessment.

c. Spawning requirements

Methodology for estimating spawning requirements for the Miramichi River was described by Randall and Chadwick (1983).

d. Spawning escapement in 1984

Number of spawners in 1984 was estimated using two methods:

Method 1. Salmon and grilse returns to Millbank were estimated using trap efficiencies of 0.034 and 0.044, respectively (Turner 1983). Spawning escapement was calculated as Millbank returns minus known angling, Native and broodstock removals. Method 2. Ratios of spawners per salmon and grilse counted at Millbank were calculated for the period 1971 to 1980 by Randall and These ratios were updated using current data Chadwick (1983). for this assessment (Table 1). Spawners were back-calculated from age 1+ parr densities, assuming 10% survival from eggs to parr (Elson 1957, 1974; Chadwick 1982) and a total rearing area of $48,262,000 \text{ m}^2$. Eqgs per fish were calculated assuming a eggs kg⁻¹, and biological fecundity of 1,764 relative characteristics of salmon sampled at Millbank (Table 2). The new ratio of spawners per salmon and grilse counted at Millbank was 6.75 (Table 1). Spawning escapement in 1984 was calculated as the product of this ratio and counts of salmon and grilse at Millbank.

For both methods, losses to disease and poaching were assumed to be 1,000 salmon and 4,000 grilse (Randall and Chadwick 1983; Randall and Schofield 1983). These values are probably an underestimate, as will be discussed later. Catch and release of large salmon by anglers also caused mortality in 1984, but we had no estimate of this mortality rate for the Miramichi River.

e. Predicting 1985 returns of salmon and grilse

Returns of large salmon to the Miramichi River in 1985 were predicted from a multiple regression between the number and proportion female grilse (year i) and total salmon returns (year i +1) (Randall and Schofield 1983). Grilse returns in 1985 were predicted from historic averages.

RESULTS

a. 1984 Landings

Native fisheries at Red Bank, Eel Ground and Burnt Church reported a total landing of 309 salmon and 381 grilse in 1984 (Table 3). Effort by all 3 Bands was approximately the same as in 1983. The Burnt Church fishery was directed primarily at striped bass; salmon catches were incidental.

The angling season for black salmon, as in 1983, extended from April 15 to May 15. About 771 salmon and 644 grilse were landed (Table 4), which was about 50% of the 1983 landings. Reduced catches reflect both decreased effort in 1984 (3,817 rod days compared to 5,968 in 1983) and low bright salmon and grilse returns in 1983.

Bright grilse catches in 1984 were 9,892 fish (Table 4), up about 250% from 1983 (3,897 fish). Increased catches resulted primarily from increases in a fishing effort; although total rod days increased only slightly from 1983 (24,679 to 28,589), all effort was directed towards grilse in 1984, and therefore, the actual exploitation rate was much greater than in 1983. The 1984 angling season for bright grilse was the same as in 1983. Seasons depend on tributary; the earliest and latest dates were June 15 and October 15, respectively.

Total grilse landings were adjusted upwards by correlation between Millbank and DNR landings (1969 to 1983, Table 5). This indicates an adjusted catch of 10,700 grilse.

Total 1984 landings by all fisheries are summarized and compared to 1983 landings in Table 6. Salmon and grilse landings were 309 and 11,081, respectively, compared to 19,466 salmon and 10,335 grilse in 1983. Landings in 1984 are compared to historical landings (1951 to 1983) in Table 7.

Counts of salmon and grilse at Millbank in 1984 increased somewhat from 1983, but both were below long-term averages (Table 2); salmon and grilse counts were 38 and 40% of 1971 to 1983 averages, respectively. Relatively low grilse counts at Millbank verified that increased grilse catches by anglers resulted from increased effort rather than from increased returns in 1984 from 1983. Greater proportions of both salmon and grilse returned later (after September 1) in 1984 than in the previous 3 years, when commercial fishing occurred in Miramichi Bay (Table 8). This indicated the commercial fishery was more selective for late-run than early-run fish.

The Millbank trap efficiency may have decreased because of dredging in recent years (1981-1983). Millbank grilse and salmon counts were significantly correlated with DNR angling catches, 1969-1983 (Table 5). The proportion of trap counts to DNR catches was less from 1981 to 1983 (0.09 and 0.11 for salmon and grilse, respectively) -compared to the 1969 to 1980 averages (0.16 and 0.17). However, these changes could also result from increased exploitation rates by anglers, particularly during years of low stock abundance (e.g. 1970 and 1979).

Counts of salmon and grilse at fish barriers in the Dungarvon and S.W. Miramichi tributaries indicated no major changes from 1983 (Table 9).

Biological characteristics of adult salmon sampled at Millbank in 1984 were compared to historic data in Table 2. Both salmon and grilse were from approximately equal portions of two-year classes - 1979 and 1980 for salmon and 1980 and 1981 for grilse.

b. Stock and recruitment

Juvenile salmon densities in the Miramichi River in 1984 were lower than in 1983 (Table 10). Small parr densities (1971 to 1984) were correlated to black salmon catches (1970 to 1983) in Figure 1. Both variables were significantly correlated (P < 0.01), and were described by the equation y = 2.7014 + 0.0031 x, where x = small parr (year i +1) and y = black salmon catch (year i).

c. Egg deposition requirements

Randall and Chadwick (1983) calculated total egg deposition requirements for the Miramich River to be 115,828,800 eggs. Average numbers of spawners required to achieve this deposition was 13,400 salmon and 38,500 grilse.

d. Spawning escapement in 1984

Methods 1 and 2 indicated total salmon returns to the Miramichi of 9,794 and 3,715 fish, respectively:

| | Method 1 | <u>Method 2</u> |
|--|--------------|-----------------|
| Salmon | | |
| 1. Total returns | 9,794 309 | 3,715 |
| 2. Harvest 3. Popohing and disease | 1 000 | 1,000 |
| 4 Broodstock | 158 | 158 |
| 5. Spawning escapement | 8,327 | 2,248 |
| 6. Target spawners | 13,400 | 13,400 |
| % of target achieved | 62% | 17% |
| Grilse | | |
| 1. Total returns | 22,955 | 21,899 |
| 2. Harvest | 11,081 | . 11,081 |
| Poaching and disease | 4,000 | 4,000 |
| 4. Broodstock | 0 | 0 |
| 5. Spawning escapement | 7,874 | 6,818 |
| 6. Target spawners | 38,500 | 38,500 |
| % of target achieved | 20% | 18% |

There was a large discrepancy between both methods: Method 1 indicated 62% of target large salmon spawners were available, while Method 2 indicated only 17%. Both methods indicated grilse spawners in 1984 were substantially below requirements (80-82%). In terms of egg deposition (from both grilse and salmon), Method 1 indicated an egg deposition of about 52 x 10^6 eggs (45% of target); Method 2 indicated substantially less (about 17 x 10^6 eggs, 15% of target).

If the Millbank trap capture efficiency has decreased in recent years, as mentioned previously, both methods would underestimate returns in 1984.

e. Forecast of 1985 returns

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Numbers of salmon expected to return to the Miramichi River in 1985 were predicted from the following equation (Table 11):

 $log_e y = 4.8716 + 0.8587 log_e x_1 - 0.0435 arcsine \sqrt{x_2}$ $R^2 = 0.69 (P < 0.003)$ where y = returns of salmon (year i +1) x_1 = Millbank grilse catch (year i) x_2 = proportion female grilse (year i)

Salmon returns were predicted to be 18,435 (6,988-48,630) fish.

Average grilse returns for the past 5 years suggest 1985 returns could be about 42,000 fish. Grilse in 1985 will be from the 1981 and 1982 year-classes. Fry (1981 and 1982) and small parr (1982 and 1983) were average (Table 10).

DISCUSSION

Returns of large salmon to the Miramichi River in 1984 were extremely low. Total returns, based on the Millbank catch of salmon, were about 9,800 fish, which agrees well with the predicted returns of 9,700 salmon in the 1983 assessment (Randall and Schofield 1983). Critically low returns of spawners justified the severe restrictions on the harvest of Miramichi River salmon applied in 1984.

Despite low returns of salmon, however, a relatively larger proportion of fish potentially survived to spawning than in previous years because of the substantial reduction in homewater harvest. Percent of total returns (estimated using Millbank data) that survived to spawning in 1984 is compared to 1983 and 1982 below:

| | <u>1984</u> | <u>1983</u> | <u>1982</u> |
|--------------------|-------------|-------------|-------------|
| Total returns | 9,794 | 23,563 | 19,976 |
| Potential spawners | 8,327 | 2,380 | 6,162 |
| Percent survival | 85% | 10% | 31% |

Survival to spawning was thus substantially higher. Although homewater returns were 50% less in 1984, spawning escapement was 71% greater than in 1983. Despite this improved survival, however, egg deposition in 1984 was only 15 to 45% of required levels.

Spawning escapement as estimated by Method 1 was probably an overestimate. There was a large discrepancy between the two estimates of spawning escapement of large salmon. Part of this discrepancy can be explained by the methodology used in Method 2: the ratio of spawners to salmon counted at Millbank was calculated when large angling catches affected this ratio. Application of this ratio to 1984 data, when no angling occurred, would therefore underestimate spawning escapement. More importantly, however, Method 1 is an estimate of <u>potential</u> spawners, while Method 2 is an estimate of <u>actual</u> spawners. It is likely that the difference between the two estimates of egg deposition was due to losses in freshwater from illegal fisheries (poaching, unreported Native and angling catches). Average discrepancy between estimates of potential and actual egg deposition from 1971 to 1982 was 61% (Table 12). These results indicate unaccounted losses in freshwater are considerable, and Method 1's estimate of potential escapement was too optimistic.

The stock-recruitment relationship illustrated in Figure 1 verified that spawning levels have been low in the Miramichi in recent years. The relationship was linear and not asymptotic, indicating recruitment was below optimum. Elson (1967) suggests small parr densities of 24 per 100 m² are normal for the Miramichi; densities from 1969 to 1984 were substantially less than this.

Grilse returns in 1984 were still substantially below average. This indicates large salmon returns in 1985 will again be poor - our prediction is about 18,000 fish. Spawning requirements could be achieved if (i) restrictions to homewater and Newfoundland fisheries applied in 1984 stay in effect for 1985, and (ii) serious effort is made to reduce freshwater mortalities presently unaccounted for. In order to reverse the serious decline in Miramichi stocks in recent years, rearing areas need to be saturated with juveniles for several consecutive years. This can only be achieved if fishing mortality remains low and survival of spawners after reaching freshwater is increased.

Methods used in this assessment to estimate escapement in 1984 and forecast returns in 1985 rely on the Millbank trap as being a reliable index of salmon escapement into the Miramichi River. Possible changes in the trap catch efficiency in recent years, as mentioned previously, are going to be tested by a mark-recapture program during 1985.

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| Year | Mean_small parr | Eggs/ | Spawı | ners | Ratio of spawner |
|------|-----------------------------------|-------|--------|-----------------|-------------------|
| (i) | (No. m ⁻² ; year i +2) | fish | Salmon | Grilse | to Millbank count |
| | | | | | |
| 1971 | 0.018 | 1,395 | 1,052 | 5,175 | 2.64 |
| 1972 | 0.099 | 2,041 | 7,304 | 16,106 | 6.35 |
| 1973 | 0.146 | 2,316 | 9,614 | 20,810 | 8.49 |
| 1974 | 0.118 | 2,745 | 6,369 | 14,377 | 3.56 |
| 1975 | 0.100 | 2,466 | 4,971 | 14,600 | 4.12 |
| 1976 | 0.099 | 1,645 | 4,647 | 24,398 | 4.93 |
| 1977 | 0.073 | 4,233 | 4,678 | 3,645 | 2.42 |
| 1978 | 0.063 | 3,227 | 3,326 | 6,096 | 4.80 |
| 1979 | 0.093 | 1,490 | 3,404 | 26,719 | 10.70 |
| 1980 | 0.095 | 2,826 | 5,484 | 10 , 740 | 5.02 |
| 1981 | 0.105 | 1,016 | 4,190 | 45,687 | 21.06 |
| 1982 | 0.072 | 1,649 | 2,803 | 18,270 | 6.87 |
| Mean | | | | | 6.75 |
| S.D. | | | | | 5.10 |

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Table 1. Ratios of spawner to fish (1SW and MSW) counted at Millbank trap, 1971 to 1982. Biological characteristics used to calculate eggs/fish are given in Table 2.

| ====== | ========== | | | ======================================= | ======== | | ================== | ======================================= | ====== | ======== | ======== |
|--------|------------|-------------|-------------|---|----------|-------------|--------------------|---|--------|----------|----------|
| | | Salmon (2SW | and older) | | | Grilse (1S | | | | | |
| | Number | Mean | Mean | 0/ /0 | Number | Mean | Mean | 0/2 | | Per | cent |
| Year | caught | length (cm) | weight (kg) | Female | caught | length (cm) | weight (kg) | Female | Total | Salmon | Grilse |
| 1971 | 399 | 71.0(317) | 4.27(321) | 91.7(12) | 1,962 | 51.1(250) | 1.41(250) | 11.0(73) | 2.361 | 16.9 | 83.1 |
| 1972 | 1,151 | 71.3(521) | 4.05(520) | 72.9(137) | 2,543 | 52.0(686) | 1.56(682) | 22.0(268) | 3,694 | 31.2 | 68.8 |
| 1973 | 1,132 | 73.9(722) | 4.38(723) | 82.4(483) | 2,450 | 53.7(742) | 1.49(741) | 16.9(616) | 3,582 | 31.6 | 68.4 |
| 1974 | 1,791 | 74.4(666) | 4.71(666) | 84.9(332) | 4,038 | 52.5(1.390) | 1.57(1.391) | 30.2(603) | 5.829 | 30.7 | 69.3 |
| 1975 | 1,208 | 74.7(342) | 4.81(343) | 88.0(259) | 3,548 | 51.4(1.026) | 1.58(1.026) | 27.4(478) | 4,756 | 25.4 | 74.6 |
| 1976 | 943 | 75.1(197) | 4.50(101) | 87.1(132) | 4,939 | 51.9(988) | 1.51(435) | 24.1(435) | 5,882 | 16.0 | 84.0 |
| 1977 | 1,934 | 73.0(524) | 4.36(138) | 91.4(385) | 1,505 | 51.9(421) | 1.60(202) | 22.8(202) | 3,439 | 56.2 | 43.8 |
| 1978 | 693 | 74.6(291) | 4.78(138) | 85.9(192) | 1,268 | 51.6(387) | 1.57(128) | 37.4(174) | 1,961 | 35.3 | 64.7 |
| 1979 | 318 | 74.6(103) | 4.59(39) | 88.3(60) | 2,500 | 51.8(728) | 1,59(222) | 27.4(402) | 2,818 | 11.3 | 88.7 |
| 1980 | 1,093 | 73.9(335) | 4.55(114) | 90.3(217) | 2,139 | 52.0(593) | 1.67(166) | 19.3(290) | 3,232 | 33.8 | 66.2 |
| 1981 | 199 | 72.4(54) | 4.27(15) | 64.5(31) | 2,174 | 51.4(605) | 1,50(186) | 25,1(219) | 2,373 | 8.4 | 91.6 |
| 1982 | 408 | 75.9(43) | 4.61(43) | 86.1(43) | 2,665 | 52.7(321) | 1,59(321) | 29.5(207) | 3,073 | 13.3 | 86.7 |
| 1983 | 245 | 72.5(75) | 4.39(75) | 78.1(32) | 810 | 52.0(214) | 1.55(214) | 29.2(72) | 1,055 | 23.2 | 76.8 |
| 1984 | 333 | 72.0(95) | 4.36(95) | 74.1(58) | 1,010 | 51.9(238) | 1.55(238) | 21.7(115) | 1,343 | 24.8 | 75.2 |

Table 2. Mean length, weight and sex ratios of salmon and grilse captured at Millbank, 1971 to 1984. (Sample sizes in parentheses).

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| | Land | ings | Effort | | | | |
|--------------|----------|--------|--------|--------------------|--|--|--|
| Fishery | Salmon | Grilse | Nets | Maximum length (m) | | | |
| Red Bank | 108 | 147 | 12 | 12.2 | | | |
| Eel Ground | 200 | 233 | 18 | 33.6 | | | |
| Burnt Church | 1 | 1 | 5 | 45.8 | | | |
| | <u> </u> | | | | | | |
| TOTAL | 309 | 381 | | | | | |

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| Table 3. | Native | fishery | landings | in | the | Miramichi | River | and Bay, | 1984. |
|----------|--------|---------|----------|----|-----|-----------|-------|----------|-------|
|----------|--------|---------|----------|----|-----|-----------|-------|----------|-------|

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| | | Black Salmon | | | | | | Bright | Salmon | | | Total | | | | |
|-----------|-----|--------------|--------|-----|-------|-------|-----|--------|--------|--------|-------|--------|--------------|--------|--------|--|
| | Sal | .mon | Grilse | | Tot | Total | | Salmon | | ilse | Total | | | | Rod | |
| | No. | Kg. | No. | Kg. | No. | Kg. | No. | Kg. | No. | Kg. | No. | Kg. | No. | Kg. | Days | |
| April | 507 | 1,645 | 301 | 399 | 808 | 2.044 | | | | | | | 808 | 2,044 | 1,432 | |
| May | 264 | 926 | 343 | 439 | 607 | 1,365 | | | | | | | 607 | 1,365 | 2,385 | |
| June | | | | | | , | - | - | 304 | 438 | 304 | 438 | 304 | 438 | 3,347 | |
| July | | | | | | | - | - | 4,847 | 7,612 | 4,847 | 7,612 | 4,847 | 7,612 | 11,278 | |
| August | | | | | | | - | _ | 2,811 | 4,266 | 2,811 | 4,266 | 2,811 | 4,266 | 6,264 | |
| September | | | | | | | - | - | 1,780 | 2,898 | 1,780 | 2,898 | 1,780 | 2,898 | 7,250 | |
| October | | | | | | | - | - | 150 | 204 | 150 | 204 | ´ 150 | 204 | 450 | |
| Totals | 771 | 2,571 | 644 | 838 | 1,415 | 3,409 | - | - | 9,892 | 15,418 | 9,892 | 15,418 | 11,307 | 18,827 | 32,406 | |

Table 4. Recreational angling landings in the Miramichi River, 1984. Data from Department of Fisheries and Oceans.

Table 5. New Brunswick Department of Natural Resources (DNR) angling statistics and counts of grilse and salmon at Millbank, 1969 to 1984. Value in parentheses was estimated, as indicated in the footnote.

| | | | ================= | ======================== | ======================================= | =========== |
|------|-----------------------|--------|-------------------|--------------------------|---|-------------|
| | DN | IR | Mill | bank | Millba | nk/DNR |
| Year | Grilse | Salmon | Grilse | Salmon | Grilse | Salmon |
| 1969 | 24,284 | 3,804 | 4,350 | 667 | 0.18 | 0.18 |
| 1970 | 19,610 | 3,268 | 2,484 | 245 | 0.13 | 0.07 |
| 1971 | 13,727 | 1,792 | 1,962 | 399 | 0.14 | 0.22 |
| 1972 | 19,101 | 8,933 | 2,543 | 1,151 | 0.13 | 0.13 |
| 1973 | 13,857 | 5,977 | 2,450 | 1,132 | 0.18 | 0.19 |
| 1974 | 18,232 | 7,184 | 4,038 | 1,791 | 0.22 | 0.25 |
| 1975 | 15,598 | 6,288 | 3,548 | 1,208 | 0.23 | 0.19 |
| 1976 | 27,128 | 7,374 | 4,939 | 943 | 0.18 | 0.13 |
| 1977 | 13,590 | 11,617 | 1,505 | 1,934 | 0.11 | 0.17 |
| 1978 | 8,265 | 4,893 | 1,268 | 693 | 0.15 | 0.14 |
| 1979 | 14,508 | 2,656 | 2,500 | 318 | 0.17 | 0.12 |
| 1980 | 11,997 | 6,546 | 2,139 | 1,093 | 0.18 | 0.17 |
| 1981 | 22,716 | 3,238 | 2,174 | 199 | 0.10 | 0.06 |
| 1982 | 21,402 | 4,608 | 2,665 | 408 | 0.12 | 0.09 |
| 1983 | 8,390 | 2,240 | 810 | 245 | 0.10 | 0.11 |
| 1984 | (10,700) ^a | 0 | 1,010 | 333 | - | - |

^a 1984 DNR grilse catch estimated from correlation between Millbank grilse (x) and DNR grilse (y) from 1969 to 1983; y = 6868.54 + 3.79 x, r = 0.78, y (1984) = 10,700.

Table 6. Preliminary 1984 salmon landings in the Miramichi River by Native fishermen and anglers. Landings for 1983 (updates from Randall and Schofield [1983]) given for comparison. There was no commercial fishery in 1984.

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| =================== | | | ========================= | ======================================= | | ===== | |
|---------------------|----------|--------|---------------------------|---|--------|-------|--|
| | | 19 | 984 | 19 | 1983 | | |
| Fisher | y | Salmon | Grilse | Salmon — | Grilse | | |
| Commercial | trap | | _ | 2,133 | 1,217 | | |
| | drift | - | - | 14,455 | 295 | | |
| | by-catch | - | - | 467 | 76 | | |
| Native | | 309 | 381 | 171 | 357 | | |
| Angling | | - | 10,700 | 2,240 | 8,390 | | |
| | | | | | | | |
| | | 309 | 11,081 | 19,466 | 10,335 | | |

Table 7. Recorded catches of salmon in all fisheries, Miramichi River, 1951-84 (includes commercial, by-catch, recreational and Native). Kelts angled in year i are added to landings in year i-1. Commercial data for 1951 to 1969 are from May and Lear (1971) and assume salmon average 4.46 kg. Commercial 1970 to 1983 are from Redbooks*. (Redbook drift net landings are adjusted upwards by 1.5 (1982) and 2.48 (1983) as discussed by Randall and Schofield, 1983). Angling data are from Smith (1981) from 1951 to 1979; 1980 to 1983 are from Swetnam and O'Neill (1984). 1984 data are preliminary. All data are numbers x 10³.

| | | | | | | REC | REAT | IONA | A L | | | | | |
|------|--------------|----------------|-------|------|----------|--------|-----------|----------|-------|-------|--------|--------|-------|-------|
| | <u>C O I</u> | <u>M E R C</u> | IAL | K | elts (yr | · i+1) | <u></u> B | right (y | /r i) | | 1 | ATIVE | | GRAND |
| Year | Gr. | Sal. | Total | Gr. | Sal. | Total | Gr. | Sal. | Total | Total | Grilse | Salmon | Total | Total |
| 1951 | | 27.6 | 27.6 | | | 12.0 | | | 9.6 | 21.6 | | | | 49.2 |
| 1952 | | 27.3 | 27.3 | | | 11.3 | | | 15.9 | 27.2 | | | | 54.5 |
| 1953 | | 24.4 | 24.4 | | | 10.1 | - | | 18.2 | 28,3 | | | | 52.7 |
| 1954 | | 50.6 | 50.6 | | | 11.2 | | | 23.5 | 34.7 | | | | 85.3 |
| 1955 | | 15.3 | 15.3 | | | 8.9 | | | 14.7 | 23.6 | | | | 38.9 |
| 1956 | | 24.7 | 24.7 | | | 9.3 | | | 28.9 | 38.2 | | | | 62.9 |
| 1957 | | 29.9 | 29.9 | | | 8.4 | | | 19.5 | 27.9 | | | | 57.8 |
| 1958 | | 25.2 | 25.2 | | | 10.2 | | | 36.7 | 46.9 | | | | 72.1 |
| 1959 | | 37.3 | 37.3 | | | 9.5 | | | 10.3 | 19.8 | | | | 57.1 |
| 1960 | | 30.8 | 30.8 | | | 5.6 | | | 4.5 | 10.1 | | | | 40.9 |
| 1961 | | 30.0 | 30.0 | | | 9.5 | | | 11.0 | 20.5 | | | | 50.5 |
| 1962 | | 41.6 | 41.6 | | | 7.3 | | | 10.3 | 17.6 | | | | 59.2 |
| 1963 | | 40.7 | 40.7 | | | 5.2 | | | 50.9 | 56.1 | | | | 96.8 |
| 1964 | | 69.8 | 69.8 | | | 9,0 | | | 35.1 | 44.1 | | | | 113.9 |
| 1965 | | 69.5 | 69.5 | | | 16.0 | 38.7 | 3.9 | 42.6 | 58.6 | | | | 128.1 |
| 1966 | | 72.9 | 72.9 | | | 20.0 | 51.7 | 5.9 | 57.6 | 77.6 | | | | 150.5 |
| 1967 | | 102.2 | 102.2 | | | 14.1 | 41.8 | 4.1 | 45.9 | 60.0 | | | | 162.2 |
| 1968 | | 48.5 | 48.5 | | | 6.9 | 7.0 | 1.5 | 8.5 | 15.4 | | | | 63.9 |
| 1969 | | 41.3 | 41.3 | 4.2 | 1.9 | 6.1 | 26.7 | 2.8 | 29.5 | 35.6 | | | | 76.9 |
| 1970 | | 39.7 | 39.7 | 2.7 | 1.7 | 4.4 | 19.7 | 2.1 | 21.8 | 26.2 | | | | 65.9 |
| 1971 | | 18.3 | 18.3 | 1.5 | 0.8 | 2.3 | 8.5 | 1.2 | 9.7 | 12.0 | | | | 30.3 |
| 1972 | | 2.5 | 2.5 | 1.8 | 5.3 | 7.1 | 15.5 | 5.5 | 21.0 | 28.1 | | | | 30.6 |
| 1973 | | 0.9 | 0.9 | 2.4 | 5.7 | 8.1 | 9.0 | 4.9 | 13.9 | 22.0 | | | | 22.9 |
| 1974 | | 1.0 | 1.0 | 1.3 | 4.5 | 5.8 | 18.0 | 5.9 | 23.9 | 29.7 | | | | 30.7 |
| 1975 | 0.4 | 0.7 | 1.1 | 3.7 | 5.1 | 8.8 | 9.7 | 3.8 | 13.5 | 22.3 | 0.4 | 0.2 | 0.6 | 24.0 |
| 1976 | 1.8 | 0.9 | 2.7 | 10.1 | 11.5 | 21.6 | 14.7 | 5.3 | 20.0 | 41.6 | 0.2 | 0.2 | 0.4 | 44.7 |
| 1977 | 0.4 | 6.9 | 7.3 | 1.9 | 5.7 | 7.6 | 8.2 | 14.3 | 22.5 | 30.1 | 0.5 | 0.4 | 0.9 | 38.3 |
| 1978 | 1.2 | 8.4 | 9.6 | 1.2 | 7.4 | 8.6 | 5.4 | 4.2 | 9.6 | 18.2 | 0.4 | 0.4 | 0.8 | 28.6 |
| 1979 | 5.5 | 1.7 | 7.2 | 1.6 | 4.5 | 6.0 | 7.6 | 2.4 | 10.1 | 16.0 | 0.1 | 0.2 | 0.3 | 23.5 |
| 1980 | 2.7 | 10.9 | 13.6 | 2.3 | 6.6 | 8.9 | 7.5 | 5.4 | 12.9 | 21.8 | - | - | - | 35.4 |
| 1981 | 1.6 | 7.8 | 9.4 | 0.9 | 0.6 | 1.5 | 7.0 | 1.6 | 8.6 | 10.1 | 1.0 | 0.5 | 1.5 | 21.0 |
| 1982 | 2.3 | 12.5 | 14.8 | 1.3 | 1.4 | 2.7 | 9.2 | 2.6 | 11.8 | 14.5 | 0.7 | 0.4 | 1.1 | 30,4 |
| 1983 | 1.6 | 17.1 | 18.7 | 0.6 | 0.8 | 1.4 | 3.9 | 1.6 | 5,5 | 6.9 | 0.4 | 0.2 | 0.6 | 26.2 |
| 1984 | 0.0 | 0.0 | 0.0 | - | - | - | 9.9 | 0.0 | 9.9 | 9.9 | 0.4 | 0,3 | 0.7 | 10,6 |

*Atlantic salmon commercial and angling statistics compiled by Freshwater & Anadromous Division, Research Branch, Halifax, NS.

Table 8. Proportions of grilse and salmon returning early (May-August) and late (after 1 September) to the Miramichi River based on Millbank counts. Years are divided into groups where commercial fishing occured in Miramichi Bay (1981-1983) and when no commercial fishing occurred (1978-1980, 1984). ____

| | | | Proportion of Catch | | | | | | | |
|------|--------|--------|---------------------|------|--------|------|--|--|--|--|
| | Total | Catch | Gril | se | Salmon | | | | | |
| Year | Grilse | Salmon | Early | Late | Early | Late | | | | |
| 1978 | 1,268 | 693 | 0.91 | 0.09 | 0.77 | 0.23 | | | | |
| 1979 | 2,500 | 318 | 0.86 | 0.14 | 0.81 | 0.19 | | | | |
| 1980 | 2,139 | 1,093 | 0.84 | 0.16 | 0.77 | 0.23 | | | | |
| 1981 | 2,174 | 199 | 0.93 | 0.07 | 0.87 | 0.13 | | | | |
| 1982 | 2,665 | 408 | °0 . 97 | 0.03 | 0.96 | 0.04 | | | | |
| 1983 | 810 | 245 | 0.95 | 0.05 | 0.92 | 0.08 | | | | |
| 1984 | 1,010 | 333 | 0.87 | 0.13 | 0.77 | 0.23 | | | | |

Table 9. Numbers of salmon and grilse counted at barriers in two tributaries of the Miramichi River. 1981 to 1984

| Tributary | Year | Salmon | Grilse | Total |
|-----------------|------|--------|--------|-------|
| North Branch of | 1981 | 54 | 645 | 699 |
| S. W. Miramichi | 1982 | 288 | 615 | 903 |
| | 1983 | 223 | 284 | 507 |
| | 1984 | 297 | 228 | 525 |
| Dungarvon River | 1981 | 112 | 570 | 682 |
| 2 | 1982 | 113 | 450 | 563 |
| | 1983 | 126 | 325 | 451 |

93

1984

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315

408

| Year | n | | | |
|---------|----|-------|------------|------------|
| | | Fry | Small Parr | Large Parr |
| 1969 | 14 | 6,17 | 13.24 | 2.61 |
| 1970 | 50 | 12.52 | 3.15 | 4.72 |
| 1971 | 73 | 14.92 | 5.49 | 1.94 |
| 1972 | 72 | 5.24 | 4.75 | 2,19 |
| 1973 | 80 | 16.73 | 1.84 | 1.72 |
| 1974 | 98 | 22.43 | 9.86 | 2.17 |
| 1975 | 89 | 31.53 | 14.57 | 3.79 |
| 1976 | 80 | 22.29 | 11.76 | 3.37 |
| 1977 | 86 | 34.82 | 9.95 | 4.04 |
| 1978 | 87 | 23.53 | 9.86 | 2.90 |
| 1979 | 48 | 13.18 | 7.31 | 2.65 |
| 1980 | 46 | 20.01 | 6.29 | 3.02 |
| 1981 | 47 | 40.89 | 9.31 | 3.30 |
| 1982 | 85 | 11.02 | 9.54 | 2.70 |
| 1983 | 85 | 30.45 | 10,45 | 3.52 |
| 1984 | 85 | 17.30 | 7.20 | 1.96 |
| Optimum | | 28.80 | 24.00 | 14.00 |

Table 10. Juvenile Atlantic salmon densities in the Miramichi River, 1969 to 1984. Optimum densities are from Elson (1967).

Table 11. Total returns of large salmon to the Miramichi River and counts and sex ratio of grilse at Millbank in the previous year. Total returns (1971-1983) were calculated by Randall and Schofield (1983).

| Year (i) | Grilse (X ₁) | % Females (X ₂) | Salmon Returns (y) (year i + 1) |
|-------------|-----------------------------|--------------------------------|------------------------------------|
| | 1,962 | 11.0 | 36,298 |
| 1972 | 2,543 | 22.0 | 34,160 |
| 1973 | 2,450 | 16.9 | 53,639 |
| 1974 | 4,038 | 30.2 | 36,272 |
| 1975 | 3,548 | 27.4 | 28,613 |
| 1976 | 4,939 | 24.1 | 63,747 |
| 1977 | 1,505 | 22.8 | 28,759 |
| 1978 | 1,268 | 37.4 | 11,012 |
| 1979 | 2,500 | 27.4 | 43,046 |
| 1980 | 2,139 | 19.3 | 13,689 |
| 1981 | 2,174 | 25.1 | 24,511 |
| 1982 | 2,665 | 29.5 | 24,261 |
| 1983 | 810 | 29.2 | 9,794 |
| 1984 | 1,010 | 21.7 | [18,435] |

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Table 12. Potential and actual egg deposition in the Miramichi River, 1971 to 1982. Potential and actual egg depositions were calculated using Methods 1 and 2, respectively (see text).

| | | Egg Deposition | (x10 ⁶) |
|------|-----------|----------------|---------------------|
| Year | Potential | Actual | Percent Eggs Lost |
| 1971 | 50, 0 | 8.7 | 83 |
| 1972 | 119.6 | 47.8 | 60 |
| 1973 | 148.6 | 70.5 | 53 |
| 1974 | 313.0 | 56.9 | 82 |
| 1975 | 218.5 | 48.3 | 78 |
| 1976 | 164.5 | 47.8 | 71 |
| 1977 | 253.7 | 35.2 | 86 |
| 1978 | 97.5 | 30.4 | 69 |
| 1979 | 65.1 | 44.9 | 31 |
| 1980 | 161.7 | 45.8 | 72 |
| 1981 | 23.2 | 50.7 | 00 |
| 1982 | 66.8 | 34.7 | 48 |
| | | | Mean 61 |
| | | | SD 25 |



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Fig. 1. Stock-recruitment relationship for Atlantic salmon in the Miramichi River. Angled black salmon (year i) were used as an index of spawning stock, and small parr densities (year i+1; number per 100 m²) as an index of recruitment.